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Ageing is a contributing factor to excess weight in adult First Nations living on the reserves of British Columbia, Canada

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ABSTRACT: *Background:* Excess weight (EW) a public health problem in First Nations living on the reserves of British Columbia (BC). EW is a multifactorial condition involving biological, genetic, cultural and environmental and sociodemographic and lifestyle factors. We hypothesize that age is a risk factor of excess weight in that population. The objective of this study was to determine whether age is an important factor to be considered in interventions aiming to prevent or manage excess weight, specifically obesity.
Method: A cross-sectional study on data collected in 2008 and 2009 through a research study named "First Nations Food, Nutrition and Environment Study" (FNFNES), aiming to document the nutritional status and exposure to contaminants in Canadian First Nations communities living south of the 60th parallel. Three level's random sampling: province, communities and households. 493 women and 356 men aged 19 years and over were randomly selected from households in 20 communities. The statistical analysis software (SAS 9.1) was used to carry out univariate, bivariate and multivariate analysis.
Results: Association between excess weight and age was observed only in women. As compared to reference age group (19 – 30years), obesity was increased 2.2 times in the 31 to 50 years age category and 4.2 times in the 50 to 70 years category. Similar trend was observed for overweight which augmented 1.06 and 1.28 times respectively in the 31 to 50 years and 51 to 70 years categories. No association was observed in men.
Conclusions: EW was associated to age in the FN women. In men, although no significant association was seen between the two variables, the prevalence of EW increased with age in bivariate analysis. Policies aiming reduction of excess weight should be implemented in early life, in childhood, for a healthier and safer adulthood.

KEYWORDS: excess weight, overweight, obesity, age, sociodemographic factors, First Nations, British Columbia, Canada.

1 BACKGROUND

There is consistent evidence showing that the prevalence of excess weight is increasing all over the world [1]. The term « Excess weight » (EW) refers to overweight or pre-obesity [1,2] and to obesity, the first being a pathway to the latter. It's an excessive accumulation of fat due to a long term energy misbalance [2,3,4].

Consequences of higher prevalence of overweight and obesity are 1) medical through high morbidity and mortality (cardiovascular diseases, hypertension, diabetes, dyslipidemia, cancer etc. [5,6,7], 2) economic (high direct costs of management co-morbidities by health services, loss of productivity, absenteeism and premature death [8,9] and 3) psychosocial (anxiety, depression, low self-esteem) [10,11].

In Canada, the prevalence of excess weight is 59.1%, of which 23.1% can be ascribed to obesity and 36.0% to overweight [12]. According to some isolated studies, these proportions are higher in Canadian aboriginal populations [13,14], which justifies the present study, contributing trying to identifying the related factors.

Canadian Aboriginal group comprises FN, Inuit and Metis communities [15,16]. Although many of them have moved to urban areas for better life conditions such as education, employment and health care, a large majority is still living on the reserves [17]. As compared to other Canadians, the Aboriginal people encounter among other problems, lower life quality and lower life expectancy [15], more mental and physical diseases, higher risk of cardiovascular diseases [18], more excess weight and diabetes [19]. For this reason, the World Health Organization [20] has recommended to search for new strategies aiming to a better understanding of the health determinants in the aboriginal populations. Earlier, Receveur et al. [21] called for new initiatives in order to document the health status of Aboriginal populations and to prevent negative health consequences.

In BC, no regional study has been carried out to date regarding FN nutrition. However, isolated studies conducted in some communities evoked a higher prevalence of obesity in aboriginal populations than in the general Canadian population [22,13] and higher morbidity and mortality related to overweight and obesity [23,24]. This study aimed to describe the phenomena of excess weight among adult First Nations, aged 19 years and over, living on the reserves of BC.

Excess weight is a multifactorial condition involving biological, genetic, cultural and environmental factors [25,26,27,8]. Association has been evoked in general populations between obesity and food insecurity [28,29,30], obesity and diet quality [13,31,32,33]; also, sociodemographic factors have been shown to play a role in the development of obesity, including age, gender, education, employment, income and ethnicity [34,35,36,37].

Age has been linked to obesity in other studies; Laitinen et al. [38] suggested that age was a predictor of abdominal obesity and that weight gain after adolescence was a strong risk factor. Therefore, he recommended more assistance and counseling to adolescents and young adults, which could help lower the risk of obesity later in the life [39, 38].

In Canadian Arctic, such association was found in Inuit and Yukon in age categories ranging from 20 to 60 and more years old. BMI means and the percentages of obesity increased with age, but less in lower categories and much more in higher age categories [13].

Starkey et al. [40], investigating the nutritional status of recipients from urban food banks in the metropolitan region of Montreal in Canada, found that their mean energy intake was similar to other Canadian populations and was not associated to sociodemographic variables except age and gender, through biological variations; in addition, the mean BMI distribution in the participants was similar in the Canadian general population.

The potential role of fetal malnutrition in the development of excess weight in fetal life and early childhood is to be considered aggravating the problem of excess weight in the world [41]. Overnutrition during fetal life, with higher intakes of free fatty acids and glucose would contribute to obesity over life [42], as a result of fetal programming leading to irreversible modifications in energy metabolism and appetite control [42]. However, in a literature review, Skidmore et al. [43] suggested that obesity in adulthood is not necessarily a consequence of excess weight in childhood, rather energy misbalance all life, from birth to oldness.

Therefore, we think that age is an important sociodemographic factor to be investigated and considered for better targeting interventions aiming to prevent or treat excess weight; indeed, the costs of excess weight can be very high, therefore evidence identifying the most concerned age category to be targeted might be helpful.

Our study aims to determine whether aging is an important factor to be considered when planning interventions aiming excess weight management, specifically obesity. It's known that in western societies, younger age groups are showing higher prevalence of obesity, but this is mainly due to school diet quality as characterized by high consumption of sweet drinks, and less physical activity.

We hypothesize that age is a risk factor of excess weight in FN living on the reserves of BC, i.e. higher age categories are more exposed to excess weight, as physiologically the ratio fat/muscles is higher than in normal younger categories [44], they may not be able to maintain a balanced diet if there is no social support and 3) physical activity decreases with age.

2 METHODS

A cross-sectional survey conducted in the frame of the author's PhD theses (University of Montreal, 2013), on data collected in 2008 and 2009 through a research study named "First Nations Food, Nutrition and Environment Study" (FNFNES), aiming to document the nutritional status and exposure to contaminants in Canadian First Nations communities living south of the 60th parallel [45] . The survey included anthropometric data, dietetic and sociodemographic and lifestyle data.

This study focuses only on the BC region, especially on the FN group, which is the largest of the aboriginal population groups living on the reserves of BC [45].

2.1 SAMPLING

As performed by FNFNES [45]. Participants had to be aged 19 years and over, identity themselves as FN living in the reserve and provide a written consent [45]. A three level random sampling approach was used [45] due to budget constraints and the large geographic distribution of the population [45,46]; 21 communities were selected out of 198 FN communities in BC. From the housing lists of the selected communities 100 households were selected and in each household, one adult person, woman or man, was selected as a household representative. The initial sample was 1103 participants of which 705 were women and 390 were men.

2.2 DATA COLLECTION TOOLS

The questionnaire used in this study was related to the FNFNES project, as based on studies conducted in Canadian Aboriginal populations [45].

In order to calculate the body mass index (BMI), expressed as a ratio weight (in kg) / height^2 (in meters) [1,47], height was measured without shoes, using a stadiometer (precision 0.5cm). For weight, a scale (precision = 100gr) was used and participants were measured in light closing, without shoes. When participants did not accept to be measured, self-reported data of height and weight were used to calculate BMI [13,48]

Information regarding age was collected using a questionnaire as suggested for socioeconomic and lifestyle variables, especially those that might influence excess weight risk, including age [49]. Age was confirmed using identity documents such as driving license, medical insurance card, student cards or hospital cards. Participants were defined as adults when they were aged 19 years and over.

2.3 VARIABLES AND INDICATORS

Excess weight was estimated by the body mass index (BMI), as well as for the sub-variables, overweight or obesity [2,3]. Participants were defined as normal, overweight or obese respectively, when BMI was between 18.5 and 24.9, 25.0 and 29.9, and 30.0 and over, respectively. The obesity group comprised 3 sub-classes: classe I (30.0≤IMC≤34.9), classe II (35.0≤IMC≤39.9) and classe III (≥40.0) [1] respectively, as correlated with “moderate”, “important” and “very important risk” of associated morbidity [50,1]

2.4 STATISTICAL METHODS

The collected data were encoded using Epi-info software, version 3.4.3. For data analysis, we used the Statistical Analysis Software (SAS), version 9.1.

2.5 DATA ANALYSIS

All analyses were stratified by gender as evidence shows that women and men report differently their BMI [51,52] and their feeding habits [53,54]. All participants missing one or more anthropometric data (weight or height), age, or had a BMI less than 18.5 were excluded [55] along with pregnant and lactating women due specific conditions [13,56]

Due to small effective numbers in some categories, the three obesity sub-categories (30.0 ≤ BMI≤ 34.9, 35.0 ≤ BMI≤ 39.9 and BMI ≥ 40.0) were grouped into one BMI group, i.e. equal or greater than 30kg/m^2 [57,55,33].

Regarding age, four categories were created according to the life physiologic steps: young adults (19-30years), mean aged adults (31-50years), adults aged 51 to 70years and adults over 70 [32]. However, the latter were excluded from analysis due to small numbers. Table 1 in the annex rubric shows the variable categories and thresholds.

Table 1. Variable characteristics and thresholds

Variable	Categories	Tresholds
Excess weight (BMI) (WHO, 2003)	Normal	18.5 ≤ BMI ≤ 24.9
	Overweight	25.0 ≤ BMI≤ 29.9
	Obese	BMI ≥ 30.0
Age (years)	19 – 30	-
(Otten et al., 2006)	31 - 50	-
	51 - 70	-

For data analysis, two steps as described here after were followed:

Step 1: Univariate and bivariate analysis

During this descriptive analysis step, preliminary signification tests were performed separately in women and men; the three level of excess weight (dependent variable) were crossed with the three age groups (independent variable) using the Pearson's Chi-square as the independent variable was categorical [58,59]. The p values generated allowed to identify bivariate associations at p = 0.05 threshold [60,61].

Step 2: Significant variables were included in multivariate analysis (logistic regression model), with excess weight being as dependent variable and age as independent variable. Significant odd ratios were used to predict associations between variables [62]. The odd ratios are presented along with confidence intervals at 95%, reference categories being attributed value 1 [63].

3 RESULTS

The results of our research are presented in tables in the following chapter, separately for women and men [64].

3.1 RESULTS FROM UNIVARIATE AND BIVARIATE ANALYSIS

Table 2 shows the sample characteristics of the population, including numbers of participants, gender and age categories. A total of 849 adults participants joined the study, among which 493 women (58.1%) and 356 men (41.9%).

Table 2. Description of the study sample

Age (years)	Women (n = 493)	Men (n = 356)	Total (n = 849)
	n (%)		
19-30	83 (16.8)	62 (17.4)	145 (17.1)
31-50	264 (53.5)	162 (45.5)	426 (50.2)
51-70	146 (29.6)	132 (37.1)	278 (32.7)
Mean ± ET	43.4 ± 12.6	45.1 ± 13.2	44.3±12.9

Overall, the majority of the participants ranged from 31 to 50 years old. In women, mean age was 43.4 (±12.6) years, with 16.8% of respondents ranging from 19 to 30 years old, 53.5% from 31 to 50 years, and 29.6% from 51 to 70 years. In men, the mean age was 45.1 (±13.2) years, with 17.4% of respondents ranging from 19 to 30 years old, 45.5% from 31 to 50 years, and 37.1% from 51 to 70 years.

Table 3 shows the distribution of BMI variable and sub-variables among both female and male participants. Overall, the mean BMI was 29±6.3 kg/m^2 ; only few of them had a normal BMI (23.4%) while the majority was of excess weight (76.6%), being either overweight (35.7%) or obese (40.9%).

Table 3. Distribution of excess weight (BMI) among adult women and men

Variable	Sub-variables	Women (n=493)	Men (n=356)	Total n = 849
		n (%)		
BMI	Normal	116 (23.6)	83 (23.3)	199 (23.4)
	Overweight	156 (31.6)	147 (41.3)	303 (35.7)
	Obesity	221 (44.8)	126 (35.4)	347 (40.9)
	Excess weight (overweight + obesity)	377 (76.4)	273 (76.7)	651 (76.6)
	Mean±ET	30.0±6.7	28.9±5.8	29±6.3

This trend was also observed within the two genders separately; in women, the mean BMI of the sample was 30.0 (±6.7)kg/m^2; only 23.5% had a normal BMI versus 31.6% overweight and 44.8% obese, which is a global prevalence of 76.4% (31.6% + 44.8%) of excess weight. In men, the mean BMI was 28.9 (±5.8); for women, a similar trend was observed: only 23.3% had a normal BMI versus 41.3% overweight and 35.4% obese, that is a global prevalence of 76.7% (41.3% + 35.4%) of excess weight.

Table 4 confronts the prevalence of excess weight for both adults FN women and men on the reserves of BC with to prevalence data from previous researches aiming the Canadian general population where excess weight was already described as public health problem. It appears that the prevalence of excess weight was higher in FN than in overall Canadian women and men. This was also the case for the sub-variables of excess weight, especially obesity as the proportions were almost doubled in women and more than 12% higher in men.

Table 4. Prevalence of excess weight in FN women and men versus overall Canadian women and men

Variable	Sub-variables	Prevalence			
		Women		Men	
		First Nations	Canada*	First Nations	Canada*
Excess weight	Overweight	31.6	30.2	41.3	42.2
	Obesity	44.8	23.2	35.4	22.9
	Excess weight	76.4	53.4	76.7	65.1
	Normal	23.6	46.6	23.3	34,9

** From Ford and Mokdad [32]*

Table 5 shows that in women, age seems to be associated excess weight (BMI) ($p<0.001$) in bivariate analysis. This result suggests that among women, those with excess weight seemed to be older than then women with normal weight. These variables will then be submitted to multivariate analysis.

Table 5. Body mass index and age in women

		BODY MASS INDEX			
		Normal (n = 116)	Overweight (n = 156)	Obesity (n = 221)	
	n	Percentages			p
Age (years)					<0,001
19-30	83	23.3	19.2	11.8	
31-50	264	55.2	54.5	52.0	
51-70	146	21.6	26.3	36.1	
Mean ± ET		41.5 ± 12.3	42.7 ± 12.4	44.8 ± 12.4	

Table 6 shows that age was not associated to excess weight in this study ($p = 0.78$). Therefore, the variables were not considered in multivariate analysis. However, it appears from this table that the prevalence of excess weight was increasing with age in the older age categories, compared to the younger age category.

Table 6. Body mass index and age in men

	n	BODY MASS INDEX			p
		Normal n = (116)	Overweight (n = 156)	Obesity (n = 221)	
		Percentages			
Age (years)					0.78
19-30	62	20.5	18.4	14.3	
31-50	162	45.8	44.9	46.0	
51-70	132	33.7	36.7	39.7	
Mean ± ET		43±13.0	45±13.0	46±13.0	

3.2 RESULTS FROM MULTIVARIATE ANALYSIS

Table 7 shows the risk of overweight and obesity varies as a function of age in women, the lowest age category (19-30 years) being taken as a reference. The risk of excess weight increases 1.06 times (CI at 95% : 0.53-2.10) and 2.22 times (CI at 95%: 1.10-4.51) respectively for overweight and obesity in the 31 to 50 years category; in the higher age category (51 – 70 years), the risk of excess weight increases 1.28 times (CI at 95%: 0.57-2.89) and 4.17 times(CI at 95%: 1.84-9.49) for overweight and obesity respectively, as compared to the reference.

Table 7. Risk of overweight/obesity and age in women

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		Overweight (25.0≤BMI≤29.9) n = 156 (Ref: normal, n= 116)	**Obesity** (BMI≥30.0) n = 221 (Ref: normal, n= 116)
	n	**OR (95% CI)**	
Age (years)			
19-30	83	1.00	1.00
31-50	264	1.06 (0.53-2.10)	2.22 (1.10-4.51)
51-70	146	1.28 (0.57-2.89)	4.17 (1.84-9.49)

4 DISCUSSION

Our study aimed to investigate the relationship between excess weight as dependent variable, and age as independent variable, in FN living on the reserves of British Columbia, in Canada, separately for women and men. This study confirms that EW was a real health problem in women and men FN living on the reserves of BC. Indeed, compared to the general Canadian population, they have higher prevalence of excess weight (Tables 3, 4).

In women, age was associated with EW as risk factor in this study (table 7); as compared to the lowest and reference age group (19 – 30years) obesity phenomenon was increased 2.2 times in the 31 to 50 years age category and 4.2 times in the 50 to 70 years category. Similar trend was observed for overweight which augmented 1.06 and 1.28 times respectively in the 31 to 50 years and 51 to 70 years categories. The trend remained unchanged even when other risk factors were added to the logistic model along with age, which indicates the strength of the association.

Looking also at results from bivariate analysis (table 5) as carried out for women, a significant association was observed between EW and age (p**<0,001**); the prevalence of EW was lower in the lowest age category (19 – 30 years), i.e. 19.2% and 11.8% respectively for OW and OB; it was higher in the 31 to 50years category (54.5% and 52% respectively for OW and OB); the prevalence dropped in the higher age category (51 to 70years) but remained higher than in the younger age category (26.3% et 36.1% respectively, for OW and OB).

Regarding men, no logic model could be drawn as there was no significant association observed between BMI and age in bivariate analysis (p=0.78) (table 6); therefore the variables could not be included in a logistic model for more investigation of the eventual link between excess weight and age. However, considering the prevalence data over the category groups, similar trend was observed in men like for women. The prevalence of EW was lower in the 19 – 30 year category (18.4% and 14.3% respectively for OW and OB); it was higher in the 31 to 50year category (44.9% and 46.0% respectively for OW and OB); the prevalence dropped in the higher age category (51 to 70years) but remained higher than in the younger age category (36.7% et 39.7% respectively, for OW and OB).

Age has been associated to EW in diverse studies. Although they used a different age classification, Mokdad et al.[65] observed similar trend for obesity in American women aged 20 to 69 years who participated in the Behavioral Risk Factors Surveillance System in 2001. In that national study, obesity augmented progressively over age categories, moving from 14.0% in the lower category (18-29years) to 26.1% in the 50 to 59 years category before dropping 25.3% from 60 years and 17.1% from 70 years, but still remaining higher in than the younger age category as observed in our study. Using both simple logistic models adjusted only for age and fully adjusted models, the study suggested that age was a risk factor of obesity, with a dose-response effect.

Our results are also similar to those found in the Canadian Arctic by Kuhnlein et al. [13] on Inuit and Yukon women. In that research, the mean BMI and the proportions of obesity increased with age; they were relatively lower in younger age categories from 20 to 40 years, augmented in the 41 to 60 years category and – this was different from our study - they continued to augment after 60 years. The difference was probably due to differences in age categorization.

This study is in accordance with Torrance et al. [66], a study conducted on Canadian women who participated in the Canadian Heart Health Survey between 1986 et 1992; they showed that obesity increased with age, from 10.6% between 20 and 44 years to 22.9% between 45 and 69years. A similar trend was observed in women who participated in two other Canadian national health studies, namely the Nutrition Canada Survey between 1970 and 1972, and the Canadian Health Survey between 1978 and 1979 [66].

Still in Canada, Tremblay et al. [37] have also observed an augmentation of the prevalence of EW and obesity with age in both aboriginal women living out-reserves and non-aboriginal women. Same results were found by Kuhnlein et al. [13] who

showed that BMI increased with age in the Canadian Arctic. Moreover, Laitinen et al. [38] observed in their study that weight gain in adolescence was strongly associated with abdominal obesity, therefore they suggested that age was a predictor of abdominal obesity.

5 CONCLUSION

This study confirms that EW is a real health problem in women and men FN living on the reserves of BC. Indeed, compared to the general Canadian population, they have higher prevalence of excess weight, especially for obesity. Both sexes are concerned by the problem but when investigating the relationship between Excess weight and age; an association was found only in women, in both bivariate and multivariate analysis. In men, no association was seen, even in bivariate analysis. We recommend more investigations such as longitudinal studies, to be carried out on bigger samples in order to clarify whether age is not a contributing factor for excess weight in men, and to confirm the findings in women.

However, considering the heavy health and socioeconomic consequences of EW, high prevalence of EW calls for measures and interventions from authorities and other stakeholders, aiming both prevention and treatment. Strategies should combine dietetic and physical exercice approaches, and be applied starting younger ages, in order to prepare a healthier and safer adulthood. Ethically, men should be included in the strategies until the lack of association is proved.

Moreover, the management of excess weight is very costly [24]; therefore, we think that focusing programs on more risky age groups instead of tackling all groups together at the same time would allow for more performance through fewer expenses, better targeting and better coverage.

WHAT IS ALREADY KNOW ON THIS TOPIC

Include maximum of 03 points of what is already known on this topic (in bullet points)

- Excess weight is associated with diet quality

WHAT THIS STUDY ADDS

Include maximum of 03 points of what your study adds (in bullet points)

- Age is an important factor to be considered when planning interventions aiming to reduce the prevalence of excess weight.

COMPETING INTERESTS

The authors declare no competing interest.

AUTHORS' CONTRIBUTIONS

The author Victor Buhendwa Mirindi performed the data analysis and wrote-up the full manuscript.

The co-author Kalum Muray contributed to writing-up the manuscript.

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