Association between sleep and overweight/obesity among women of childbearing age in Canada

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Abstract

Objectives Tests of the relationship between sleep and overweight/obesity (OW/OB) among women have been inconsistent. Few studies reporting such associations have focused on women of childbearing age. This paper investigates this association among Canadian women of childbearing age.

Methods Data were from the Canadian Community Health Survey 2011–2014. The sample consisted of women aged 18–44 years. All variables were self-reported. Sleep duration was dichotomized as insufficient (< 7 h/night) or adequate ($\geq$ 7 h/night). A composite score of sleep quality was used and dichotomized as poor none/little of the time or some/most/all of the time. Height and weight were used to calculate body mass index. Associations between sleep and OW/OB were assessed using logistic regression analyses with survey weights. Three models were computed for sleep duration/quality: model without covariates, model adjusted for demographics (age, ethnicity, level of education, household income, marital status, employment, parity, region, and season), and model adjusted for demographics and variables associated with OW/OB (mood disorder, fruit and vegetable intake, physical activity, smoking, and alcohol).

Results Total sample consisted of 9749 women of childbearing age. Thirty-eight percent had insufficient sleep duration. Sleep duration was significantly associated with OW/OB in the model with no covariates and discriminated 52.8% of women of childbearing age, but this association was no longer significant in the models adjusted for covariates. Sleep quality was not significantly linked to OW/OB in any of the models.

Conclusion Targeting sleep alone would likely not contribute to lower risk of OW/OB among Canadian women of childbearing age. Additional studies, especially longitudinal ones, are needed to confirm these findings.

Résumé

Objectifs Les résultats des études sur l'association entre le sommeil et le surpoids/obésité (SP/OB) chez les femmes sont contradictoires. Peu d'études rapportant une telle association se sont concentrées sur les femmes en âge de procréer. Cette étude examine cette association chez des femmes en âge de procréer canadiennes.

Méthodologie Les données provenaient de l'Enquête sur la santé dans les collectivités canadiennes 2011–2014. L'échantillon était composé de femmes âgées de 18 à 44 ans. Toutes les variables étaient autodéclarées. La durée du sommeil était dichotomisée comme insuffisante (< 7 heures/nuit) ou adéquate ($\geq$ 7 heures/nuit). Un score composite de la qualité du sommeil a été utilisé et dichotomisé comme étant faible jamais/rarement ou parfois/la plupart du temps/tout le temps. La taille et le poids ont été utilisés pour calculer l'indice de masse corporel. L'association entre le sommeil et le SP/OB a été examinée à l'aide d'analyses de régression logistique avec des poids d'échantillonnage. Trois modèles ont été calculés pour la durée/qualité du sommeil: un modèle sans covariables, un modèle ajusté pour les données démographiques (âge, ethnie, niveau d'éducation, revenu du ménage, état matrimonial, statut d'emploi, parité, région et saison) et un modèle ajusté pour les données démographiques et les variables associées au SP/OB (trouble de l'humeur, consommation de fruits et légumes, activité physique, tabagisme et consommation d'alcool).

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Résultats L'échantillon total était composé de 9749 femmes en âge de procréer. Trente-huit pourcent d'entre-elles avaient une durée du sommeil insuffisante. La durée du sommeil était significativement associée au SP/OB dans le modèle sans covariables et permettait de discriminer 52,8 % des femmes en âge de procréer, mais cette association n'était plus significative dans les modèles ajustés pour les covariables. La qualité du sommeil n'était pas significativement liée au SP/OB dans aucun des modèles.

Conclusion Cibler uniquement le sommeil risque peu de contribuer à diminuer le risque de SP/OB chez les femmes en âge de procréer canadiennes. Des études supplémentaires, en particulier avec des devis longitudinaux, sont nécessaires afin de confirmer ces résultats.

Keywords Sleep · Overweight · Obesity · Body mass index · Women · Canada

Mots-clés Sommeil · Surpoids · Obésité · Indice de masse corporel · Femmes · Canada

Introduction

Associations have been reported between sleep and multiple health outcomes, including overweight/obesity (OW/OB) in adults (Itani et al. 2017; Magee and Hale 2012; Nielsen et al. 2011; Wu et al. 2014; Fatima et al. 2016). The majority of studies focused on sleep duration (Itani et al. 2017; Magee and Hale 2012; Nielsen et al. 2011; Wu et al. 2014), although sleep quality has also impacted risk of OW/OB (Fatima et al. 2016; Rahe et al. 2015). The United States (US) National Sleep Foundation recommends between 7 and 9 h of sleep among adults aged from 18 to 64 years (Hirshkowitz et al. 2015). Canada recently developed its own sleep duration recommendations, but only for children and youth aged 5 to 17 years (Tremblay et al. 2016). Short sleep, usually defined as sleep durations below national recommendations, may contribute to OW/OB among adults (Itani et al. 2017; Magee and Hale 2012; Nielsen et al. 2011; Wu et al. 2014).

Some more recent studies have tested the association between sleep quality and OW/OB. While there is no consensus on how best to measure sleep quality, one of the more common tools has been the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al. 1989). The PSQI includes seven components of sleep quality: overall quality, latency (i.e., the time it takes to fall asleep at night), duration, efficiency (i.e., a proportion of the time asleep over the time spent in bed), disturbances (i.e., the number of awakenings at night), use of sleeping medication, and daytime dysfunction (i.e., having trouble staying awake and getting things done during the day) (Buysse et al. 1989). Studies of poor sleep quality, whether measured using the PSQI or not, have indicated that it may be a risk factor for OW/OB among adults (Fatima et al. 2016; Rahe et al. 2015).

Women have been more at risk for short (Grandner et al. 2015) and poor sleep quality (Nugent and Black 2016; Mehta et al. 2015) compared to men as their sleep can be impacted by hormonal factors, such as menstrual cycle, pregnancy, and menopause (Mehta et al. 2015) and by socio-demographic factors, such as marital status, employment, and parity (Grandner et al. 2015). It is therefore surprising that only a

few studies have specifically focused on women when examining the association between sleep and OW/OB.

Three studies (two cross-sectional and one longitudinal) found significant associations between short sleep and obesity among population-based samples of Swedish women when controlling for age, marital status, employment, psychological distress, medication, physical activity, smoking, and alcohol consumption. The first study included 400 women aged 20 to 70 years (Theorell-Haglow et al. 2010). Sleep duration was measured using one night of polysomnography and waist circumference (WC) was measured by a nurse. Sleep duration was significantly associated with WC ($\beta = -1.24$, $p = 0.016$) (Theorell-Haglow et al. 2010). The second study reported baseline data of a cohort study and included 6461 women aged ≥ 20 years (Theorell-Haglow et al. 2012). Sleep duration and WC were self-reported. Sleep duration was significantly associated with WC ($\beta = -2.81$, $p = 0.002$), and when women were divided into two groups based on their age (i.e., < 50 versus ≥ 50 years old), the association between short sleep (< 6 h/night) and $WC \geq 88$ cm was only significant among women < 50 years old (odds ratio [OR] = 1.83, 95% confidence interval [CI] 1.43–2.34) (Theorell-Haglow et al. 2012). The third study reported the results at 10 years for the cohort study and included 4903 women (Theorell-Haglow et al. 2014). Sleep duration, height, weight, and WC were self-reported. Short sleep was only associated with BMI ≥ 30 kg/m² at the 10-year follow-up (OR = 1.71, 95% CI 1.01–2.87) (Theorell-Haglow et al. 2014).

A cross-sectional study did *not* find a significant association between sleep duration and adiposity but reported a significant association with poor sleep quality among 330 US women aged 17 to 26 years (Bailey et al. 2014). Sleep duration and quality were measured by 7 days of actigraphy, and height, weight, and percent body fat were measured by staff. Sleep quality was defined in terms of sleep efficiency, which is the amount of time participants were asleep over the amount of time they were in bed. Sleep duration was *not* significantly linked to BMI nor percent body fat, while sleep efficiency was significantly linked to BMI ($\beta = -0.20$, $p = 0.0003$) and

percent body fat ($\beta = -0.20$, $p = 0.0003$) when controlling for age, season, and physical activity (Bailey et al. 2014). Another cross-sectional study found that sleep quality was *not* significantly linked to OW/OB among 927 US women aged 16 to 40 years of lower socio-economic status (SES) (Tom and Berenson 2013). Sleep quality was measured by the PSQI, and height, weight, and WC were measured during clinic visits. Sleep quality was not significantly associated with being overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$ and $< 30 \text{ kg/m}^2$) or obese ($\text{BMI} \geq 30 \text{ kg/m}^2$) nor with $\text{WC} \geq 88 \text{ cm}$ when controlling for age, race/ethnicity, perceived stress, and depressive symptoms (Tom and Berenson 2013). In sum, the results of the few studies conducted exclusively among women have been conflicting.

Even fewer studies have focused on women of childbearing age. A cross-sectional study among 3607 US women of childbearing age (15 to 44 years) using data from the National Health and Nutrition Examination Survey (NHANES), years 2005–2010, indicated that they reported more frequently having poor sleep compared to pregnant women of the same age range (Amyx et al. 2017). Another cross-sectional study among 927 US women of childbearing age (16 to 40 years) of lower SES reported that poor sleep measured by the PSQI was not related to OW/OB (Tom and Berenson 2013). Thus, it is unclear whether sleep duration and sleep quality are related to OW/OB among women of childbearing age.

The mechanisms responsible for the links between sleep and OW/OB are not fully known. Short sleep can disrupt hormones regulating appetite (i.e., ghrelin) and satiety (i.e., leptin), which would result in increased food intake (St-Onge 2013; Lundahl and Nelson 2015) and eventually, OW/OB. Short sleep also may impair executive functioning and judgement, resulting in increased impulsivity when making decisions regarding food choices and heighten chances of picking unhealthy food, such as fast food (Lundahl and Nelson 2015). To our knowledge, no study has investigated the association between sleep and OW/OB among women of childbearing age in Canada using data from the Canadian Community Health Survey (CCHS). We hypothesize that adequate sleep duration and better sleep quality will be associated with lower odds of OW/OB measured by BMI. This

information can be useful to determine whether sleep should be targeted in interventions aimed at preventing OW/OB among Canadian women of childbearing age.

Methods

Data source and population

Data were from the CCHS, years 2011–2014. Microdata from the CCHS annual component for 2011 (12 month file), 2012 (12 month file), and 2013–2014 (24 month combined file) were used and accessed via the Quebec inter-University Centre for Social Statistics at Laval University. The CCHS is a repeated cross-sectional annual health survey that collects information on a nationally representative sample of non-institutionalized civilian Canadians aged 12 years and older (Statistics Canada 2014). The CCHS has three components: (1) core content asked of all respondents, (2) optional content chosen by health regions, and (3) rapid response modules asked of all respondents living in the ten provinces for one data collection period (Statistics Canada 2014). Questions on sleep were part of the optional content and therefore not asked of participants from all provinces or territories of Canada. The years 2011–2014 are the most recent CCHS data available and were chosen because they contained information on sleep duration, sleep quality, and BMI. The CCHS, years 2011–2014, contained information on sleep for the following seven provinces and territories of Canada: Prince Edward Island, Nova Scotia, Quebec, Manitoba, Alberta, Yukon, and the Northwest Territories (see Table 1). Only the province of Manitoba had sleep data for all 4 years, and only the province of Alberta had sleep data on 3 out of 4 years (2011, 2012 and 2014). The other provinces and territories of Canada had data for 2 out of 4 years. Questions on height and weight (to calculate BMI) were part of the core content and thus asked of all respondents. More detailed information on the CCHS can be found on Statistics Canada's website (Statistics Canada 2014).

The population under study consisted of women of childbearing age (18 to 44 years), as defined by the Centers for Disease Control and Prevention (Centers for Disease Control

Table 1 Canadian provinces with sleep data in the Canadian Community Health Survey, years 2011–2014

Years	Provinces of Canada												
	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC	YT	NT	NU
2011			✓		✓		✓		✓		✓	✓	
2012			✓		✓		✓		✓		✓		
2013		✓					✓						
2014		✓					✓		✓			✓	

NL Newfoundland and Labrador, PE Prince Edward Island, NS Nova Scotia, NB New Brunswick, QC Quebec, ON Ontario, MB Manitoba, SK Saskatchewan, AB Alberta, BC British Columbia, YT Yukon, NT Northwest Territories, NU Nunavut

and Prevention 2015). Pregnant women and those for whom it was not possible to ascertain whether they were pregnant or not were excluded from the analyses.

Variables

All variables related to sleep were self-reported by participants. Sleep duration was measured using the following item “How long do you usually spend sleeping each night?” Possible responses were as follows: (1) under 2 h, (2) 2 h to less than 3 h, (3) 3 h to less than 4 h, (4) 4 h to less than 5 h, (5) 5 h to less than 6 h, (6) 6 h to less than 7 h, (7) 7 h to less than 8 h, (8) 8 h to less than 9 h, (9) 9 h to less than 10 h, (10) 10 h to less than 11 h, (11) 11 h to less than 12 h, and (12) 12 h or more. Sleep quality was measured with the following three items: “How often do you have trouble going or staying asleep?”; “How often do you find your sleep refreshing?”; and “How often do you find it difficult to stay awake when you want to?” (Cronbach’s alpha 0.48). Possible answers were as follows: (1) none of the time, (2) a little of the time, (3) some of the time, (4) most of the time, and (5) all of the time. The first item measured sleep latency (the time for falling asleep at night or having trouble falling asleep) and sleep disturbances (awakenings at night or having trouble staying asleep) and the third item measured daytime dysfunction (trouble staying awake and getting things done) according to the PSQI (Buysse et al. 1989). A composite score of sleep quality was created by summing the answers to the three items. A higher score (range 3 to 15) indicated poorer sleep quality.

Height (in feet and inches or cm) and weight (in pounds or kg) were self-reported by participants. They were converted into kilograms and metres to calculate BMI. BMI ≥ 25 kg/m² was considered OW/OB (NHLBI Obesity Education Initiative Expert Panel 1998). The following demographic and socioeconomic information were used to describe the sample and/or to be included as covariates in the statistical analyses: age, ethnicity, level of education, household income, marital status, employment, parity, region, and season.

The following variables were included as covariates in the statistical analyses, since there is evidence that they are related to OW/OB: mood disorders (Mannan et al. 2016), fruit and vegetable intake (Schwingshackl et al. 2015), physical activity (Chin et al. 2016), smoking (Tuovinen et al. 2016), and alcohol consumption (Traversy and Chaput 2015). The presence of a mood disorder was measured with the following item: “We are interested in conditions diagnosed by a health professional and [that] are expected to last or have already lasted 6 months or more. Do you have a mood disorder such as depression, bipolar disorder, mania or dysthymia?” (yes/no). Fruit and vegetable consumption was measured with the following six items: (1) “How often do you usually drink fruit juices such as orange, grapefruit or tomato?”; (2) “Not

Table 2 Total weighted sample characteristics (*N* = 9749)

Variables	Mean or % (standard error)
Age (years)	31.1 (0.2)
Ethnicity (%)	
• Non-Hispanic white	80.8 (0.9)
• Asian	9.5 (0.7)
• Black	3.4 (0.3)
• Latin American	2.5 (0.4)
• Arab	2.8 (0.4)
• Other	1.0 (0.2)
Level of education (%)	
• Less than high school diploma	7.2 (0.5)
• High school diploma	15.3 (0.7)
• Some post-secondary studies	9.0 (0.5)
• Post-secondary certificate/diploma or university degree	68.5 (0.9)
Household income (CAD\$)	\$78,650 (\$1037)
Marital status (%)	
• Married/living common-law	56.1 (0.9)
• Single, never married	37.9 (0.9)
• Widowed/separated/divorced	6.0 (0.5)
Employment status (%)	
• Unemployed	21.2 (0.7)
• Part-time (< 30 h/week)	20.0 (0.8)
• Full-time (≥ 30 h/week)	58.8 (0.9)
Number of children	0.9 (0.0)
Region of Canada (%)	
• Quebec	52.5 (0.9)
• Prairies (MB, AB)	40.3 (0.9)
• Maritimes (PE, NS)	6.8 (0.4)
• Northern Canada (YT, NT)	0.4 (0.0)
Season interviewed (%)	
• Winter	21.7 (0.7)
• Spring	26.5 (0.8)
• Summer	25.4 (0.9)
• Fall	26.4 (0.8)
Sleep duration (%)	
• < 4 h/night	0.9 (0.1)
• ≥ 4 h/night and < 5 h/night	3.2 (0.3)
• ≥ 5 h/night and < 6 h/night	9.9 (0.5)
• ≥ 6 h/night and < 7 h/night	24.0 (0.9)
• ≥ 7 h/night and < 8 h/night	32.6 (0.9)
• ≥ 8 h/night and < 9 h/night	23.1 (0.8)
• ≥ 9 h/night and < 10 h/night	4.3 (0.4)
• ≥ 10 h/night	2.0 (0.2)
Sleep quality score (range 3 to 15)	7.1 (0.0)
• Latency and disturbances (range 1 to 5)	2.5 (0.0)
• Not finding sleep refreshing (range 1 to 5)	2.6 (0.0)
• Daytime dysfunction (range 1 to 5)	2.1 (0.0)
Body mass index (kg/m ²)	24.7 (0.1)

Table 2 (continued)

Variables	Mean or % (standard error)
• Underweight/normal weight (< 25 kg/m ²) (%)	63.6 (0.9)
• Overweight (≥ 25 kg/m ² and < 30 kg/m ²) (%)	21.1 (0.7)
• Obese (≥ 30 kg/m ²) (%)	15.3 (0.6)

MB Manitoba, AB Alberta, PE Prince Edward Island, NS Nova Scotia, YT Yukon, NT Northwest Territories

counting juice, how often do you usually eat fruit?"; (3) "How often do you usually eat green salad?"; (4) "How often do you usually eat potatoes, not including French fries, fried potatoes, or potato chips?"; (5) "How often do you usually eat carrots?"; and (6) "Not counting carrots, potatoes, or salad, how many servings of other vegetables do you usually eat?" For the first five questions, participants could answer in terms of times per day, week, month, or year. For the sixth question, participants could answer in terms of servings per day, week, month, or year. All the answers were converted into times per week or servings per week, since the majority of participants had used this answering option. Physical activity was measured with the following item: "Have you done any of the following [walking for exercise, gardening or yard work, swimming, bicycling, popular or social dance, home exercises, ice hockey, ice skating, in-line skating or rollerblading, jogging or running, golfing, exercise class or aerobics, downhill skiing or snowboarding, bowling, baseball or softball, tennis, weight-training, fishing, volleyball, basketball, soccer, any other, no physical activity] in the past 3 months?" (yes/no). Smoking was measured with the following item: "At the present time, do you smoke cigarettes daily, occasionally or not at all?" (daily/occasionally/not at all). Alcohol consumption was measured with the following item: "During the past 12 months, have you had a drink of beer, wine, liquor or any other alcohol beverage?" (yes/no).

Statistical analyses

Sleep duration and quality were dichotomized. Sleep duration was dichotomized as insufficient (< 7 h per night) or adequate (≥ 7 h per night) according to the latest recommendations of the US National Sleep Foundation (Hirshkowitz et al. 2015). Sleep quality was dichotomized as having trouble going to sleep or staying asleep, *not* finding sleep refreshing (item reversed) and finding it difficult to stay awake when you want to none or little of the time or some, most or all of the time. The association between sleep duration/quality and BMI was assessed by means of logistic regression analyses with survey weights. Survey weights were used to account for the complex sampling plan design of the CCHS and to obtain a sample that

is representative of the Canadian population at the health region level (Canada 2014). A normalized survey weight was used to combine data from 2011 to 2014. To compute it, the survey weight in the master file for each year was used and this value was divided by the pooled mean value. The linearity of the logit, an assumption for using logistic regression analyses, was verified by using the Box-Tidwell approach (Tabachnick and Fidell 2013). Three models were computed for each component of sleep (duration and quality): (1) an unadjusted analysis (no covariates), (2) an analysis partially adjusted for demographics (age, ethnicity, level of education, household income, marital status, employment, parity, region, and season), and (3) an analysis fully adjusted for demographics and variables associated with OW/OB (mood disorder, fruit and vegetable intake, physical activity, smoking, and alcohol consumption). The area under the ROC curve as a measure of model fitting was reported for each model (Hosmer and Lemeshow 2000). An area under the ROC curve of 50% is considered no discrimination; between 70% and 80%, acceptable; between 80% and 90%, excellent; and 90% and more, outstanding (Hosmer and Lemeshow 2000). Alpha level was set at $p < 0.05$, and all analyses were performed using SAS, version 9.3 (SAS Institute, Cary, NC, USA).

Results

Sample characteristics

The total sample consisted of 9749 women of childbearing age, 18 to 44 years old. The mean age was 31.1 ± 0.2 years, and the majority (80.8%) were non-Hispanic white. The majority of women (68.5%) had a post-secondary certificate/diploma or a university degree and the mean household income was CAD $\$78,650 \pm 1037$. The majority of women were married or living common-law (56.1%) and working full-time (58.8%). Mean parity was less than one child (0.9 ± 0). Slightly more than half of the sample (55.7%) slept the recommended 7 to 9 h per night, and the average score for sleep quality was 7.1 ± 0.0 , indicating an overall good sleep quality. This was reflected in the low mean scores for latency and disturbances (2.5 ± 0.0), not finding sleep refreshing (2.6 ± 0.0) and daytime dysfunction (2.1 ± 0.0). More than a third (36.4%) of participants had a BMI indicating the presence of OW/OB (≥ 25 kg/m²). Complete sample characteristics are presented in Table 2.

Association between sleep and overweight/obesity

Sleep duration was significantly associated with BMI in the unadjusted analysis which discriminated 52.8% of women of

Table 3 Association between sleep duration (≥ 7 h/night) and overweight/obesity (BMI ≥ 25 kg/m²)

Variables	Odds ratio (<i>p</i> value) and 95% confidence interval		
	Unadjusted analysis	Partially adjusted analysis	Fully adjusted analysis
Sleep duration	0.84 (<i>p</i> = 0.03) 0.72, 0.98	0.94 (<i>p</i> = 0.43) 0.80, 1.10	0.93 (<i>p</i> = 0.39) 0.79, 1.10
Age		1.04 (<i>p</i> < 0.01) 1.03, 1.05	1.04 (<i>p</i> < 0.01) 1.03, 1.05
Ethnicity			
• Non-Hispanic white		Reference	Reference
• Asian		0.67 (<i>p</i> = 0.03) 0.47, 0.96	0.57 (<i>p</i> < 0.01) 0.40, 0.82
• Black		1.72 (<i>p</i> = 0.02) 1.08, 2.70	1.49 (<i>p</i> = 0.10) 0.93, 2.38
• Latin American		0.74 (<i>p</i> = 0.30) 0.42, 1.30	0.70 (<i>p</i> = 0.22) 0.40, 1.23
• Arab		1.09 (<i>p</i> = 0.81) 0.54, 2.22	0.82 (<i>p</i> = 0.61) 0.38, 1.75
• Other		1.10 (<i>p</i> = 0.86) 0.39, 3.13	0.93 (<i>p</i> = 0.89) 0.33, 2.63
Level of education			
• Less than high school diploma		1.28 (<i>p</i> = 0.13) 0.93, 1.75	1.27 (<i>p</i> = 0.16) 0.91, 1.75
• High school diploma		1.01 (<i>p</i> = 0.95) 0.79, 1.28	0.99 (<i>p</i> = 0.96) 0.78, 1.27
• Some post-secondary studies		0.97 (<i>p</i> = 0.84) 0.74, 1.28	0.96 (<i>p</i> = 0.79) 0.72, 1.28
• Post-secondary certificate/diploma or university degree		Reference	Reference
Household income		1.00 (<i>p</i> < 0.01) 1.00, 1.00	1.00 (<i>p</i> = 0.01) 1.00, 1.00
Marital status			
• Married/living common-law		Reference	Reference
• Single, never married		0.84 (<i>p</i> = 0.09) 0.69, 1.03	0.85 (<i>p</i> = 0.12) 0.69, 1.04
• Widowed/separated/divorced		0.87 (<i>p</i> = 0.51) 0.58, 1.32	0.89 (<i>p</i> = 0.57) 0.59, 1.33
Employment			
• Unemployed		0.96 (<i>p</i> = 0.75) 0.78, 1.19	0.94 (<i>p</i> = 0.62) 0.76, 1.18
• Part-time (< 30 h/week)		0.97 (<i>p</i> = 0.78) 0.78, 1.20	0.97 (<i>p</i> = 0.79) 0.78, 1.20
• Full-time (≥ 30 h/week)		Reference	Reference
Number of children		1.05 (<i>p</i> = 0.22) 0.96, 1.16	1.05 (<i>p</i> = 0.25) 0.96, 1.16
Region of Canada			
• Quebec		Reference	Reference
• Prairies		1.45 (<i>p</i> < 0.01) 1.20, 1.75	1.41 (<i>p</i> < 0.01) 1.16, 1.69
• Maritimes		1.69 (<i>p</i> < 0.01) 1.32, 2.22	1.64 (<i>p</i> < 0.01) 1.27, 2.13

Table 3 (continued)

Variables	Odds ratio (<i>p</i> value) and 95% confidence interval		
	Unadjusted analysis	Partially adjusted analysis	Fully adjusted analysis
• Northern Canada		1.18 (<i>p</i> = 0.32)	1.16 (<i>p</i> = 0.37)
		0.85, 1.64	0.84, 1.61
Season interviewed			
• Winter		1.06 (<i>p</i> = 0.63)	1.05 (<i>p</i> = 0.64)
		0.84, 1.33	0.83, 1.33
• Spring		1.15 (<i>p</i> = 0.21)	1.14 (<i>p</i> = 0.26)
		0.92, 1.45	0.91, 1.43
• Summer		Reference	Reference
• Fall		1.25 (<i>p</i> = 0.06)	1.23 (<i>p</i> = 0.08)
		0.99, 1.56	0.97, 1.56
Mood disorder		2.27 (<i>p</i> < 0.01)	2.22 (<i>p</i> < 0.01)
		1.72, 3.03	1.64, 2.94
Fruit and vegetable intake			1.00 (<i>p</i> = 0.12)
			1.00, 1.01
Physical activity			0.96 (<i>p</i> = 0.87)
			0.63, 1.48
Smoking			0.91 (<i>p</i> = 0.36)
			0.74, 1.11
Alcohol consumption			0.67 (<i>p</i> < 0.01)
			0.52, 0.88
Area under the ROC curve	52.8	64.6	64.8
− 2 log likelihood	12,402.17	10,820.71	10,732.90

Numbers in italics are statistically significant (*p* < 0.05)

BMI body mass index

childbearing age, but this association was no longer significant in the model adjusted for demographics (partially adjusted analysis) nor the one adjusted for demographics and variables associated with OW/OB (fully adjusted model) (see Table 3). Sleep quality was not significantly linked to BMI in any of the three models (unadjusted, partially and fully adjusted analyses) (see Table 4). All models poorly discriminated women of childbearing age based on their BMI with areas under the ROC curve below the 70% threshold (Hosmer and Lemeshow 2000).

Discussion

Sleep duration was significantly associated with OW/OB ($BMI \geq 25 \text{ kg/m}^2$) when it was the only variable in the logistic regression analysis (i.e., unadjusted model), indicating that sleeping at least 7 h per night as recommended by the US National Sleep Foundation (Hirshkowitz et al. 2015) was associated with lower chances of being OW/OB among Canadian women of childbearing age. However, this association was no longer significant when demographics (i.e.,

partially adjusted model) and variables associated with OW/OB (i.e., fully adjusted model) were entered into the analyses. A study conducted among young US women aged from 17 to 26 years also reported that sleep duration was not significantly associated with BMI (Bailey et al. 2014). Yet, previous evidence from cross-sectional (Theorell-Haglow et al. 2010, 2012) and longitudinal (10-year follow-up) (Theorell-Haglow et al. 2014) studies conducted among Swedish women indicated that sleep duration was significantly associated with obesity when controlling for similar covariates, such as age, smoking, alcohol, physical activity, and depression. A number of factors may explain these differences in findings: (a) these studies used obesity (e.g., $BMI \geq 30 \text{ kg/m}^2$ (Theorell-Haglow et al. 2014) or $WC \geq 88 \text{ cm}$ (Theorell-Haglow et al. 2012)) and not OW/OB as the outcome; (b) they used different measures of obesity, such as WC (Theorell-Haglow et al. 2010, 2012) or a weight gain of $\geq 10 \text{ kg}$ at follow-up (Theorell-Haglow et al. 2014); (c) they included all non-pregnant women aged ≥ 20 years (Theorell-Haglow et al. 2010, 2012, 2014), not just those of childbearing age; (d) they used different definitions of sleep duration (e.g., normal sleep was between 6 and 9 h) (Theorell-Haglow et al. 2012, 2014);

Table 4 Association between sleep quality (none/little sleep problems) and overweight/obesity (BMI ≥ 25 kg/m²)

Variables	Odds ratio (<i>p</i> value) and 95% confidence interval		
	Unadjusted analysis	Partially adjusted analysis	Fully adjusted analysis
Sleep quality	0.87 (<i>p</i> = 0.06) 0.75, 1.01	0.91 (<i>p</i> = 0.27) 0.78, 1.07	0.91 (<i>p</i> = 0.23) 0.77, 1.07
Age		1.04 (<i>p</i> < 0.01) 1.03, 1.05	1.04 (<i>p</i> < 0.01) 1.03, 1.05
Ethnicity			
• Non-Hispanic white		Reference	Reference
• Asian		0.68 (<i>p</i> = 0.03) 0.47, 0.96	0.58 (<i>p</i> < 0.01) 0.40, 0.82
• Black		1.72 (<i>p</i> = 0.02) 1.09, 2.78	1.52 (<i>p</i> = 0.09) 0.94, 2.44
• Latin American		0.75 (<i>p</i> = 0.31) 0.43, 1.32	0.71 (<i>p</i> = 0.23) 0.41, 1.23
• Arab		1.09 (<i>p</i> = 0.80) 0.54, 2.22	0.82 (<i>p</i> = 0.61) 0.38, 1.75
• Other		1.10 (<i>p</i> = 0.85) 0.40, 3.03	0.93 (<i>p</i> = 0.88) 0.33, 2.56
Level of education			
• Less than high school diploma		1.27 (<i>p</i> = 0.14) 0.93, 1.75	1.25 (<i>p</i> = 0.17) 0.91, 1.75
• High school diploma		1.00 (<i>p</i> = 0.97) 0.79, 1.28	0.99 (<i>p</i> = 0.94) 0.78, 1.27
• Some post-secondary studies		0.96 (<i>p</i> = 0.81) 0.73, 1.28	0.95 (<i>p</i> = 0.76) 0.72, 1.27
• Post-secondary certificate/diploma or university degree		Reference	Reference
Household income		1.00 (<i>p</i> < 0.01) 1.00, 1.00	1.00 (<i>p</i> = 0.01) 1.00, 1.00
Marital status			
• Married/living common-law		Reference	Reference
• Single, never married		0.84 (<i>p</i> = 0.09) 0.68, 1.03	0.85 (<i>p</i> = 0.11) 0.69, 1.04
• Widowed/separated/divorced		0.87 (<i>p</i> = 0.50) 0.57, 1.30	0.88 (<i>p</i> = 0.56) 0.59, 1.33
Employment status			
• Unemployed		0.96 (<i>p</i> = 0.73) 0.78, 1.19	0.94 (<i>p</i> = 0.60) 0.76, 1.18
• Part-time (< 30 h/week)		0.97 (<i>p</i> = 0.76) 0.78, 1.20	0.97 (<i>p</i> = 0.77) 0.78, 1.20
• Full-time (≥ 30 h/week)		Reference	Reference
Number of children		1.05 (<i>p</i> = 0.22) 0.96, 1.16	1.05 (<i>p</i> = 0.24) 0.96, 1.16
Region of Canada			
• Quebec		Reference	Reference
• Prairies		1.47 (<i>p</i> < 0.01) 1.22, 1.75	1.41 (<i>p</i> < 0.01) 1.18, 1.69
• Maritimes		1.69 (<i>p</i> < 0.01) 1.32, 2.22	1.64 (<i>p</i> < 0.01) 1.27, 2.13

Table 4 (continued)

Variables	Odds ratio (<i>p</i> value) and 95% confidence interval		
	Unadjusted analysis	Partially adjusted analysis	Fully adjusted analysis
• Northern Canada		1.19 (<i>p</i> = 0.30)	1.16 (<i>p</i> = 0.35)
		0.85, 1.64	0.84, 1.61
Season interviewed			
• Winter		1.06 (<i>p</i> = 0.62)	1.05 (<i>p</i> = 0.64)
		0.84, 1.33	0.84, 1.33
• Spring		1.15 (<i>p</i> = 0.21)	1.14 (<i>p</i> = 0.26)
		0.92, 1.45	0.91, 1.43
• Summer		Reference	Reference
• Fall		1.25 (<i>p</i> = 0.06)	1.23 (<i>p</i> = 0.08)
		0.99, 1.56	0.98, 1.56
Mood disorder		2.22 (<i>p</i> < 0.01)	2.17 (<i>p</i> < 0.01)
		1.67, 2.94	1.61, 2.86
Fruit and vegetable intake			1.00 (<i>p</i> = 0.13)
			1.00, 1.01
Physical activity			0.96 (<i>p</i> = 0.85)
			0.63, 1.47
Smoking			0.91 (<i>p</i> = 0.36)
			0.74, 1.11
Alcohol consumption			0.67 (<i>p</i> < 0.01)
			0.51, 0.87
Area under the ROC curve	51.5	64.5	64.7
– 2 log likelihood	12,407.21	10,818.87	10,730.76

Numbers in italics are statistically significant (*p* < 0.05)

BMI body mass index

and (e) they used objective measures of sleep (e.g., polysomnography) (Theorell-Haglow et al. 2010). The differences in findings may also have arisen from cultural and/or genetic differences between women in Sweden and those in Canada.

Sleep quality among women of childbearing age in Canada was not significantly linked to OW/OB in any of the logistic regression models (i.e., unadjusted, partially, or fully adjusted models). This is similar to a study among US women of childbearing age (16 to 40 years) of lower SES which reported that poor sleep measured by the PSQI was not related to OW/OB (Centers for Disease Control and Prevention 2015). However, these findings contradict studies conducted among adults that reported a significant association between sleep quality and risk of OW/OB (Fatima et al. 2016; Rahe et al. 2015). These studies employed different measures of sleep quality. The CCHS, years 2011–2014, only had data on sleep latency, disturbances, finding sleep refreshing, and daytime dysfunction, while the US study employed all seven components of sleep quality according to the PSQI (Buysse et al. 1989). Additional studies on the association between sleep quality and OW/OB among women of childbearing age are thus needed to

determine whether this segment of the population is different from all adults. Ideally, studies should also use a validated measure of sleep quality, such as the PSQI (Buysse et al. 1989) and/or an objective measure of sleep quality, such as actigraphy.

This study has a number of strengths and weaknesses. Strengths include the large sample size, carefully collected data as part of this nationally sponsored health monitoring assessment, and the inclusion of various covariates in the statistical analyses to rule out as much as possible the influence of variables that are generally reported to impact OW/OB. To our knowledge, this is also the first Canadian study to explore the association between sleep and OW/OB among women of childbearing age. The main weakness is that the analyses were cross-sectional, and consequently, causal inferences cannot be made based on the current results. The logistic regression models poorly discriminated women of childbearing age based on their BMI with areas under the ROC curve below 70% (Hosmer and Lemeshow 2000), indicating that other variables not measured in the current study might be better to distinguish risk of OW/OB among this population and possible residual confounding. Sleep duration and quality and all

other variables, including height and weight used to calculate BMI, were self-reported by respondents, which can result in bias and random measurement errors. Objective measures of sleep, such as actigraphy, and of risk of OW/OB, such as measured height and weight, would likely have provided more precise and accurate estimations of sleep duration, quality, and BMI. It is generally best to use both self-reported and objective measures of sleep to counterbalance the strengths and weaknesses associated with each measure. The measure of sleep quality available in the CCHS was not validated, had a low reliability coefficient (Cronbach's alpha 0.48), and did not assess all seven components of sleep quality of the PSQI (Buysse et al. 1989); it therefore might not have been a comprehensive measure of sleep quality. Finally, it is important to mention that the current results cannot be generalized to all women of childbearing age in Canada, since the CCHS, years 2011–2014, did not sample participants of all provinces regarding sleep; the items on sleep were part of the optional content of the survey. Newfoundland and Labrador, New Brunswick, Saskatchewan, and Nunavut, as well as heavily populated provinces of Canada, such as Ontario and British Columbia, were not surveyed. The results can only be generalized to the seven provinces and territories surveyed.

Our findings suggest that targeting sleep duration and sleep quality alone would not considerably contribute to lower risk of OW/OB among women of childbearing age in Canada, since sleep duration and quality were not significantly associated with OW/OB when controlling for demographics and variables associated with OW/OB. Additional studies among women of childbearing age are needed to confirm these findings, and ideally, future studies should adopt a longitudinal design and use both self-reported and objective measures of sleep duration and quality and an objective measure of risk of OW/OB.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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