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Psychological distress mediates the association between daytime sleepiness and consumption of sweetened products: Cross-sectional findings in a Catholic Middle Eastern Canadian community.

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Abstract

Objective: To examine the associations between consumption of sweetened products, daytime sleepiness (DS) and psychological distress (PD) in a Catholic Middle Eastern Canadian community, and to test the hypothesis that the association between DS and consumption of sweetened products is mediated by PD.

Design: Cross-sectional study

Setting: A Catholic Middle-Eastern Canadian community

Participants: 186 men and women aged between 18-60 years old

Primary and secondary outcome measures: Sweetened product consumption was measured using a food frequency questionnaire (total sugars/day). DS and PD were measured using standardized questionnaire. The generalised linear model was used to estimate associations between sweetened product consumption, age, sex, self-reported body mass index, DS and PD. Baron and Kenny's four-step approach in addition to the Sobel test were used to establish mediation.

Results: Average DS score was 8.2 (SD= 4.5) with 19.5% having excessive scores (>12). Mean PD score was 20.8 (SD= 6.2) with 11.8% having high distress scores. Average consumption of sweetened products was 15.5 g/day (SD=13.9). Baron and Kenny's four-step approach to establish mediation were confirmed. First, DS was associated with consumption of sweetened products ($p<0.03$). Second, DS and PD were correlated ($r=0.197$; $p<0.04$). Third, PD was associated with consumption of sweetened products ($p<0.01$) when both PD and DS were entered as predictors in a multivariate regression. Fourth, the coefficient relating sweetened product consumption to DS was larger ($\beta=0.05$) than the coefficient relating DS to sweetened products consumption ($\beta=0.03$) with both DS and PD entered in the multivariate model. Finally, the Sobel test was significant (2.14; $p<0.03$).

Conclusion: Daytime sleepiness is associated to the consumption of sweetened products in the Catholic Middle Eastern community of Montreal, Canada. This association is partially mediated by psychological distress.

Key words: Migrant health, Middle Eastern Canadian, sweetened foods, daytime sleepiness, psychological distress, mediation analysis.

Article focus:

- This study examines the association between consumption of sweetened products, daytime sleepiness and psychological distress in a Catholic Middle Eastern Canadian community.
- We use Baron and Kenny's (1986) four-step approach and the Sobel test to verify alternative mediating models between these three variables.

Key messages

- Daytime sleepiness is associated to the consumption of sweetened products and this association is partially mediated by psychological distress.
- This study highlights that sleep, mood and diet are interconnected, and that efforts to improve diet quality must consider the psychosocial well-being of individuals

Strength and limitations

- The strengths include the testing of alternative mediating models and the use of well-established procedures to assess mediation
- Due to the cross-sectional nature of the study it is impossible to know the causal order of the observed associations, and the existence of bi-directional effects. The results of this study are also limited to the studied community and future work is necessary to expand them in other migrant populations.

Introduction

The prevalence of overweight/obesity and chronic diseases, as well as their associated risk factors, vary dramatically by ethnic groups in Canada[1]. Canadians of Arab (or Middle East) origin[1] represent more than 1.2% of the total Canadian population[2] and comprise one of the largest non-European ethnic groups in Canada. After adjusting for socioeconomic factors, Arab Canadians are more likely to be obese than White, Chinese, Japanese and South Asian groups [3]. Furthermore, the prevalence of obesity is much higher amongst long-term Arab migrants (≥11 or more years) than the more recent migrants (≤10 years) to Canada[1]. The high prevalence of obesity amongst Arabs and the finding that the prevalence increases with time may result from the adoption of dietary and behavioural risk factors uncommon to the environment of their home countries prior to migration and acquired during the acculturation process in Canada[1, 4, 5].

A modifiable dietary risk factor contributing to the development of obesity is the consumption of ultra-processed products high in dietary sugars, or sweet food and drink products [6]. Such products include soft drinks, sweetened juices and beverages, candies and chocolates, sugary baked goods, ice creams, and other desserts [7]. These products share many nutritional characteristics that make them unhealthy; they are energy dense (for solids), they have an excessive content in free sugars, and some are also high in fats and saturated fats[8]. Furthermore, they are sold in large portion sizes and are commonly consumed as snacks both of which may contribute to energy imbalance[9]. Even more problematic is the fact that sweet food and drink have specific psychological properties that trigger consumption; they are hyper-palatable [10-12] and their sweet taste works to alleviate dysphoric mood or stress through dopaminergic and opioidergic neuro-transmission in the brain[13-15].

[1] Denotes people from the Middle East or North African region who reported Arab (or an origin that originates in the region commonly referred to as the Arab world), either alone or in combination with other ethnic origins in response to the question on ethnic origin in the 2001 Census or 2002 Ethnic Diversity Survey. In this paper, the terms Arab and Middle Eastern are used interchangeably.

Middle Easterners are known for the daily consumption of sweet tea. However, other sweet products have a secondary role in traditional Middle Eastern cuisine in that they are mostly home-prepared pastries and deserts most frequently consumed during festivities and on special occasions [16, 17]. Young Egyptian women and men more often reported cravings for savories (meat and vegetables based dishes) than cravings for sweets, contrary to studies conducted in Canada and United States [18]. However, the quantity, use and significance of sweet food and drink have significantly changed in the last decades in Lebanon, Egypt and Syria, with a parallel increase in obesity and chronic diseases [16, 19, 20]. Similarly, Arabs are exposed to a new food environment when they migrate to Canada where sweetened products are abundant, cheap, convenient, accessible, and part of the mainstream food culture. Such an experience creates a variety of social and economic challenges for maintaining ethnic cuisine as a marker of community affiliation and may be a potential source of stress and anxiety [21].

Understanding why individuals consume sweetened products is a complex issue, especially given the psychological properties of these foods and their effects in the brain. A review of the literature suggests that two sets of inter-related psychosocial factors are associated with the consumption of sweetened products; sleep-related problems and mood/stress-related problems. However, the nature of the relationships between these factors is not well understood [22].

Excessive daytime sleepiness is characterized by persistent sleepiness and lack of energy, most often caused by sleep deprivation, obstructive sleep apnea and/or use of medication [23]. It is present in all individuals, regardless of age, and recognized as the first symptom that defines narcolepsy [24]. Both excessive daytime sleepiness [25, 26] and narcolepsy [24] have been associated with the development and/or exacerbation of obesity. One potential mechanism explaining this association is through effects on appetite and intake of food[22]. Indeed, excessive daytime sleepiness has been associated with the consumption of food high in fats, as well as refined carbohydrates[22]. A recent study found that excessive daytime sleepiness was associated with the consumption of refined carbohydrate-rich snacks amongst Japanese children[27]. A very-low

carbohydrate, high-protein diet has shown improvement in daytime alertness in adults patients with narcolepsy[28]. In another study, subjects fed a carbohydrate liquid diet scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet [29]. Hormonal, metabolic, and inflammatory mechanisms could explain why a diet high in fats and/or sugars could induce somnogenic effects in the body [22].

There is evidence that the association between daytime sleepiness and sweet products may be explained by the meditating effects of mood/stress problems, such as psychological distress. This mediating effect is supported in the literature for several of Baron and Kenny's criteria to establish mediation[30]. First, there is supporting evidence that daytime sleepiness is associated with consumption of processed food high in dietary sugars[28{Gaina, 2007 #257]}. Second, daytime sleepiness is correlated with depression and psychological distress in both Western and Arab populations [31-34]. Third, a preference for chocolate and other sweet products is well documented in depressed and psychological distressed individuals[35, 36]. This preference could be explained by the effects of sweets on relieving mood or stress [13-15]. If sleepy individuals also tend to feel distressed, and psychological distress induces the consumption of sweet products, then the relationship between daytime sleepiness and the consumption of these products could be, at least, partially mediated by psychological distress.

Daytime sleepiness and psychological distress, and their relationship to the consumption of sweet products have never been studied in Arab Canadians. Addressing this gap could shed light on the prevention/management of obesity in the Canadian Arab community. The burden of obesity in this community has important human and economic consequences for the Canadian public health system because Arabs are one of the fastest growing migrant groups in Canada, constituting more than 4% of the urban population of Montreal and Ottawa[2]. Understanding the relationship between daytime sleepiness, psychological distress and diet could provide useful information to improve daytime alertness, psychological well-being and diet quality, all of which are known risk factors to obesity and chronic diseases. From this perspective, this paper has two objectives: 1) to report on the prevalence of excessive daytime sleepiness and psychological distress in an

Arab community living in Montreal[2], and 2) to test whether the relationship between daytime sleepiness and consumption of sweet products is mediated by psychological distress using Baron and Kenny's [30] criteria and the Sobel test.

Methods:

Participants

The Middle Eastern or Arab community living in Canada is heterogeneous in terms of its country of birth and religious affiliation. The main groups are Lebanese (41%), Egyptian (12%), Syrian (6%), Moroccan (6%), and Iraqi (6%)[2]. Canadians of Arab origin are equally divided between Muslims and Christians, of which the majority is Catholic[2]. The sociocultural heterogeneity within the Middle Eastern community is essential to acknowledge, especially because religious beliefs impose dietary restrictions and may influence psychosocial factors related to health in Arab Muslims [21, 37].

The target population of this study is an established Catholic Middle Eastern community living in Montreal, Canada. This population is composed of first and second generation migrants, mostly from Egypt, Lebanon and Syria. Recruitment and data collection occurred at three Catholic Middle Eastern churches located in Montreal. Participation was solicited through public announcements and was limited to one respondent per household to avoid bias related to family customs. Subjects were all volunteers and could withdraw from the study at any point.

The research protocol was submitted and approved by the ethics committee of the Centre Hospitalier de l'Université de Montréal (SL 06-063). All participants provided informed written consent.

Instruments

Socio-demographic characteristics were collected using a self-reported questionnaire adapted from Health Canada[38]. Physical activity was assessed by asking the question "how many times per week do you exercise enough to sweat? ". Participants self-reported height and weight. Food consumption was assessed using a food frequency questionnaire

(FFQ) previously developed and validated with the study community to measure consumption of 26 different sweet food and drink products [7]. To answer the FFQ, respondents reported the average number of days per week, in a typical week, in which each listed product was eaten or drank (i.e., excluding festivities). Participants were also asked to report how many portions of the food item they typically ate. Examples of portions sizes were taken from the Canadian Nutrient File (CNF) and provided to participants[39]. For the purpose of this study, we selected food items representing sweet products, which include cookies, chocolate, cakes and candies.

Daytime sleepiness was measured using the *Epworth Sleepiness Scale* (ESS)[40]. This self-report instrument contains eight items describing situations conducive to daytime sleepiness. Respondents expressed their perceived likelihood of falling asleep in a number of situations using a four-point scale (0 to 3). The ESS instrument has a high internal consistency (Cronbach's alpha = 0.88) and a high test-retest reliability (r = 0.82)[41].

Psychological distress was measured using the *Kessler Psychological Distress Scale* (K10)[42]. This instrument is composed of 10 questions on anxiety and depressive symptomology. Respondents self-reported the degree to which they had these feelings for the month prior to completing the instrument using a five-point Likert scale (all the time, often, sometimes, rarely, never). Scores, ranging from 10 to 50, represent an increasing gradient of psychological distress.

Analysis

Data were analyzed using SPSS (Version 18.0). As a first step, we present descriptive data on the consumption of sweet products according to sex, age, body mass index (BMI), daytime sleepiness, and psychological distress. Consumption of sweet products corresponded to the daily amount of total sugars eaten from cakes, cookies, chocolate, and candies. This was calculated using data on the frequency and portions consumed from these products obtained from the FFQ, and the estimated amount of total sugars contained in mean portions of these products using CNF.

For descriptive purposes, daytime sleepiness scores on the ESS were coded into three levels of increasing daytime sleepiness: low (ESS scores 0-5), intermediate (ESS scores 6-11) and high (ESS scores 12-24). Intermediate (6-11) and high (12-24) ESS scores were shown to have a 30% and 69% increased risk for sleep onset during the Multiple Sleep Latency Test (MSLT), an objective measure of daytime sleep tendency[43]. Psychological distress scores on the K10 were grouped into standard groups as low (10-20), moderate (21-29) and high levels of psychological distress (30-50)[42]. BMI was calculated as weight (kg)/ height $(m)^2$ and categorized as normal weight (BMI < 25); overweight 25 ≥ BMI< 30); and obese (BMI>30) [44].

As a second step, univariate regression analysis was performed to estimate the associations between consumption of sweet products and age, sex, BMI, daytime sleepiness and psychological distress. Similar tests were performed to verify if the consumption of sweet products varied by other socio-demographics (country of birth, time since migration, family income, education level, civil status and employment status). For all regression analyses, consumption of sweet products was log-transformed. Age, daytime sleepiness and psychological scores were normally distributed and used as continuous measures.

Next, we applied the Baron and Kenny [30]criteria to assess whether the relationship between daytime sleepiness (independent variable) and consumption of sweet products (dependent variable) was mediated by psychological distress (mediator). According to Baron and Kenny four statistical conditions need to be met in order to establish mediation[30]. First, univariate regression was used to test if daytime sleepiness was significantly associated with consumption of sweet products. Second, we assessed whether daytime sleepiness and psychological distress were significantly associated. Third, we tested whether psychological distress (mediator) was associated with the consumption of sweet products when both daytime sleepiness and psychological distress and were entered as predictors in a multivariate regression analysis. Fourth, we verified that the coefficient relating daytime sleepiness to consumption of sweet products was larger (in absolute value) than the coefficient relating both variables in the multivariate

regression model when the mediating variable was entered. The Sobel test was used to statistically evaluate whether the indirect effect of the independent variable on the dependent variable through the mediator variable was significant[45].

As a final step, we ran alternative mediation models to rule out plausible competing interpretations of the data and to verify whether our hypothesized model best fit the data. First, daytime sleepiness was entered as the mediator of the relationship between psychological distress (independent) and consumption of sweet products (dependent). In a second alternative model, consumption of sweet products was entered as the mediator of the relationship between daytime sleepiness (independent variable) and psychological distress (dependent variable).

Results

Participants were aged between 18 and 60 years (Mean = 34.6; SD = 12.5). There were slightly more women (n=101) than men (n=85). Country of birth included Egypt (31.9 %), Lebanon (25.1 %), Syria (14.7 %), and other Middle Eastern countries (5.3 %). Individuals migrated between 1962 and 2007, of which 86% arrived before 2000, meaning they have spent more than 10 years in Canada. An additional 23.0% of subjects were born in Canada; these were second-generation migrants (i.e., children of immigrating parents born in the Middle Eastern). Participant´s civil status was as follows; married or engaged (47.3%), single (46.2%), separated/divorced (4.3%), and widowed (2.2%). The vast majority of respondents had at least a college diploma (88.0%), and most had a university degree (65.8%). Most participants had a family income above CAD $50,000 (66.9%).

Average consumption of sweet products was of 15.5 g/day (SD=13.9; N = 186) with the range from 0 to 93.1 g/day. The share of each food item to the amount of total sugars from these products was as follows; cakes (51.3%), chocolate (24.7%), cookies (16.1%) and candies (7.9 %).

The average daytime sleepiness score on ESS was 8.2 (SD= 4.5) (N=186). A third of individuals (30.1%) had a low daytime sleepiness score (0-5) and half (50.5%) had an intermediate daytime sleepiness score (6-11). One-fifth of individuals (19.5%) had a high daytime sleepiness score (12-24). Almost one-third of individuals met the clinical criteria for excessive daytime sleepiness (EDS) (defined as ESS scores above 10). Daytime sleepiness did not vary by sex, age or BMI.

The average psychological distress score on the K10 was 20.8 (SD= 6.2) (N=186). More than one half the respondents (55.4%) had a low distress score of 0-20; one-third (32.8%) had a moderate distress score of 21-30; and one-tenth had a high distress score of 30-50 (11.8%). Psychological distress did not vary by sex, age or BMI.

Table 1 presents descriptive data on the consumption of sweet products according to age, sex, physical activity, BMI, daytime sleepiness, and psychological distress. Females consumed slightly more sweet products than males (1.7g/day), while patterns for age and BMI were less defined. Importantly, the consumption of sweet products varied according to psychological distress and daytime sleepiness score levels. Individuals with high distress ate an additional 5.6g of total sugars/day, 45% more than individuals with moderate distress, and an additional 8.5g of total sugars/day, 68% more than individuals with low distress. Individuals with high daytime sleepiness (>12) ate an additional 2.9g of total sugars/day, 23% more than subjects with moderate daytime sleepiness, and an additional 6.9g of total sugars/day, 54% more than individuals with low daytime sleepiness. Other socio-demographics were not related statistically to the consumption of sweet products.

Table 1 also presents the results of univariate analyses between consumption of sweet products (log-transformed) and age, sex, BMI, daytime sleepiness, and psychological distress. Consumption of sweet products did not vary significantly by age, sex or BMI. The consumption of sweet products was positively associated with psychological distress ($p<0.00$), as well with daytime sleepiness ($p<0.03$).

Multivariate analysis (Table 2) consisted of simultaneous modeling daytime sleepiness and psychological distress. In this model, the association between psychological distress and consumption of sweet products remained statistically significant ($p<0.01$) whereas the relationship with daytime sleepiness was not significant ($p<0.08$).

We were able to verify all four steps required by the Baron and Kenny[30] to establish mediation. First, daytime sleepiness was significantly associated with the consumption of sweet products ($p<0.03$). Second, daytime sleepiness and psychological distress were significantly correlated ($r=0.197$; $p<0.04$). Third, psychological distress was associated with the consumption of sweet products ($p<0.01$) when both psychological distress and daytime sleepiness were entered as predictors in the multivariate regression model. Fourth, the coefficient relating daytime sleepiness to consumption of sweet products was larger ($\beta=0.05$) than the coefficient relating daytime sleepiness to consumption of sweet products ($\beta=0.03$) with both daytime sleepiness and psychological distress entered in the multivariate regression model. Finally, the Sobel test showed that the indirect effect of the independent variable on the dependent variable through the mediator variable was significant (Sobel statistic=2.14; SE=0.01; $p<0.03$).

In order to strengthen the robustness of the results, two alternative mediation models were tested. In the first alternative model, Baron and Kenny's third criteria was not satisfied. Indeed, daytime sleepiness (mediator) was not associated ($p<0.15$) with psychological distress (dependent) when both daytime sleepiness and consumption of sweet products (independent) were entered as predictors in a multivariate regression analysis. In the second alternative model, all of Baron and Kenny's criteria were satisfied. However, comparing both models using Akaike information criterion (AIC) indicated that the hypothesized mediation model (AIC=848) is a far better fit than this second alternative model (AIC=1205). Furthermore, the Sobel test for the second alternative mediation model showed that the indirect effect of the independent variable on the dependent variable through the mediator variable was not significant (Sobel statistic=1.63 SE=0.12; $p<0.1$).

Discussion

The data presented in this paper show that the level of daytime sleepiness in the Catholic Middle Eastern Canadian community is statistically associated with higher consumption of sweetened products, such as chocolate, candies, cakes and cookies. Most importantly, we found that this relationship is partially mediated by the level of psychological distress.

The strengths of this study are the use of well-established procedures to assess mediation - Baron and Kenny's (1986) four-step approach and the Sobel test, and the testing of alternative mediating models. Our analysis, however, was based on assumptions of having a correctly specified mediation model, including no misspecifications of causal order and of causal direction, or of imperfect measurements and unmeasured variables [46]. In reality, such assumptions are difficult or even impossible to achieve. By testing alternative mediate models we showed that the one we described is the best fitted to account for the relationship between these three variables. Furthermore, data from prior research support the proposition that a mediation relation exists between these variables.

The relationship observed between daytime sleepiness and consumption of food high in dietary sugars is consistent with previous studies conducted in western and non-western settings [27-29]. Similarly, previous work provides strong support that the consumption of sweetened products is triggered by negative emotional or distress feelings in western populations. Negative mood (as measured by anxiety, fatigue and depression scales) has been correlated with craving intensity for sweet food [36]. Experimental studies have also demonstrated an association between stress or negative mood and the consumption of savory foods in emotional eaters [35, 47]. Thus one explanation in support of our mediating model is that individuals who experience daytime sleepiness may consume energy dense sugary rich foods to upgrade their energy level or to alleviate their negative mood or psychological distress. This explanation fits with the fueling and emotional functions attributed to sweetened food and drink products by members of the studied community in semi-structured interviews [7]. Furthermore, this explanation has

biological plausibility since sweet taste may alleviate dysphoric mood or stress through dopaminergic and opioidergic neurotransmission in the brain [13-15].

Our study highlights that sleep, mood and diet are interconnected, and that efforts to improve diet quality must consider the psychosocial well-being of individuals, especially given the known properties of sweets to temporarily alleviate fatigue, stress and anxiety. These results have important public health implications for the prevention of obesity and chronic diseases, which are growing concerns in the Arab Canadian community[3]. Indeed, consumption of processed products high in dietary sugars is recognized as an important contributor to the development of these diseases[6]. As reported elsewhere, the consumption level of total sugars (all foods considered), ~ 20% of diet, in this community is now similar that of the Canadian and Quebec population[7]. The average daytime sleepiness score (8.2) and the prevalence of EDS (28%) measured in this paper are within the range noted in western countries[48]. The obesity prevalence of 15.6% is also similar to the Canadian average and the general Arab community, when self-reported measures are taken[3].

The prevalence of high psychological distress (K10>30) at 11.8% is nearly half that of the Canadian average, reported to be 20.7% [49]. It is possible that sociocultural factors such as family social support or having a religious faith protect against anxiety and depression. Religious affiliation, for example, is higher in the Middle Eastern community (94%) than in the overall population (83%)[2]. Also, the strength and size of social network shown to have tempering effect on weight gain and the general health of individuals living in large Canadian ethnic groups [5]. The sources of psychological distress in the Middle Eastern Canadian community are, however, unknown and warrant future research. Socioeconomic difficulties do not seem to play an essential role in our population sample, since employment rate, education level and household income were found to be relatively high. The difficulties of maintaining traditional dietary practices in the host country may be potential sources of social and economic stress [7, 21].

This study has limitations. First, the sample size was small and thus statistical power was limited. However, the composition of our sample reflects the characteristics of the general Catholic Middle Eastern Canadian community in terms of birthplace, religious affiliation, education and income[2]. Our findings, however, cannot be generalized to the Muslim Arab Canadian community. Second, the study is based on self-reported subjective measures. However, both instruments we used (ESS and K10) are valid and reliable instruments widely used in both sleep and mood-related studies. Third, we did not account for other sleep problem measures, including duration of sleep and sleep deprivation, as well as other potential confounding disorders. Sleep duration and obstructive sleep apnea are the most common causes of daytime sleepiness[22], but studies examining the relationships between sleep duration, dietary intake and obesity has produced mixed results[50]. Fourth, findings are based on cross-sectional data. Therefore, it is impossible to know the causal order of the observed associations, and the existence of bi-directional effects, for example, between the consumption of foods high in dietary sugars and daytime sleepiness.

Conclusion

This study expands the limited evidence base concerning the association between consumption of sweetened products, daytime sleepiness and psychological distress in any communities including migrants ones. One novel contribution of this study is its inclusion of a measure of psychological distress and the use of Baron and Kenny's [30]four-step approach and the Sobel test to establish that the consumption of sweetened products and daytime sleepiness is partially mediated by psychological distress. One possible explanation in support of this relationship is that individuals experiencing daytime sleepiness may reach for energy dense sugary rich foods in order to upgrade their energy level or to alleviate their psychological distress. Further work is needed to test this mediation hypothesis, and to identify the potential sources of anxiety and depression amongst the Arab Canadian population.

Table 1 Consumption of sweetened products (total sugars/day) according to psychosocial distress and daytime sleepiness scores (N=186).

Factors	Subjects		Sweetened products (g/day)		P <*
	N	%	Mean	SE	
Sex					0.66
Male	85	45.7	14.6	1.5	
Female	101	54.3	16.3	1.4	
Age					0.59
18-30	83	44.6	19.5	1.6	
31-40	50	26.9	12.7	1.7	
41-50	21	11.3	17.2	4.2	
51-60	32	17.2	12.4	1.8	
Physical activity					0.33
0	65	35.0	16.8	1.6	
1-2 /week	73	39.2	15.6	1.7	
3-4 /week	48	25.8	13.6	2.2	
Body mass index					0.86
Normal (18.5-24.9)	88	44.6	16.5	1.5	
Overweight (25-29.9)	69	37.1	13.6	1.4	
Obese(>30)	29	15.6	17.1	3.3	
Psychological distress (K10 scores)					0.00
Low (10-20)	103	55.4	12.7	1.1	
Moderate (21-30)	61	32,8	18.3	1.8	
High (30-50)	22	11,8	21.2	4.3	
Daytime sleepiness (ESS scores)					0.03
Low (0-5)	56	30,1	12.7	1.5	
Moderate (6-11)	94	50,5	15.6	1.5	
High (12-24)	36	19,4	19.6	2.3	

*In the univariate regression analysis, sweetened products was log-transformed and all variables were entered as continuous (age, BMI, psychological distress scores (10-50) and daytime sleepiness scores (0-24). T–test performed for sex. Physical activity categories were created by asking "how many times per week do you exercising enough to sweat?" and answers range from 0-4 times per week.

Table 2 Relationships between consumption of sweetened products, daytime sleepiness and psychological distress in the multivariate model (N=186)

	β	SE	T value	P<
Model 1(unadjusted)	0.05	0.02	1.15	0.04
Model 2*		0.02	1.15	0.04
Intercept	0.97	0.37	2.62	0.01
Daytime sleepiness	0.03	0.02	1.74	0.08
Psychological distress	0.05	0.02	2.70	0.01

β = Beta coefficient; SE=standard error. R^2 =0.06

Consumption of sweetened products was log-transformed. Psychological distress scores (10-50) and daytime sleepiness scores (0-24) are entered as continuous and are normally distributed.

*model adjusted for psychological distress (mediator), and covariates (age, sex, physical activity and BMI)

Data Sharing

Original data for this paper is available from the corresponding author

Contributorship

The study was developed and designed by all authors, and supervised by MD. Data preparation and analysis was undertaken by JCM, MC, and OR. The initial draft of the paper was prepared by JCM, following extensive discussions with MC, OR MD. Successive drafts were developed by JCM, with inputs from the other co-authors. All authors have reviewed and approved the final version.

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Psychological distress mediates the association between daytime sleepiness and consumption of sweetened products: Cross-sectional findings in a Catholic Middle Eastern Canadian community

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Psychological distress mediates the association between daytime sleepiness and consumption of sweetened products: Cross-sectional findings in a Catholic Middle Eastern Canadian community.

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Abstract

Objective: To examine the associations between consumption of sweetened products, daytime sleepiness (DS) and psychological distress (PD) in a Catholic Middle Eastern Canadian community, and to test the hypothesis that the association between DS and consumption of sweetened products is mediated by PD.

Design: Cross-sectional study

Setting: A Catholic Middle-Eastern Canadian community

Participants: 186 men and women aged between 18-60 years old

Primary and secondary outcome measures: Sweetened product consumption was measured using a food frequency questionnaire (total sugars/day). DS and PD were measured using standardized questionnaire. The generalised linear model was used to estimate associations between sweetened product consumption, age, sex, self-reported body mass index, DS and PD. Baron and Kenny's four-step approach in addition to the Sobel test were used to establish mediation.

Results: Average DS score was 8.2 (SD= 4.5) with 19.5% having excessive scores (>12). Mean PD score was 20.8 (SD= 6.2) with 11.8% having high distress scores. Average consumption of sweetened products was 15.5 g/day (SD=13.9). Baron and Kenny's three steps to establish partial mediation were confirmed. First, DS was associated with consumption of sweetened products ($p<0.03$). Second, DS and PD were correlated ($r=0.197$; $p<0.04$). Third, PD was associated with consumption of sweetened products ($p<0.01$) when both PD and DS were entered as predictors in a multivariate regression. However, Baron and Kenny's fourth step to establish complete mediation was not met. The effect of DS on consumption of sweetened products controlling for PD was reduced but it was not zero. Finally, the Sobel test was significant (2.14; $p<0.03$).

Conclusion: The association between daytime sleepiness and consumption of sweetened products in the Catholic Middle Eastern Canadian communit is partially mediated by psychological distress. Further work should test this mediation relationship in larger samples and verify the potential effects of other sleep variables in this relationship.

Key words: Migrants, Middle Eastern Canadian, sweetened products, dietary sugars, daytime sleepiness, sleep, psychological distress, depression, mediation analysis.

Article focus:

- This study examines the association between consumption of sweetened products, daytime sleepiness and psychological distress in a Catholic Middle Eastern Canadian community
- We use Baron and Kenny's (1986) four-step approach and the Sobel test to examine alternative mediating models between these three variables

Key messages

- Daytime sleepiness is associated to the consumption of sweetened products and this association is partially mediated by psychological distress
- This study highlights that sleep, mood and diet are interconnected, and that efforts to improve diet quality must consider the psychosocial well-being of individuals

Strength and limitations

- The strengths include the testing of alternative mediating models and the use of well-established procedures to assess mediation
- Due to the cross-sectional nature of the study it is impossible to know the causal order of the observed associations, and the existence of bi-directional effects
- Further work is needed to test this mediation relationship in larger samples and to verify the potential effects of sleep duration and quality of sleep in this relationship.

Introduction

The prevalence of overweight/obesity and chronic diseases, as well as their associated risk factors, vary dramatically by ethnic groups in Canada[1]. Canadians of Arab (or Middle East) origin[1] represent more than 1.2% of the total Canadian population[2] and comprise one of the largest non-European ethnic groups in Canada. After adjusting for socioeconomic factors, Arab Canadians are less likely to be obese than Black, Latin, and Aboriginal groups, however more likely to be obese than Chinese, Japanese, South Asian groups, as well as the White reference group [3]. Furthermore, the prevalence of obesity is much higher amongst long-term Arab migrants (≥11 or more years) than the more recent migrants (≤10 years) to Canada[1]. The high prevalence of obesity amongst Arabs and the finding that the prevalence increases with time may result from the adoption of dietary and behavioural risk factors uncommon to the environment of their home countries prior to migration and acquired during the acculturation process in Canada[1, 4, 5].

A modifiable dietary risk factor contributing to the development of obesity is the consumption of ultra-processed products high in dietary sugars, or sweet food and drink products [6]. Such products include soft drinks, sweetened juices and beverages, candies and chocolates, sugary baked goods, ice creams, and other desserts[7]. These products share many nutritional characteristics that make them unhealthy; they are energy dense (for solids), they have an excessive content in free sugars, and some are also high in fats and saturated fats[8]. Furthermore, they are sold in large portion sizes and are commonly consumed as snacks both of which may contribute to energy imbalance[9]. Even more problematic is the fact that sweetened products have specific psychological properties that trigger consumption; they are hyper-palatable [10-12] and their sweet taste works to alleviate dysphoric mood or stress through dopaminergic and opioidergic neuro-transmission in the brain[13-15].

[1] Denotes people from the Middle East or North African region who reported Arab (or an origin that originates in the region commonly referred to as the Arab world), either alone or in combination with other ethnic origins in response to the question on ethnic origin in the 2001 Census or 2002 Ethnic Diversity Survey. In this paper, the terms Arab and Middle Eastern are used interchangeably.

Middle Easterners are known for the daily consumption of sweet tea. However, other sweetened products have a secondary role in traditional Middle Eastern cuisine in that they are mostly home-prepared pastries and deserts most frequently consumed during festivities and on special occasions [16, 17]. Young Egyptian women and men more often reported cravings for savories (meat and vegetables based dishes) than cravings for sweets, contrary to studies conducted in Canada and United States [18]. However, the quantity, use and significance of sweetened products have significantly changed in the last decades in Lebanon, Egypt and Syria, with a parallel increase in obesity and chronic diseases [16, 19, 20]. Similarly, Arabs are exposed to a new food environment when they migrate to Canada where sweetened products are abundant, cheap, convenient, accessible, and part of the mainstream food culture. Such an experience creates a variety of social and economic challenges for maintaining ethnic cuisine as a marker of community affiliation and may be a potential source of stress and anxiety [21].

Understanding why individuals consume sweetened products is a complex issue, especially given the psychological properties of these products and their effects in the brain. A review of the literature suggests that two sets of inter-related psychosocial factors are associated with the consumption of sweetened products; sleep-related problems and mood/stress-related problems. However, the nature of the relationships between these factors is not well understood [22].

Excessive daytime sleepiness is characterized by persistent sleepiness and lack of energy, most often caused by sleep deprivation, obstructive sleep apnea and/or use of medication [23]. It is present in all individuals, regardless of age, and recognized as the first symptom that defines narcolepsy [24]. Both excessive daytime sleepiness [25, 26] and narcolepsy [24] have been associated with the development and/or exacerbation of obesity. One potential mechanism explaining this association is through effects on appetite and intake of food[22]. Indeed, excessive daytime sleepiness has been associated with the consumption of food high in fats, as well as refined carbohydrates[22]. A recent study found that excessive daytime sleepiness was associated with the consumption of refined carbohydrate-rich snacks amongst Japanese children[27]. A very-low

carbohydrate, high-protein diet has shown improvement in daytime alertness in adults patients with narcolepsy[28]. In another study, subjects fed a carbohydrate liquid diet scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet [29]. Hormonal, metabolic, and inflammatory mechanisms could explain why a diet high in fats and/or sugars could induce somnogenic effects in the body [22].

There is evidence that the association between daytime sleepiness and sweetened products may be explained by the meditating effects of mood/stress problems, such as psychological distress. This mediating effect is supported in the literature for some of Baron and Kenny's criteria to establish mediation[30]. First, there is supporting evidence that daytime sleepiness is associated with consumption of processed food high in dietary sugars [27,28]. Second, daytime sleepiness is correlated with depression and psychological distress in both Western and Arab populations [31-34]. Third, a preference for chocolate and other sweetened products is well documented in depressed and psychological distressed individuals[35, 36]. This preference could be explained by the effects of sweets on relieving mood or stress [13-15]. If sleepy individuals also tend to feel distressed, and psychological distress induces the consumption of sweetened products, then the relationship between daytime sleepiness and the consumption of these products could be, at least, partially mediated by psychological distress.

Daytime sleepiness and psychological distress, and their relationship to the consumption of sweetened products have never been studied in Arab Canadians. Addressing this gap could shed light on the prevention/management of obesity in the Canadian Arab community. The burden of obesity in this community has important human and economic consequences for the Canadian public health system because Arabs are one of the fastest growing migrant groups in Canada, constituting more than 4% of the urban population of Montreal and Ottawa[2]. Understanding the relationship between daytime sleepiness, psychological distress and diet could provide useful information to improve daytime alertness, psychological well-being and diet quality, all of which are known risk factors to obesity and chronic diseases. From this perspective, this paper has two objectives: 1) to assess the prevalence of excessive daytime sleepiness and psychological distress in an

Arab community living in Montreal[2], and 2) to test whether the relationship between daytime sleepiness and consumption of sweetened products is mediated by psychological distress using Baron and Kenny's [30] criteria and the Sobel test.

Methods:

Participants

The Middle Eastern or Arab community living in Canada is heterogeneous in terms of its country of birth and religious affiliation. The main groups are Lebanese (41%), Egyptian (12%), Syrian (6%), Moroccan (6%), and Iraqi (6%)[2]. Canadians of Arab origin are equally divided between Muslims and Christians, of which the majority is Catholic[2]. The sociocultural heterogeneity within the Middle Eastern community is essential to acknowledge, especially because religious beliefs impose dietary restrictions and may influence psychosocial factors related to health in Arab Muslims [21, 37].

The target population of this study is an established Catholic Middle Eastern community living in Montreal, Canada. This population is composed of first and second generation migrants, mostly from Egypt, Lebanon and Syria. Recruitment and data collection occurred at three Catholic Middle Eastern churches located in Montreal. Participation was solicited through public announcements and was limited to one respondent per household to avoid bias related to family customs. Subjects were all volunteers and could withdraw from the study at any point.

The research protocol was submitted and approved by the ethics committee of the Centre Hospitalier de l'Université de Montréal (SL 06-063). All participants provided informed written consent.

Instruments

Socio-demographic characteristics were collected using a self-reported questionnaire adapted from Health Canada[38]. Physical activity was assessed by asking the question "how many times per week do you exercise enough to sweat? " Five response categories were provided ranging from 0 to 4 or more times per week. Participants also self-reported

height and weight. BMI was calculated as weight (kg)/ height $(m)^2$ and categorized as normal weight (BMI < 25); overweight 25 ≥ BMI< 30); and obese (BMI>30) [39].

Food consumption was assessed using a food frequency questionnaire (FFQ) previously developed and pretested with the study community to measure consumption of 26 different sweet food and drink products [7]. This questionnaire is easy to read and to understand, and culturally relevant to the study community. To answer the FFQ, respondents reported the average number of days per week, in a typical week, in which each listed product was eaten or drank (i.e., excluding festivities). Participants were also asked to report how many portions of the food item they typically ate. Examples of portions sizes were taken from the Canadian Nutrient File (CNF) and provided to participants[40]. For the purpose of this study, we selected food items representing sweetened products, which include cookies, chocolate, cakes and candies.

Daytime sleepiness was measured using the self-report *Epworth Sleepiness Scale* (ESS) [41]. Respondents used a four-point scale (0 to 3) to express their perceived likelihood of falling asleep during the day in eight different situations (sitting and reading, watching television, sitting inactive in a public place, as a passenger in a car for an hour without a break, lying down to rest in the afternoon when circumstances permit, sitting and talking to someone, and sitting quietly after a lunch without alcohol). The ESS instrument has a high internal consistency (Cronbach's alpha = 0.88) and a high test-retest reliability after 5 months (r = 0.82)[42]. For descriptive purposes, daytime sleepiness scores on the ESS were coded into three levels of increasing daytime sleepiness: low (ESS scores 0-5), intermediate (ESS scores 6-11) and high (ESS scores 12-24). Intermediate (6-11) and high (12-24) ESS scores were shown to have a 30% and 69% increased risk for sleep onset during the Multiple Sleep Latency Test (MSLT), an objective measure of daytime sleep tendency [43].

Psychological distress was measured using the *Kessler Psychological Distress Scale* (K10) [44]. This instrument is composed of 10 questions on anxiety and depressive symptomology. Respondents self-reported the degree to which they had these feelings for

the month prior to completing the instrument using a five-point Likert scale (all the time, often, sometimes, rarely, never). Scores, ranging from 10 to 50, represent an increasing gradient of psychological distress. The K10 instrument has a high internal consistency (Cronbach's alpha = 0,92) [44]. For descriptive purposes, psychological distress scores on the K10 were grouped into standard groups as low (10-20), moderate (21-29) and high levels of psychological distress (30-50) [44].

Analysis

Data were analyzed using SPSS (Version 18.0). As a first step, we present descriptive data on the consumption of sweetened products according to sex, age, body mass index (BMI), physical activity, daytime sleepiness, and psychological distress. Consumption of sweetened products corresponded to the daily amount of total sugars eaten from cakes, cookies, chocolate, and candies. This was calculated using data on the frequency and portions consumed from these products obtained from the FFQ, and the estimated amount of total sugars contained in mean portions of these products using CNF.

As a second step, univariate regression analysis was performed to estimate the associations between consumption of sweetened products and age, sex, physical activity, BMI, daytime sleepiness and psychological distress. Similar tests were performed to verify if the consumption of sweetened products varied by other socio-demographics (country of birth, time since migration, family income, education level, civil status and employment status). For all regression analyses, consumption of sweetened products was log-transformed. Physical activity was used as a ordinal measure using the five answer choices (0-4 times or more per week). All other variables were used as continuous measures.

Next, we applied the Baron and Kenny [30,45] criteria to assess whether the relationship between daytime sleepiness (independent variable) and consumption of sweetened products (dependent variable) was mediated by psychological distress (mediator). According to Baron and Kenny four statistical conditions need to be met in order to establish complete mediation and three conditions to establish partial mediation [30, 45].

First, univariate regression was used to test if daytime sleepiness was significantly associated with consumption of sweetened products. Second, we assessed whether daytime sleepiness and psychological distress were significantly associated. Third, we tested whether psychological distress (mediator) was associated with the consumption of sweetened products when both daytime sleepiness and psychological distress were entered as predictors in a multivariate regression analysis. Fourth, to establish that psychological distress completely mediates the relationship between daytime sleepiness and consumption of sweetened products, we examined whether the effect of daytime sleepiness on consumption of sweetened products controlling for psychological distress was zero. If the first three steps are met but the Step 4 is not, then partial mediation is indicated [45]. The Sobel test was used to statistically evaluate whether the indirect effect of the independent variable on the dependent variable through the mediator variable was significant[46].

As a final step, we ran alternative mediation models to rule out plausible competing interpretations of the data and to verify whether our hypothesized model best fit the data. First, daytime sleepiness was entered as the mediator of the relationship between psychological distress (independent) and consumption of sweetened products (dependent). In a second alternative model, consumption of sweetened products was entered as the mediator of the relationship between daytime sleepiness (independent variable) and psychological distress (dependent variable).

Results

Participants were aged between 18 and 60 years (Mean = 34.6; Standard deviation (SD) = 12.5). There were slightly more women (*n* 101) than men (*n* 85). Country of birth included Egypt (31.9 %), Lebanon (25.1 %), Syria (14.7 %), and other Middle Eastern countries (5.3 %). Individuals migrated between 1962 and 2007, of which 86% arrived before 2000, meaning they have spent more than 10 years in Canada. An additional 23.0% of subjects were born in Canada; these were second-generation migrants (i.e., children of immigrating parents born in the Middle Eastern). Participant´s civil status was as follows; married or engaged (47.3%), single (46.2%), separated/divorced (4.3%), and

widowed (2.2%). The vast majority of respondents had at least a college diploma (88.0%), and most had a university degree (65.8%). Most participants had a family income above CAD $50,000 (66.9%).

Average consumption of sweetened products was of 15.5 g/day (SD=13.9; *n* 186) with the range from 0 to 93.1 g/day. The share of each food item to the amount of total sugars from these products was as follows; cakes (51.3%), chocolate (24.7%), cookies (16.1%) and candies (7.9 %).

The average daytime sleepiness score on ESS was 8.2 (SD= 4.5) (*n* 186). A third of individuals (30.1%) had a low daytime sleepiness score (0-5) and half (50.5%) had an intermediate daytime sleepiness score (6-11). One-fifth of individuals (19.5%) had a high daytime sleepiness score (12-24). Almost one-third of individuals met the clinical criteria for excessive daytime sleepiness (EDS) (defined as ESS scores above 10). Daytime sleepiness did not vary by sex, age or BMI.

The average psychological distress score on the K10 was 20.8 (SD= 6.2) (*n* 186). More than one half the respondents (55.4%) had a low distress score of 0-20; one-third (32.8%) had a moderate distress score of 21-30; and one-tenth had a high distress score of 30-50 (11.8%). Psychological distress did not vary by sex, age or BMI.

Table 1 presents descriptive data on the consumption of sweetened products according to age, sex, physical activity, BMI, daytime sleepiness, and psychological distress. Females consumed slightly more sweetened products than males (1.7g/day), while patterns for age and BMI were less defined. Importantly, the consumption of sweetened products varied according to psychological distress and daytime sleepiness score levels. Individuals with high distress ate an additional 5.6g of total sugars/day, 45% more than individuals with moderate distress, and an additional 8.5g of total sugars/day, 68% more than individuals with low distress. Individuals with high daytime sleepiness (>12) ate an additional 2.9g of total sugars/day, 23% more than subjects with moderate daytime sleepiness, and an additional 6.9g of total sugars/day, 54% more than individuals with low daytime

sleepiness. Other socio-demographics were not related statistically to the consumption of sweetened products.

Table 1 also presents the results of univariate regression analyses between consumption of sweetened products (log-transformed) and age, sex, BMI, daytime sleepiness, and psychological distress. Consumption of sweetened products did not vary significantly by age, sex or BMI. The consumption of sweetened products was positively associated with psychological distress ($p<0.00$), as well with daytime sleepiness ($p<0.04$).

Multivariate analysis (Table 2) consisted of simultaneous modeling daytime sleepiness and psychological distress. In this model, the association between psychological distress and consumption of sweetened products remained statistically significant ($p<0.01$), whereas the relationship with daytime sleepiness was no longer significant ($p<0.09$).

We were able to verify the first three steps of Baron and Kenny[30] to establish mediation. First, daytime sleepiness was significantly associated with the consumption of sweetened products ($p<0.04$). Second, daytime sleepiness and psychological distress were significantly correlated ($r=0.15$; $p<0.04$). Third, psychological distress was associated with the consumption of sweetened products ($p<0.01$) when both psychological distress and daytime sleepiness were entered as predictors in the multivariate regression model. However, the fourth step was not met. In our analysis, the effect of daytime sleepiness on consumption of sweetened products controlling for psychological distress was reduced but it was not zero. Finally, the Sobel test showed that the indirect effect of the independent variable on the dependent variable through the mediator variable was significant (Sobel statistic=2.14; SE=0.01; $p<0.03$).

In order to strengthen the robustness of the results, two alternative mediation models were tested. In the first alternative model, Baron and Kenny's third criteria was not satisfied. Indeed, daytime sleepiness (mediator) was not associated ($p<0.15$) with psychological distress (dependent) when both daytime sleepiness and consumption of sweetened products (independent) were entered as predictors in a multivariate regression

analysis. In the second alternative model, all first three Baron and Kenny's criteria were satisfied. However, comparing both models using Akaike information criterion (AIC) indicated that the hypothesized mediation model (AIC=848) is a far better fit than this second alternative model (AIC=1205). Furthermore, the Sobel test for the second alternative mediation model showed that the indirect effect of the independent variable on the dependent variable through the mediator variable was not significant (Sobel statistic=1.63 SE=0.12; $p<0.1$).

Lastly, the robustness of our analyses could be biased by the moderate association that exists between daytime sleepiness and the K10 instrument first item (K1) that assesses faitgue/tiredness ($r=0.18$; $p<0.02$). To verify this, we repeated our analyses by using a total score of K9 (i.e., K10 after excluding item #1). This did not change the nature of our results because 1) daytime sleepiness and K9 were still significantly correlated ($r=0.14$; $p<0.04$); 2) K9 was associated with the consumption of sweetened products ($\beta=0.17$; $p<0.02$) when both K9 and daytime sleepiness were entered as predictors in the multivariate regression model, and 3) the effect of daytime sleepiness on consumption of sweetened products controlling for psychological distress was reduced but it was not zero.

Discussion

The data presented in this paper show that the level of daytime sleepiness in the Catholic Middle Eastern Canadian community is statistically associated with higher consumption of sweetened products, such as chocolate, candies, cakes and cookies. Most importantly, we found that the first three criteria defined by Baron and Kenny to establish mediation were met, but that the fourth criteria was not. The results suggest that the relationship between daytime sleepiness and consumption of sweetened products is partially mediated by the level of psychological distress.

The strengths of this study are the use of well-established procedures to assess mediation - Baron and Kenny's (1986) four-step approach and the Sobel test, and the examination of alternative mediating models. Our analysis, however, was based on assumptions of

having a correctly specified mediation model, including no misspecifications of causal order and of causal direction, or of imperfect measurements and unmeasured variables [47]. In reality, such assumptions are difficult or even impossible to achieve. By testing alternative mediate models we showed that the one we described is the best fitted to account for the relationship between these three variables. Furthermore, data from prior research support the proposition that a mediation relation exists between these variables.

The relationship observed between daytime sleepiness and consumption of food high in dietary sugars is consistent with previous studies conducted in western and non-western settings [27-29]. Similarly, previous work provides strong support that the consumption of sweetened products is triggered by negative emotional or distress feelings in western populations. Negative mood (as measured by anxiety, fatigue and depression scales) has been correlated with craving intensity for sweet food [36]. Experimental studies have also demonstrated an association between stress or negative mood and the consumption of savory foods in emotional eaters [35, 48]. Thus one explanation in support of our mediating model is that individuals who experience daytime sleepiness may consume energy dense sugary rich foods to upgrade their energy level or to alleviate their negative mood or psychological distress. This explanation fits with the fueling and emotional functions attributed to sweetened food and drink products by members of the studied community in semi-structured interviews [49]. Furthermore, this explanation has biological plausibility since sweet taste may alleviate dysphoric mood or stress through dopaminergic and opioidergic neurotransmission in the brain [13-15].

It would be interesting to explore which of anxiety or depression correlate stronger with daytime sleepiness since the K10 instrument contains items that assesses both symptoms. However, this instrument is used as a single scale because anxiety and depression items are highly correlated. There is nevertheless evidence that both anxiety and depression are highly correlated with excessive daytime sleepiness and fatigue [34].

Our study highlights that sleep, mood and diet are interconnected, and that efforts to improve diet quality must consider the psychosocial well-being of individuals, especially given the known properties of sweets to temporarily alleviate fatigue, stress and anxiety. These results have important public health implications for the prevention of obesity and chronic diseases, which are growing concerns in the Arab Canadian community[3]. Indeed, consumption of processed products high in dietary sugars is recognized as an important contributor to the development of these diseases[6]. As reported elsewhere, the consumption level of total sugars (all foods considered), ~ 20% of diet, in this community is now similar that of the Canadian and Quebec population[7]. The average daytime sleepiness score (8.2) and the prevalence of EDS (28%) measured in this paper are within the range noted in western countries[50]. The obesity prevalence of 15.6% is also similar to the Canadian average and the general Arab community, when self-reported measures are taken[3].

The prevalence of high psychological distress (K10>30) at 11.8% is nearly half that of the Canadian average, reported to be 20.7% [51]. It is possible that sociocultural factors such as family social support or having a religious faith protect against anxiety and depression. Religious affiliation, for example, is higher in the Middle Eastern community (94%) than in the overall population (83%)[2]. Also, the strength and size of social network shown to have tempering effect on weight gain and the general health of individuals living in large Canadian ethnic groups [5]. The sources of psychological distress in the Middle Eastern Canadian community are, however, unknown and warrant future research. Socioeconomic difficulties do not seem to play an essential role in our population sample, since employment rate, education level and household income were found to be relatively high. The difficulties of maintaining traditional dietary practices in the host country may be potential sources of social and economic stress [21].

In our analysis, BMI had a positive, but not significant association with daytime sleepiness. In a previous paper, we observed an inverse (but not significant) relationship between consumption of sweetened products and BMI in the same community [7]. These results, however, must be interpreted by taking into account that overweight and obese

subjects may have under-reported their weight or under-reported their consumption of sweetened products, but also the cross-sectional design.

This study has limitations. First, the sample size was small and thus statistical power was limited. However, the composition of our sample reflects the characteristics of the general Catholic Middle Eastern Canadian community in terms of birthplace, religious affiliation, education and income[2]. Our findings, however, cannot be generalized to the Muslim Arab Canadian community. Second, the study is based on self-reported measures. However, both instruments we used (ESS and K10) are valid and reliable instruments widely used in both sleep and mood-related studies. Third, we did not account for other sleep problem measures, including duration of sleep and sleep deprivation, as well as other potential confounding disorders. Sleep duration and obstructive sleep apnea are the most common causes of daytime sleepiness[22], but studies examining the relationships between sleep duration, dietary intake and obesity has produced mixed results[52]. Fourth, findings are based on cross-sectional data. Therefore, it is impossible to know the causal order of the observed associations, and the existence of bi-directional effects, for example, between the consumption of foods high in dietary sugars and daytime sleepiness.

Conclusion

This study expands the limited evidence base concerning the association between consumption of sweetened products, daytime sleepiness and psychological distress in any communities including migrants ones. One novel contribution of this study is its inclusion of a measure of psychological distress and the use of Baron and Kenny's [30, 44] four-step approach and the Sobel test to establish that the consumption of sweetened products and daytime sleepiness is partially mediated by psychological distress. One possible explanation in support of this relationship is that individuals experiencing daytime sleepiness may reach for energy dense sugary rich foods in order to upgrade their energy level or to alleviate their psychological distress. Further work is needed to test this mediation relationship in larger samples and to verify the potential effects of sleep duration and quality of sleep in this relationship.

Table 1 Consumption of sweetened products (total sugars/day) according to age, sex, BMI, physical activity, BMI, psychosocial distress and daytime sleepiness scores (*n* 186).

Factors	Subjects		Sweetened products (g/day)		P <*
	n	%	Mean	SE	
Sex					0.66
Male	85	45.7	14.6	1.5	
Female	101	54.3	16.3	1.4	
Age					0.59
18-30	83	44.6	19.5	1.6	
31-40	50	26.9	12.7	1.7	
41-50	21	11.3	17.2	4.2	
51-60	32	17.2	12.4	1.8	
Physical activity					0.31
No activity	57	30.6	16.6	1.8	
1 time per week	50	26.9	17.3	2.1	
2 times per week	31	16.7	13.4	2.2	
3 times per week	30	16.1	11.4	1.6	
≥ 4 times per week	18	9.7	17.3	5.0	
Body mass index					0.86
Normal (18.5-24.9)	88	44.6	16.5	1.5	
Overweight (25-29.9)	69	37.1	13.6	1.4	
Obese(>30)	29	15.6	17.1	3.3	
Psychological distress (K10 scores)					0.00
Low (10-20)	103	55.4	12.7	1.1	
Moderate (21-30)	61	32.8	18.3	1.8	
High (30-50)	22	11.8	21.2	4.3	
Daytime sleepiness (ESS scores)					0.04
Low (0-5)	56	30.1	12.7	1.5	
Moderate (6-11)	94	50.5	15.6	1.5	
High (12-24)	36	19.4	19.6	2.3	

*In the univariate regression analysis, sweetened products was log-transformed and all variables were entered as continuous (age, BMI, psychological distress scores (10-50) and daytime sleepiness scores (0-24). Physical activity categories were created by asking "how many times per week do you exercising enough to sweat?" and answers ranged from 0-4 or more times per week.

Table 2 Relationships between consumption of sweetened products, daytime sleepiness and psychological distress in the multivariate model (*n* 186)

	β	SE	Sβ	T value	P<
Model[1]					
Daytime sleepiness	0.05	0.02	0.16	2.15	0.04
Model[2]					
Constant	2.75	0.54		5.10	0.00
Daytime sleepiness	0.03	0.02	0.12	1.69	0.09
Psychological distress	0.05	0.02	0.19	2.61	0.01

β = Beta coefficient; Sβ = standardized Beta coefficient; SE= standard error
Consumption of sweetened products was log-transformed. Psychological distress scores (10-50) and daytime sleepiness scores (0-24) are entered as continuous and are normally distributed.
[1] Model summary: R=0.15, F=4.26, p<0.04; [2] Model summary: R=0.27, F=2.37, p<0.03, adjusted for psychological distress (mediator) and age.

Contributorship

The study was developed and designed by all authors, and supervised by MD. Data preparation and analysis was undertaken by JCM, MC, and OR. The initial draft of the paper was prepared by JCM, following extensive discussions with MC, OR MD. Successive drafts were developed by JCM, with inputs from the other co-authors. All authors have reviewed and approved the final version.

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Psychological distress mediates the association between daytime sleepiness and consumption of sweetened products: Cross-sectional findings in a Catholic Middle Eastern Canadian community.

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Abstract

Objective: To examine the associations between consumption of sweetened products, daytime sleepiness (DS) and psychological distress (PD) in a Catholic Middle Eastern Canadian community, and to test the hypothesis that the association between DS and consumption of sweetened products is mediated by PD.

Design: Cross-sectional study

Setting: A Catholic Middle-Eastern Canadian community

Participants: 186 men and women aged between 18-60 years old

Primary and secondary outcome measures: Sweetened product consumption was measured using a food frequency questionnaire (total sugars/day). DS and PD were measured using standardized questionnaire. The generalised linear model was used to estimate associations between sweetened product consumption, age, sex, self-reported body mass index, DS and PD. Baron and Kenny's four-step approach in addition to the Sobel test were used to establish mediation.

Results: Average DS score was 8.2 (SD= 4.5) with 19.5% having excessive scores (>12). Mean PD score was 20.8 (SD= 6.2) with 11.8% having high distress scores. Average consumption of sweetened products was 15.5 g/day (SD=13.9). Baron and Kenny's three steps to establish partial mediation were confirmed. First, DS was associated with consumption of sweetened products ($p<0.03$). Second, DS and PD were correlated ($r=0.197$; $p<0.04$). Third, PD was associated with consumption of sweetened products ($p<0.01$) when both PD and DS were entered as predictors in a multivariate regression. However, Baron and Kenny's fourth step to establish complete mediation was not met. The effect of DS on consumption of sweetened products controlling for PD was reduced but it was not zero. Finally, the Sobel test was significant (2.14; $p<0.03$).

Conclusion: The association between daytime sleepiness and consumption of sweetened products in the Catholic Middle Eastern Canadian communit is partially mediated by psychological distress. Further work should test this mediation relationship in larger samples and verify the potential effects of other sleep variables in this relationship.

Key words: Migrants, Middle Eastern Canadian, sweetened products, dietary sugars, daytime sleepiness, sleep, psychological distress, depression, mediation analysis.

Article focus:

- This study examines the association between consumption of sweetened products, daytime sleepiness and psychological distress in a Catholic Middle Eastern Canadian community
- We use Baron and Kenny's (1986) four-step approach and the Sobel test to examine alternative mediating models between these three variables

Key messages

- Daytime sleepiness is associated to the consumption of sweetened products and this association is partially mediated by psychological distress
- This study highlights that sleep, mood and diet are interconnected, and that efforts to improve diet quality must consider the psychosocial well-being of individuals

Strength and limitations

- The strengths include the testing of alternative mediating models and the use of well-established procedures to assess mediation
- Due to the cross-sectional nature of the study it is impossible to know the causal order of the observed associations, and the existence of bi-directional effects
- Further work is needed to test this mediation relationship in larger samples and to verify the potential effects of sleep duration and quality of sleep in this relationship.

Introduction

The prevalence of overweight/obesity and chronic diseases, as well as their associated risk factors, vary dramatically by ethnic groups in Canada[1]. Canadians of Arab (or Middle East) origin[1] represent more than 1.2% of the total Canadian population[2] and comprise one of the largest non-European ethnic groups in Canada. After adjusting for socioeconomic factors, Arab Canadians are less likely to be obese than Black, Latin, and Aboriginal groups, however more likely to be obese than Chinese, Japanese, South Asian groups, as well as the White reference group [3]. Furthermore, the prevalence of obesity is much higher amongst long-term Arab migrants (≥11 or more years) than the more recent migrants (≤10 years) to Canada[1]. The high prevalence of obesity amongst Arabs and the finding that the prevalence increases with time may result from the adoption of dietary and behavioural risk factors uncommon to the environment of their home countries prior to migration and acquired during the acculturation process in Canada[1, 4, 5].

A modifiable dietary risk factor contributing to the development of obesity is the consumption of ultra-processed products high in dietary sugars, or sweet food and drink products [6]. Such products include soft drinks, sweetened juices and beverages, candies and chocolates, sugary baked goods, ice creams, and other desserts[7]. These products share many nutritional characteristics that make them unhealthy; they are energy dense (for solids), they have an excessive content in free sugars, and some are also high in fats and saturated fats[8]. Furthermore, they are sold in large portion sizes and are commonly consumed as snacks both of which may contribute to energy imbalance[9]. Even more problematic is the fact that sweetened products have specific psychological properties that trigger consumption; they are hyper-palatable [10-12] and their sweet taste works to alleviate dysphoric mood or stress through dopaminergic and opioidergic neuro-transmission in the brain[13-15].

[1] Denotes people from the Middle East or North African region who reported Arab (or an origin that originates in the region commonly referred to as the Arab world), either alone or in combination with other ethnic origins in response to the question on ethnic origin in the 2001 Census or 2002 Ethnic Diversity Survey. In this paper, the terms Arab and Middle Eastern are used interchangeably.

Middle Easterners are known for the daily consumption of sweet tea. However, other sweetened products have a secondary role in traditional Middle Eastern cuisine in that they are mostly home-prepared pastries and deserts most frequently consumed during festivities and on special occasions [16, 17]. Young Egyptian women and men more often reported cravings for savories (meat and vegetables based dishes) than cravings for sweets, contrary to studies conducted in Canada and United States [18]. However, the quantity, use and significance of sweetened products have significantly changed in the last decades in Lebanon, Egypt and Syria, with a parallel increase in obesity and chronic diseases [16, 19, 20]. Similarly, Arabs are exposed to a new food environment when they migrate to Canada where sweetened products are abundant, cheap, convenient, accessible, and part of the mainstream food culture. Such an experience creates a variety of social and economic challenges for maintaining ethnic cuisine as a marker of community affiliation and may be a potential source of stress and anxiety [21].

Understanding why individuals consume sweetened products is a complex issue, especially given the psychological properties of these products and their effects in the brain. A review of the literature suggests that two sets of inter-related psychosocial factors are associated with the consumption of sweetened products; sleep-related problems and mood/stress-related problems. However, the nature of the relationships between these factors is not well understood [22].

Excessive daytime sleepiness is characterized by persistent sleepiness and lack of energy, most often caused by sleep deprivation, obstructive sleep apnea and/or use of medication [23]. It is present in all individuals, regardless of age, and recognized as the first symptom that defines narcolepsy [24]. Both excessive daytime sleepiness [25, 26] and narcolepsy [24] have been associated with the development and/or exacerbation of obesity. One potential mechanism explaining this association is through effects on appetite and intake of food[22]. Indeed, excessive daytime sleepiness has been associated with the consumption of food high in fats, as well as refined carbohydrates[22]. A recent study found that excessive daytime sleepiness was associated with the consumption of refined carbohydrate-rich snacks amongst Japanese children[27]. A very-low

carbohydrate, high-protein diet has shown improvement in daytime alertness in adults patients with narcolepsy[28]. In another study, subjects fed a carbohydrate liquid diet scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet [29]. Hormonal, metabolic, and inflammatory mechanisms could explain why a diet high in fats and/or sugars could induce somnogenic effects in the body [22].

There is evidence that the association between daytime sleepiness and sweetened products may be explained by the meditating effects of mood/stress problems, such as psychological distress. This mediating effect is supported in the literature for some of Baron and Kenny's criteria to establish mediation[30]. First, there is supporting evidence that daytime sleepiness is associated with consumption of processed food high in dietary sugars [27,28]. Second, daytime sleepiness is correlated with depression and psychological distress in both Western and Arab populations [31-34]. Third, a preference for chocolate and other sweetened products is well documented in depressed and psychological distressed individuals[35, 36]. This preference could be explained by the effects of sweets on relieving mood or stress [13-15]. If sleepy individuals also tend to feel distressed, and psychological distress induces the consumption of sweetened products, then the relationship between daytime sleepiness and the consumption of these products could be, at least, partially mediated by psychological distress.

Daytime sleepiness and psychological distress, and their relationship to the consumption of sweetened products have never been studied in Arab Canadians. Addressing this gap could shed light on the prevention/management of obesity in the Canadian Arab community. The burden of obesity in this community has important human and economic consequences for the Canadian public health system because Arabs are one of the fastest growing migrant groups in Canada, constituting more than 4% of the urban population of Montreal and Ottawa[2]. Understanding the relationship between daytime sleepiness, psychological distress and diet could provide useful information to improve daytime alertness, psychological well-being and diet quality, all of which are known risk factors to obesity and chronic diseases. From this perspective, this paper has two objectives: 1) to assess the prevalence of excessive daytime sleepiness and psychological distress in an

Arab community living in Montreal[2], and 2) to test whether the relationship between daytime sleepiness and consumption of sweetened products is mediated by psychological distress using Baron and Kenny's [30] criteria and the Sobel test.

Methods:

Participants

The Middle Eastern or Arab community living in Canada is heterogeneous in terms of its country of birth and religious affiliation. The main groups are Lebanese (41%), Egyptian (12%), Syrian (6%), Moroccan (6%), and Iraqi (6%)[2]. Canadians of Arab origin are equally divided between Muslims and Christians, of which the majority is Catholic[2]. The sociocultural heterogeneity within the Middle Eastern community is essential to acknowledge, especially because religious beliefs impose dietary restrictions and may influence psychosocial factors related to health in Arab Muslims [21, 37].

The target population of this study is an established Catholic Middle Eastern community living in Montreal, Canada. This population is composed of first and second generation migrants, mostly from Egypt, Lebanon and Syria. Recruitment and data collection occurred at three Catholic Middle Eastern churches located in Montreal. Participation was solicited through public announcements and was limited to one respondent per household to avoid bias related to family customs. Subjects were all volunteers and could withdraw from the study at any point.

The research protocol was submitted and approved by the ethics committee of the Centre Hospitalier de l'Université de Montréal (SL 06-063). All participants provided informed written consent.

Instruments

Socio-demographic characteristics were collected using a self-reported questionnaire adapted from Health Canada[38]. Physical activity was assessed by asking the question "how many times per week do you exercise enough to sweat? " Five response categories were provided ranging from 0 to 4 or more times per week. Participants also self-reported

height and weight. BMI was calculated as weight (kg)/ height $(m)^2$ and categorized as normal weight (BMI < 25); overweight 25 ≥ BMI< 30); and obese (BMI>30) [39].

Food consumption was assessed using a food frequency questionnaire (FFQ) previously developed and pretested with the study community to measure consumption of 26 different sweet food and drink products [7]. This questionnaire is easy to read and to understand, and culturally relevant to the study community. To answer the FFQ, respondents reported the average number of days per week, in a typical week, in which each listed product was eaten or drank (i.e., excluding festivities). Participants were also asked to report how many portions of the food item they typically ate. Examples of portions sizes were taken from the Canadian Nutrient File (CNF) and provided to participants[40]. For the purpose of this study, we selected food items representing sweetened products, which include cookies, chocolate, cakes and candies.

Daytime sleepiness was measured using the self-report *Epworth Sleepiness Scale* (ESS) [41]. Respondents used a four-point scale (0 to 3) to express their perceived likelihood of falling asleep during the day in eight different situations (sitting and reading, watching television, sitting inactive in a public place, as a passenger in a car for an hour without a break, lying down to rest in the afternoon when circumstances permit, sitting and talking to someone, and sitting quietly after a lunch without alcohol). The ESS instrument has a high internal consistency (Cronbach's alpha = 0.88) and a high test-retest reliability after 5 months (r = 0.82)[42]. For descriptive purposes, daytime sleepiness scores on the ESS were coded into three levels of increasing daytime sleepiness: low (ESS scores 0-5), intermediate (ESS scores 6-11) and high (ESS scores 12-24). Intermediate (6-11) and high (12-24) ESS scores were shown to have a 30% and 69% increased risk for sleep onset during the Multiple Sleep Latency Test (MSLT), an objective measure of daytime sleep tendency [43].

Psychological distress was measured using the *Kessler Psychological Distress Scale* (K10) [44]. This instrument is composed of 10 questions on anxiety and depressive symptomology. Respondents self-reported the degree to which they had these feelings for

the month prior to completing the instrument using a five-point Likert scale (all the time, often, sometimes, rarely, never). Scores, ranging from 10 to 50, represent an increasing gradient of psychological distress. The K10 instrument has a high internal consistency (Cronbach's alpha = 0,92) [44]. For descriptive purposes, psychological distress scores on the K10 were grouped into standard groups as low (10-20), moderate (21-29) and high levels of psychological distress (30-50) [44].

Analysis

Data were analyzed using SPSS (Version 18.0). As a first step, we present descriptive data on the consumption of sweetened products according to sex, age, body mass index (BMI), physical activity, daytime sleepiness, and psychological distress. Consumption of sweetened products corresponded to the daily amount of total sugars eaten from cakes, cookies, chocolate, and candies. This was calculated using data on the frequency and portions consumed from these products obtained from the FFQ, and the estimated amount of total sugars contained in mean portions of these products using CNF.

As a second step, univariate regression analysis was performed to estimate the associations between consumption of sweetened products and age, sex, physical activity, BMI, daytime sleepiness and psychological distress. Similar tests were performed to verify if the consumption of sweetened products varied by other socio-demographics (country of birth, time since migration, family income, education level, civil status and employment status). For all regression analyses, consumption of sweetened products was log-transformed. Physical activity was used as a ordinal measure using the five answer choices (0-4 times or more per week). All other variables were used as continuous measures.

Next, we applied the Baron and Kenny [30,45] criteria to assess whether the relationship between daytime sleepiness (independent variable) and consumption of sweetened products (dependent variable) was mediated by psychological distress (mediator). According to Baron and Kenny four statistical conditions need to be met in order to establish complete mediation and three conditions to establish partial mediation [30, 45].

First, univariate regression was used to test if daytime sleepiness was significantly associated with consumption of sweetened products. Second, we assessed whether daytime sleepiness and psychological distress were significantly associated. Third, we tested whether psychological distress (mediator) was associated with the consumption of sweetened products when both daytime sleepiness and psychological distress were entered as predictors in a multivariate regression analysis. Fourth, to establish that psychological distress completely mediates the relationship between daytime sleepiness and consumption of sweetened products, we examined whether the effect of daytime sleepiness on consumption of sweetened products controlling for psychological distress was zero. If the first three steps are met but the Step 4 is not, then partial mediation is indicated [45]. The Sobel test was used to statistically evaluate whether the indirect effect of the independent variable on the dependent variable through the mediator variable was significant[46].

As a final step, we ran alternative mediation models to rule out plausible competing interpretations of the data and to verify whether our hypothesized model best fit the data. First, daytime sleepiness was entered as the mediator of the relationship between psychological distress (independent) and consumption of sweetened products (dependent). In a second alternative model, consumption of sweetened products was entered as the mediator of the relationship between daytime sleepiness (independent variable) and psychological distress (dependent variable).

Results

Participants were aged between 18 and 60 years (Mean = 34.6; Standard deviation (SD) = 12.5). There were slightly more women (*n* 101) than men (*n* 85). Country of birth included Egypt (31.9 %), Lebanon (25.1 %), Syria (14.7 %), and other Middle Eastern countries (5.3 %). Individuals migrated between 1962 and 2007, of which 86% arrived before 2000, meaning they have spent more than 10 years in Canada. An additional 23.0% of subjects were born in Canada; these were second-generation migrants (i.e., children of immigrating parents born in the Middle Eastern). Participant´s civil status was as follows; married or engaged (47.3%), single (46.2%), separated/divorced (4.3%), and

widowed (2.2%). The vast majority of respondents had at least a college diploma (88.0%), and most had a university degree (65.8%). Most participants had a family income above CAD $50,000 (66.9%).

Average consumption of sweetened products was of 15.5 g/day (SD=13.9; *n* 186) with the range from 0 to 93.1 g/day. The share of each food item to the amount of total sugars from these products was as follows; cakes (51.3%), chocolate (24.7%), cookies (16.1%) and candies (7.9 %).

The average daytime sleepiness score on ESS was 8.2 (SD= 4.5) (*n* 186). A third of individuals (30.1%) had a low daytime sleepiness score (0-5) and half (50.5%) had an intermediate daytime sleepiness score (6-11). One-fifth of individuals (19.5%) had a high daytime sleepiness score (12-24). Almost one-third of individuals met the clinical criteria for excessive daytime sleepiness (EDS) (defined as ESS scores above 10). Daytime sleepiness did not vary by sex, age or BMI.

The average psychological distress score on the K10 was 20.8 (SD= 6.2) (*n* 186). More than one half the respondents (55.4%) had a low distress score of 0-20; one-third (32.8%) had a moderate distress score of 21-30; and one-tenth had a high distress score of 30-50 (11.8%). Psychological distress did not vary by sex, age or BMI.

Table 1 presents descriptive data on the consumption of sweetened products according to age, sex, physical activity, BMI, daytime sleepiness, and psychological distress. Females consumed slightly more sweetened products than males (1.7g/day), while patterns for age and BMI were less defined. Importantly, the consumption of sweetened products varied according to psychological distress and daytime sleepiness score levels. Individuals with high distress ate an additional 5.6g of total sugars/day, 45% more than individuals with moderate distress, and an additional 8.5g of total sugars/day, 68% more than individuals with low distress. Individuals with high daytime sleepiness (>12) ate an additional 2.9g of total sugars/day, 23% more than subjects with moderate daytime sleepiness, and an additional 6.9g of total sugars/day, 54% more than individuals with low daytime

sleepiness. Other socio-demographics were not related statistically to the consumption of sweetened products.

Table 1 also presents the results of univariate regression analyses between consumption of sweetened products (log-transformed) and age, sex, BMI, daytime sleepiness, and psychological distress. Consumption of sweetened products did not vary significantly by age, sex or BMI. The consumption of sweetened products was positively associated with psychological distress ($p<0.00$), as well with daytime sleepiness ($p<0.04$).

Multivariate analysis (Table 2) consisted of simultaneous modeling daytime sleepiness and psychological distress. In this model, the association between psychological distress and consumption of sweetened products remained statistically significant ($p<0.01$), whereas the relationship with daytime sleepiness was no longer significant ($p<0.09$).

We were able to verify the first three steps of Baron and Kenny[30] to establish mediation. First, daytime sleepiness was significantly associated with the consumption of sweetened products ($p<0.04$). Second, daytime sleepiness and psychological distress were significantly correlated ($r=0.15$; $p<0.04$). Third, psychological distress was associated with the consumption of sweetened products ($p<0.01$) when both psychological distress and daytime sleepiness were entered as predictors in the multivariate regression model. However, the fourth step was not met. In our analysis, the effect of daytime sleepiness on consumption of sweetened products controlling for psychological distress was reduced but it was not zero. Finally, the Sobel test showed that the indirect effect of the independent variable on the dependent variable through the mediator variable was significant (Sobel statistic=2.14; SE=0.01; $p<0.03$).

In order to strengthen the robustness of the results, two alternative mediation models were tested. In the first alternative model, Baron and Kenny's third criteria was not satisfied. Indeed, daytime sleepiness (mediator) was not associated ($p<0.15$) with psychological distress (dependent) when both daytime sleepiness and consumption of sweetened products (independent) were entered as predictors in a multivariate regression

analysis. In the second alternative model, all first three Baron and Kenny's criteria were satisfied. However, comparing both models using Akaike information criterion (AIC) indicated that the hypothesized mediation model (AIC=848) is a far better fit than this second alternative model (AIC=1205). Furthermore, the Sobel test for the second alternative mediation model showed that the indirect effect of the independent variable on the dependent variable through the mediator variable was not significant (Sobel statistic=1.63 SE=0.12; $p<0.1$).

Lastly, the robustness of our analyses could be biased by the moderate association that exists between daytime sleepiness and the K10 instrument first item (K1) that assesses faitgue/tiredness ($r=0.18$; $p<0.02$). To verify this, we repeated our analyses by using a total score of K9 (i.e., K10 after excluding item #1). This did not change the nature of our results because 1) daytime sleepiness and K9 were still significantly correlated ($r=0.14$; $p<0.04$); 2) K9 was associated with the consumption of sweetened products ($\beta=0.17$; $p<0.02$) when both K9 and daytime sleepiness were entered as predictors in the multivariate regression model, and 3) the effect of daytime sleepiness on consumption of sweetened products controlling for psychological distress was reduced but it was not zero.

Discussion

The data presented in this paper show that the level of daytime sleepiness in the Catholic Middle Eastern Canadian community is statistically associated with higher consumption of sweetened products, such as chocolate, candies, cakes and cookies. Most importantly, we found that the first three criteria defined by Baron and Kenny to establish mediation were met, but that the fourth criteria was not. The results suggest that the relationship between daytime sleepiness and consumption of sweetened products is partially mediated by the level of psychological distress.

The strengths of this study are the use of well-established procedures to assess mediation - Baron and Kenny's (1986) four-step approach and the Sobel test, and the examination of alternative mediating models. Our analysis, however, was based on assumptions of

having a correctly specified mediation model, including no misspecifications of causal order and of causal direction, or of imperfect measurements and unmeasured variables [47]. In reality, such assumptions are difficult or even impossible to achieve. By testing alternative mediate models we showed that the one we described is the best fitted to account for the relationship between these three variables. Furthermore, data from prior research support the proposition that a mediation relation exists between these variables.

The relationship observed between daytime sleepiness and consumption of food high in dietary sugars is consistent with previous studies conducted in western and non-western settings [27-29]. Similarly, previous work provides strong support that the consumption of sweetened products is triggered by negative emotional or distress feelings in western populations. Negative mood (as measured by anxiety, fatigue and depression scales) has been correlated with craving intensity for sweet food [36]. Experimental studies have also demonstrated an association between stress or negative mood and the consumption of savory foods in emotional eaters [35, 48]. Thus one explanation in support of our mediating model is that individuals who experience daytime sleepiness may consume energy dense sugary rich foods to upgrade their energy level or to alleviate their negative mood or psychological distress. This explanation fits with the fueling and emotional functions attributed to sweetened food and drink products by members of the studied community in semi-structured interviews [49]. Furthermore, this explanation has biological plausibility since sweet taste may alleviate dysphoric mood or stress through dopaminergic and opioidergic neurotransmission in the brain [13-15].

It would be interesting to explore which of anxiety or depression correlate stronger with daytime sleepiness since the K10 instrument contains items that assesses both symptoms. However, this instrument is used as a single scale because anxiety and depression items are highly correlated. There is nevertheless evidence that both anxiety and depression are highly correlated with excessive daytime sleepiness and fatigue [34].

Our study highlights that sleep, mood and diet are interconnected, and that efforts to improve diet quality must consider the psychosocial well-being of individuals, especially given the known properties of sweets to temporarily alleviate fatigue, stress and anxiety. These results have important public health implications for the prevention of obesity and chronic diseases, which are growing concerns in the Arab Canadian community[3]. Indeed, consumption of processed products high in dietary sugars is recognized as an important contributor to the development of these diseases[6]. As reported elsewhere, the consumption level of total sugars (all foods considered), ~ 20% of diet, in this community is now similar that of the Canadian and Quebec population[7]. The average daytime sleepiness score (8.2) and the prevalence of EDS (28%) measured in this paper are within the range noted in western countries[50]. The obesity prevalence of 15.6% is also similar to the Canadian average and the general Arab community, when self-reported measures are taken[3].

The prevalence of high psychological distress (K10>30) at 11.8% is nearly half that of the Canadian average, reported to be 20.7% [51]. It is possible that sociocultural factors such as family social support or having a religious faith protect against anxiety and depression. Religious affiliation, for example, is higher in the Middle Eastern community (94%) than in the overall population (83%)[2]. Also, the strength and size of social network shown to have tempering effect on weight gain and the general health of individuals living in large Canadian ethnic groups [5]. The sources of psychological distress in the Middle Eastern Canadian community are, however, unknown and warrant future research. Socioeconomic difficulties do not seem to play an essential role in our population sample, since employment rate, education level and household income were found to be relatively high. The difficulties of maintaining traditional dietary practices in the host country may be potential sources of social and economic stress [21].

In our analysis, BMI had a positive, but not significant association with daytime sleepiness. In a previous paper, we observed an inverse (but not significant) relationship between consumption of sweetened products and BMI in the same community [7]. These results, however, must be interpreted by taking into account that overweight and obese

subjects may have under-reported their weight or under-reported their consumption of sweetened products, but also the cross-sectional design.

This study has limitations. First, the sample size was small and thus statistical power was limited. However, the composition of our sample reflects the characteristics of the general Catholic Middle Eastern Canadian community in terms of birthplace, religious affiliation, education and income[2]. Our findings, however, cannot be generalized to the Muslim Arab Canadian community. Second, the study is based on self-reported measures. However, both instruments we used (ESS and K10) are valid and reliable instruments widely used in both sleep and mood-related studies. Third, we did not account for other sleep problem measures, including duration of sleep and sleep deprivation, as well as other potential confounding disorders. Sleep duration and obstructive sleep apnea are the most common causes of daytime sleepiness[22], but studies examining the relationships between sleep duration, dietary intake and obesity has produced mixed results[52]. Fourth, findings are based on cross-sectional data. Therefore, it is impossible to know the causal order of the observed associations, and the existence of bi-directional effects, for example, between the consumption of foods high in dietary sugars and daytime sleepiness.

Conclusion

This study expands the limited evidence base concerning the association between consumption of sweetened products, daytime sleepiness and psychological distress in any communities including migrants ones. One novel contribution of this study is its inclusion of a measure of psychological distress and the use of Baron and Kenny's [30, 44] four-step approach and the Sobel test to establish that the consumption of sweetened products and daytime sleepiness is partially mediated by psychological distress. One possible explanation in support of this relationship is that individuals experiencing daytime sleepiness may reach for energy dense sugary rich foods in order to upgrade their energy level or to alleviate their psychological distress. Further work is needed to test this mediation relationship in larger samples and to verify the potential effects of sleep duration and quality of sleep in this relationship.

Table 1 Consumption of sweetened products (total sugars/day) according to age, sex, BMI, physical activity, BMI, psychosocial distress and daytime sleepiness scores (*n* 186).

Factors	Subjects		Sweetened products (g/day)		P <*
	n	%	Mean	SE	
Sex					0.66
Male	85	45.7	14.6	1.5	
Female	101	54.3	16.3	1.4	
Age					0.59
18-30	83	44.6	19.5	1.6	
31-40	50	26.9	12.7	1.7	
41-50	21	11.3	17.2	4.2	
51-60	32	17.2	12.4	1.8	
Physical activity					0.31
No activity	57	30.6	16.6	1.8	
1 time per week	50	26.9	17.3	2.1	
2 times per week	31	16.7	13.4	2.2	
3 times per week	30	16.1	11.4	1.6	
≥ 4 times per week	18	9.7	17.3	5.0	
Body mass index					0.86
Normal (18.5-24.9)	88	44.6	16.5	1.5	
Overweight (25-29.9)	69	37.1	13.6	1.4	
Obese(>30)	29	15.6	17.1	3.3	
Psychological distress (K10 scores)					0.00
Low (10-20)	103	55.4	12.7	1.1	
Moderate (21-30)	61	32.8	18.3	1.8	
High (30-50)	22	11.8	21.2	4.3	
Daytime sleepiness (ESS scores)					0.04
Low (0-5)	56	30.1	12.7	1.5	
Moderate (6-11)	94	50.5	15.6	1.5	
High (12-24)	36	19.4	19.6	2.3	

*In the univariate regression analysis, sweetened products was log-transformed and all variables were entered as continuous (age, BMI, psychological distress scores (10-50) and daytime sleepiness scores (0-24). Physical activity categories were created by asking "how many times per week do you exercising enough to sweat?" and answers ranged from 0-4 or more times per week.

Table 2 Relationships between consumption of sweetened products, daytime sleepiness and psychological distress in the multivariate model (*n* 186)

	β	SE	Sβ	T value	P<
Model[1]					
Daytime sleepiness	0.05	0.02	0.16	2.15	0.04
Model[2]					
Constant	2.75	0.54		5.10	0.00
Daytime sleepiness	0.03	0.02	0.12	1.69	0.09
Psychological distress	0.05	0.02	0.19	2.61	0.01

β = Beta coefficient; Sβ = standardized Beta coefficient; SE= standard error

Consumption of sweetened products was log-transformed. Psychological distress scores (10-50) and daytime sleepiness scores (0-24) are entered as continuous and are normally distributed.

[1] Model summary: R=0.15, F=4.26, p<0.04; [2] Model summary: R=0.27, F=2.37, p<0.03, adjusted for psychological distress (mediator) and age.

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