

# 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:** A cross-sectional study.

**Setting:** A Catholic Middle-Eastern Canadian community.

**Participants:** 186 men and women aged between 18 and 60 years.

### Primary and secondary outcome measures:

Sweetened product consumption was measured using a food frequency questionnaire (total sugars/day). DS and PD were measured using standardised questionnaires. 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;  $p<0.03$ ).

**Conclusions:** The association between DS and consumption of sweetened products in the Catholic Middle-Eastern Canadian community is partially mediated by psychological distress. Further work should test this mediation relationship in larger samples and verify the

## ARTICLE SUMMARY

### 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<sup>30</sup> four-step approach and the Sobel test to examine alternative mediating models between these three variables.

### Key messages

- Daytime sleepiness is associated with 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 of this study

- The strengths include the testing of alternative mediating models and the use of well-established procedures to assess mediation.
- Owing to the cross-sectional nature of the study, it is impossible to know the causal order of the observed associations, and the existence of bidirectional 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.

potential effects of other sleep variables 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.<sup>1</sup> Canadians of Arab (or Middle East) origin<sup>1</sup> represent more than 1.2% of the total Canadian population<sup>2</sup> 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.<sup>3</sup> Furthermore, the prevalence of obesity is much higher among long-term Arab migrants ( $\geq 11$  or more years) than the more recent migrants ( $\leq 10$  years) to Canada.<sup>1</sup> The high prevalence of obesity among the 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.<sup>1 4 5</sup>

A modifiable dietary risk factor contributing to the development of obesity is the consumption of ultraprocessed products high in dietary sugars, or sweetened food and drink products.<sup>6</sup> Such products include soft drinks, sweetened juices and beverages, candies and chocolates, sugary baked goods, ice creams and other desserts.<sup>7</sup> 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.<sup>8</sup> Furthermore, they are sold in large portion sizes and are commonly consumed as snacks both of which may contribute to energy imbalance.<sup>9</sup> Even more problematic is the fact that sweetened products have specific psychological properties that trigger consumption; they are hyperpalatable<sup>10-12</sup> and their sweet taste works to alleviate dysphoric mood or stress through dopaminergic and opioidergic neurotransmission in the brain.<sup>13-15</sup>

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.<sup>16 17</sup> Young Egyptian women and men more often reported cravings for savouries (meat-based and vegetable-based dishes) than cravings for sweets, contrary to studies conducted in Canada and in the USA.<sup>18</sup> 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.<sup>16 19 20</sup> 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.<sup>21</sup>

Understanding why individuals consume sweetened products is a complex issue, especially given the psychological properties of these products. 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.<sup>22</sup>

Excessive daytime sleepiness is characterised by persistent sleepiness and lack of energy, most often caused by sleep deprivation, obstructive sleep apnoea and/or use of medication.<sup>23</sup> It is present in all individuals, regardless of age and recognised as the first symptom that defines narcolepsy.<sup>24</sup> Both excessive daytime sleepiness<sup>25 26</sup> and narcolepsy<sup>24</sup> 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.<sup>22</sup> Indeed, excessive daytime sleepiness has been associated with the consumption of food high in fats as well as refined carbohydrates.<sup>22</sup> A recent study found that excessive daytime sleepiness was associated with the consumption of refined carbohydrate-rich snacks among Japanese children.<sup>27</sup> A very low-carbohydrate, high-protein diet has shown improvement in daytime alertness in adult patients with narcolepsy.<sup>28</sup> In another study, individuals fed a carbohydrate liquid diet scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet.<sup>29</sup> Hormonal, metabolic and inflammatory mechanisms could explain why a diet high in fats and/or sugars could induce somnogenic effects in the body.<sup>22</sup>

There is evidence that the association between daytime sleepiness and sweetened products may be explained by the mediating effects of mood/stress problems, such as psychological distress. This mediating effect is supported in the literature for some of Baron and Kenny's<sup>30</sup> criteria to establish mediation. First, there is supporting evidence that daytime sleepiness is associated with consumption of ultra-processed products high in dietary sugars.<sup>27 28</sup> Second, daytime sleepiness is correlated with depression and psychological distress in both Western and Arab populations.<sup>31-34</sup> Third, a preference for chocolate and other sweetened products is well documented in depressed and psychologically distressed individuals.<sup>35 36</sup> This preference could be explained by the effects of sweets on relieving mood or stress.<sup>13-15</sup> 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

<sup>1</sup>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.

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.<sup>2</sup> Understanding the relationship between daytime sleepiness, psychological distress and diet could provide some 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<sup>2</sup> 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<sup>30</sup> 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%).<sup>2</sup> Canadians of Arab origin make up equal groups of Muslims and Christians, of which the majority is Catholic.<sup>2</sup> 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.<sup>21 37</sup>

The target population of this study is an established Catholic Middle-Eastern community living in Montreal, Canada. This population is composed of first-generation 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. Individuals were all volunteers and could withdraw from the study at any point of time.

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

Sociodemographic characteristics were collected using a self-reported questionnaire adapted from Health Canada.<sup>38</sup> 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. Body mass index (BMI) was calculated as weight (kg)/height (m)<sup>2</sup> and categorised as normal weight (18.5–24.9); overweight (25–29.9) and obese (>30).<sup>39</sup>

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.<sup>7</sup> This questionnaire was 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 consumed (ie, excluding festivities). Participants were also asked to report how many portions of the food item they typically had. Examples of portion sizes were taken from the Canadian Nutrient File (CNF) and provided to participants.<sup>40</sup> For the purpose of this study, we selected food items representing sweetened products, which include cakes, cookies, chocolate and candies.

Daytime sleepiness was measured using the self-report Epworth Sleepiness Scale (ESS).<sup>41</sup> Respondents used a four-point scale (0–3) 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 ( $r=0.82$ ).<sup>42</sup> 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.<sup>43</sup>

Psychological distress was measured using the Kessler Psychological Distress Scale (K10).<sup>44</sup> This instrument is composed of 10 questions on anxiety and depressive symptomatology. 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  $\alpha=0.92$ ).<sup>44</sup> 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).<sup>44</sup>

### Analysis

Data were analysed using SPSS (V.18.0). As a first step, we present descriptive data on the consumption of sweetened products according to sex, age, BMI, physical

activity, daytime sleepiness and psychological distress. Consumption of sweetened products corresponded to the daily amount of total sugars consumed 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 CNE.

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 sociodemographics (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 an 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<sup>30 45</sup> 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 to establish complete mediation and three conditions to establish partial mediation.<sup>30 45</sup> 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 were met but step 4 was not, then partial mediation was indicated.<sup>45</sup> 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.<sup>46</sup>

As a final step, we ran alternative mediation models to rule out plausible competing interpretations of the data and to verify whether our hypothesised 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; 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% of individuals were born in Canada; these were second-generation migrants (ie, children of immigrating parents born in the Middle-East). 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 of above CAD \$50 000 (66.9%).

Average consumption of sweetened products was 15.5 g/day (SD=13.9; n=186) ranging 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 the 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 half of 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 1.7 g of total sugars/day more than males, 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 consumed an additional 5.6 g of total sugars/day, 45% more than individuals with moderate distress, and an additional 8.5 g of total sugars/day, 68% more than individuals with low distress. Individuals with high daytime sleepiness (>12) consumed an additional 2.9 g of total sugars/day, 23% more than individuals with moderate daytime sleepiness, and an additional 6.9 g of total sugars/day, 54% more than the individuals with low daytime sleepiness. Other sociodemographics were not related statistically to the consumption of sweetened products.

Table 1 also presents the results of univariate regression analyses between consumption of sweetened

## Psychological distress, daytime sleepiness and consumption of sweet products

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

Factors	Individuals		Sweetened products (g/day)		p Value<*
	N	Per cent	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/week	50	26.9	17.3	2.1	
2 times/week	31	16.7	13.4	2.2	
3 times/week	30	16.1	11.4	1.6	
≥ 4 times/week	18	9.7	17.3	5.0	
BMI					0.86
Normal (18.5–24.9)	88	47.3	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 (31–50)	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 exercise enough to sweat?' and answers ranged from 0 to 4 or more times/week. BMI, body mass index; ESS, Epworth Sleepiness Scale; K10, Kessler Psychological Distress Scale.

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 modelling 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<sup>30</sup> to establish mediation. First, daytime sleepiness was significantly associated with the consumption of

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

	$\beta$	SE	S $\beta$	T Value	p Value<
Model*					
Daytime sleepiness	0.05	0.02	0.16	2.15	0.04
Model†					
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

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 summary:  $R=0.15$ ,  $F=4.26$ ,  $p<0.04$ .

†Model summary:  $R=0.27$ ,  $F=2.37$ ,  $p<0.03$ , adjusted for psychological distress (mediator) and age.

$\beta$ , Beta coefficient; S $\beta$ , standardised  $\beta$  coefficient.

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 upon 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 hypothesised 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;  $p < 0.1$ ).

Last, 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 fatigue/tiredness ( $r = 0.18$ ;  $p < 0.02$ ). To verify this, we repeated our analyses by using a total score of K9 (ie, 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 upon consumption of sweetened products controlling for psychological distress was reduced, but it was not zero.

## DISCUSSION

The data presented in this report show that the level of daytime sleepiness in the Catholic Middle-Eastern Canadian community is statistically associated with a higher consumption of sweetened products, such as cakes, cookies, chocolate and candies. 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<sup>30</sup> 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 mis-specifications of causal order and of causal direction, or of imperfect measurements and unmeasured variables.<sup>47</sup> 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 ultra-processed products high in dietary sugars is consistent with previous studies conducted in Western and non-Western settings.<sup>27–29</sup> 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 sweetened products.<sup>36</sup> Experimental studies have also demonstrated an association between stress or negative mood and the consumption of savoury foods in emotional eaters.<sup>35 48</sup> 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 fuelling and emotional functions attributed to sweetened food and drink products by members of the studied community in semistructured interviews.<sup>49</sup> Furthermore, this explanation has biological plausibility since sweet taste may alleviate dysphoric mood or stress through dopaminergic and opioidergic neurotransmission in the brain.<sup>13–15</sup>

It would be interesting to explore whether it is anxiety or depression that correlates strongly with daytime sleepiness as 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. Nevertheless, there is evidence that both anxiety and depression are highly correlated with excessive daytime sleepiness and fatigue.<sup>34</sup>

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.<sup>3</sup> Indeed, consumption of processed products high in dietary sugars is recognised as an important contributor to the development of these diseases.<sup>6</sup> As reported elsewhere, the consumption level of total sugars (all foods considered), ~20% of diet, in this community is now similar to that consumed by the Canadian and Quebec population.<sup>7</sup> The average daytime sleepiness score (8.2) and the prevalence of EDS (28%) measured in this report are within the range noted in Western countries.<sup>50</sup> The obesity prevalence of 15.6% is also similar to the Canadian average and the general Arab community, when self-reported measures are taken.<sup>3</sup>

The prevalence of high psychological distress (K10>30) at 11.8% is nearly half of that of the Canadian average, reported to be 20.7%.<sup>51</sup> It is possible that socio-cultural 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%).<sup>2</sup> 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.<sup>5</sup> 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.<sup>21</sup>

In our analysis, BMI had a positive, but not significant association with daytime sleepiness. In a previous report, we observed an inverse (but not a significant) relationship between consumption of sweetened products and BMI in the same community.<sup>7</sup> These results, however, must be interpreted not only by taking into account that overweight and obese individuals may have under-reported their weight or under-reported their consumption of sweetened products, but also the cross-sectional design.

This study has its own 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.<sup>2</sup> Our findings, however, cannot be generalised 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-related 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 apnoea are the most common causes of daytime sleepiness,<sup>22</sup> but studies examining the relationships between sleep duration, dietary intake and obesity has produced mixed results.<sup>52</sup>

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 bidirectional effects, for example, between the consumption of sweetened products 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 community including the migrant ones. One novel contribution of this study is its inclusion of a measure of psychological distress and the use of Baron and Kenny's<sup>30 44</sup> 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 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.

**Contributors** 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 and MD. Successive drafts were developed by JCM, with inputs from the other coauthors. All authors have reviewed and approved the final version.

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