



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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4 1 Psychological distress mediates the association between daytime
5 2 sleepiness and consumption of sweetened products: Cross-
6 3 sectional findings in a Catholic Middle Eastern Canadian
7 4 community.
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11 6 **Jean-Claude Moubarac^a, PhD, Margaret Cargo^b, PhD, Olivier**
12 7 **Receveur^c, PhD and Mark Daniel^b, PhD**
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15
16 9 ^a École de Santé Publique, Université de Montréal, 1420, boul.Mont-Royal, Montréal
17 10 (Québec) H2V 4P3, Canada. ^b School of Health Sciences, University of South Australia,
18 11 GPO Box 2471, Adelaide SA 5001, Australia, ^c Département de Nutrition, Université de
19 12 Montréal, 2405, Ch.de la Côte-Sainte-Catherine, Montréal (Québec) H3T 1A8, Canada.
20 13
21 14

22 15
23 16 **Institution where the work was performed:** École de Santé Publique, Université de
24 17 Montréal, 1420, boul.Mont-Royal, Montréal (Québec) H2V 4P3, Canada
25 18

26 19 **Corresponding author (Jean-Claude Moubarac): jcmoubarac@gmail.com**
27 20 Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde, Universidade de São Paulo,
28 21 Av. Dr. Arnaldo 715, 01246-904, São Paulo, SP, Brasil. Tel: 55-11-2592-2572
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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.

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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.

128 Introduction

129 The prevalence of overweight/obesity and chronic diseases, as well as their associated
130 risk factors, vary dramatically by ethnic groups in Canada[1]. Canadians of Arab (or
131 Middle East) origin¹ represent more than 1.2% of the total Canadian population[2] and
132 comprise one of the largest non-European ethnic groups in Canada. After adjusting for
133 socioeconomic factors, Arab Canadians are more likely to be obese than White, Chinese,
134 Japanese and South Asian groups [3]. Furthermore, the prevalence of obesity is much
135 higher amongst long-term Arab migrants (≥ 11 or more years) than the more recent
136 migrants (≤ 10 years) to Canada[1]. The high prevalence of obesity amongst Arabs and
137 the finding that the prevalence increases with time may result from the adoption of
138 dietary and behavioural risk factors uncommon to the environment of their home
139 countries prior to migration and acquired during the acculturation process in Canada[1, 4,
140 5].

141
142 A modifiable dietary risk factor contributing to the development of obesity is the
143 consumption of ultra-processed products high in dietary sugars, or sweet food and drink
144 products [6]. Such products include soft drinks, sweetened juices and beverages, candies
145 and chocolates, sugary baked goods, ice creams, and other desserts [7]. These products
146 share many nutritional characteristics that make them unhealthy; they are energy dense
147 (for solids), they have an excessive content in free sugars, and some are also high in fats
148 and saturated fats[8]. Furthermore, they are sold in large portion sizes and are commonly
149 consumed as snacks both of which may contribute to energy imbalance[9]. Even more
150 problematic is the fact that sweet food and drink have specific psychological properties
151 that trigger consumption; they are hyper-palatable [10-12] and their sweet taste works to
152 alleviate dysphoric mood or stress through dopaminergic and opioidergic neuro-
153 transmission in the brain[13-15].

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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.

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3 155 Middle Easterners are known for the daily consumption of sweet tea. However, other
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5 156 sweet products have a secondary role in traditional Middle Eastern cuisine in that they are
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7 157 mostly home-prepared pastries and deserts most frequently consumed during festivities
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9 158 and on special occasions [16, 17]. Young Egyptian women and men more often reported
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11 159 cravings for savories (meat and vegetables based dishes) than cravings for sweets,
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13 160 contrary to studies conducted in Canada and United States [18]. However, the quantity,
14
15 161 use and significance of sweet food and drink have significantly changed in the last
16
17 162 decades in Lebanon, Egypt and Syria, with a parallel increase in obesity and chronic
18
19 163 diseases [16, 19, 20]. Similarly, Arabs are exposed to a new food environment when they
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21 164 migrate to Canada where sweetened products are abundant, cheap, convenient,
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23 165 accessible, and part of the mainstream food culture. Such an experience creates a variety
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25 166 of social and economic challenges for maintaining ethnic cuisine as a marker of
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27 167 community affiliation and may be a potential source of stress and anxiety [21].
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30 169 Understanding why individuals consume sweetened products is a complex issue,
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32 170 especially given the psychological properties of these foods and their effects in the brain.
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34 171 A review of the literature suggests that two sets of inter-related psychosocial factors are
35
36 172 associated with the consumption of sweetened products; sleep-related problems and
37
38 173 mood/stress-related problems. However, the nature of the relationships between these
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40 174 factors is not well understood [22].
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43 176 Excessive daytime sleepiness is characterized by persistent sleepiness and lack of energy,
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45 177 most often caused by sleep deprivation, obstructive sleep apnea and/or use of medication
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47 178 [23]. It is present in all individuals, regardless of age, and recognized as the first
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49 179 symptom that defines narcolepsy [24]. Both excessive daytime sleepiness [25, 26] and
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51 180 narcolepsy [24] have been associated with the development and/or exacerbation of
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53 181 obesity. One potential mechanism explaining this association is through effects on
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55 182 appetite and intake of food[22]. Indeed, excessive daytime sleepiness has been associated
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57 183 with the consumption of food high in fats, as well as refined carbohydrates[22]. A recent
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59 184 study found that excessive daytime sleepiness was associated with the consumption of
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185 refined carbohydrate-rich snacks amongst Japanese children[27]. A very-low

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3 186 carbohydrate, high-protein diet has shown improvement in daytime alertness in adults
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5 187 patients with narcolepsy[28]. In another study, subjects fed a carbohydrate liquid diet
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7 188 scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet
8
9 189 [29]. Hormonal, metabolic, and inflammatory mechanisms could explain why a diet high
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11 190 in fats and/or sugars could induce somnogenic effects in the body [22].
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14 192 There is evidence that the association between daytime sleepiness and sweet products
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16 193 may be explained by the mediating effects of mood/stress problems, such as
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18 194 psychological distress. This mediating effect is supported in the literature for several of
19
20 195 Baron and Kenny's criteria to establish mediation[30]. First, there is supporting evidence
21
22 196 that daytime sleepiness is associated with consumption of processed food high in dietary
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24 197 sugars[28{Gaina, 2007 #257}]. Second, daytime sleepiness is correlated with depression
25
26 198 and psychological distress in both Western and Arab populations [31-34]. Third, a
27
28 199 preference for chocolate and other sweet products is well documented in depressed and
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30 200 psychological distressed individuals[35, 36]. This preference could be explained by the
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32 201 effects of sweets on relieving mood or stress [13-15]. If sleepy individuals also tend to
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34 202 feel distressed, and psychological distress induces the consumption of sweet products,
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36 203 then the relationship between daytime sleepiness and the consumption of these products
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38 204 could be, at least, partially mediated by psychological distress.
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41 206 Daytime sleepiness and psychological distress, and their relationship to the consumption
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43 207 of sweet products have never been studied in Arab Canadians. Addressing this gap could
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45 208 shed light on the prevention/management of obesity in the Canadian Arab community.
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47 209 The burden of obesity in this community has important human and economic
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49 210 consequences for the Canadian public health system because Arabs are one of the fastest
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51 211 growing migrant groups in Canada, constituting more than 4% of the urban population of
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53 212 Montreal and Ottawa[2]. Understanding the relationship between daytime sleepiness,
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55 213 psychological distress and diet could provide useful information to improve daytime
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57 214 alertness, psychological well-being and diet quality, all of which are known risk factors
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59 215 to obesity and chronic diseases. From this perspective, this paper has two objectives: 1) to
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216 report on the prevalence of excessive daytime sleepiness and psychological distress in an

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3 217 Arab community living in Montreal[2], and 2) to test whether the relationship between
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5 218 daytime sleepiness and consumption of sweet products is mediated by psychological
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7 219 distress using Baron and Kenny's [30] criteria and the Sobel test.
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10 221 **Methods:**

11
12 222 *Participants*

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14 223 The Middle Eastern or Arab community living in Canada is heterogeneous in terms of its
15
16 224 country of birth and religious affiliation. The main groups are Lebanese (41%), Egyptian
17
18 225 (12%), Syrian (6%), Moroccan (6%), and Iraqi (6%)[2]. Canadians of Arab origin are
19
20 226 equally divided between Muslims and Christians, of which the majority is Catholic[2].
21
22 227 The sociocultural heterogeneity within the Middle Eastern community is essential to
23
24 228 acknowledge, especially because religious beliefs impose dietary restrictions and may
25
26 229 influence psychosocial factors related to health in Arab Muslims [21, 37].
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29 231 The target population of this study is an established Catholic Middle Eastern community
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31 232 living in Montreal, Canada. This population is composed of first and second generation
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33 233 migrants, mostly from Egypt, Lebanon and Syria. Recruitment and data collection
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35 234 occurred at three Catholic Middle Eastern churches located in Montreal. Participation
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37 235 was solicited through public announcements and was limited to one respondent per
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39 236 household to avoid bias related to family customs. Subjects were all volunteers and could
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41 237 withdraw from the study at any point.
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44 239 The research protocol was submitted and approved by the ethics committee of the Centre
45
46 240 Hospitalier de l'Université de Montréal (SL 06-063). All participants provided informed
47
48 241 written consent.
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50 242

51 243 *Instruments*

52 244 Socio-demographic characteristics were collected using a self-reported questionnaire
53
54 245 adapted from Health Canada[38]. Physical activity was assessed by asking the question
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56 246 "how many times per week do you exercise enough to sweat? ". Participants self-reported
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58 247 height and weight. Food consumption was assessed using a food frequency questionnaire
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3 248 (FFQ) previously developed and validated with the study community to measure
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5 249 consumption of 26 different sweet food and drink products [7]. To answer the FFQ,
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7 250 respondents reported the average number of days per week, in a typical week, in which
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9 251 each listed product was eaten or drank (i.e., excluding festivities). Participants were also
10
11 252 asked to report how many portions of the food item they typically ate. Examples of
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13 253 portions sizes were taken from the Canadian Nutrient File (CNF) and provided to
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15 254 participants[39]. For the purpose of this study, we selected food items representing sweet
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17 255 products, which include cookies, chocolate, cakes and candies.
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19 257 Daytime sleepiness was measured using the *Epworth Sleepiness Scale* (ESS)[40]. This
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21 258 self-report instrument contains eight items describing situations conducive to daytime
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23 259 sleepiness. Respondents expressed their perceived likelihood of falling asleep in a
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25 260 number of situations using a four-point scale (0 to 3). The ESS instrument has a high
26
27 261 internal consistency (Cronbach's alpha = 0.88) and a high test-retest reliability ($r =$
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29 262 0.82)[41].
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31 264 Psychological distress was measured using the *Kessler Psychological Distress Scale*
32
33 265 (K10)[42]. This instrument is composed of 10 questions on anxiety and depressive
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35 266 symptomology. Respondents self-reported the degree to which they had these feelings for
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37 267 the month prior to completing the instrument using a five-point Likert scale (all the time,
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39 268 often, sometimes, rarely, never). Scores, ranging from 10 to 50, represent an increasing
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41 269 gradient of psychological distress.
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44 271 *Analysis*

45 272 Data were analyzed using SPSS (Version 18.0). As a first step, we present descriptive
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47 273 data on the consumption of sweet products according to sex, age, body mass index
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49 274 (BMI), daytime sleepiness, and psychological distress. Consumption of sweet products
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51 275 corresponded to the daily amount of total sugars eaten from cakes, cookies, chocolate,
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53 276 and candies. This was calculated using data on the frequency and portions consumed
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55 277 from these products obtained from the FFQ, and the estimated amount of total sugars
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57 278 contained in mean portions of these products using CNF.
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3 279 For descriptive purposes, daytime sleepiness scores on the ESS were coded into three
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5 280 levels of increasing daytime sleepiness: low (ESS scores 0-5), intermediate (ESS scores
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7 281 6-11) and high (ESS scores 12-24). Intermediate (6-11) and high (12-24) ESS scores
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9 282 were shown to have a 30% and 69% increased risk for sleep onset during the Multiple
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11 283 Sleep Latency Test (MSLT), an objective measure of daytime sleep tendency[43].

12 284 Psychological distress scores on the K10 were grouped into standard groups as low (10-
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14 285 20), moderate (21-29) and high levels of psychological distress (30-50)[42]. BMI was
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16 286 calculated as weight (kg)/ height (m)² and categorized as normal weight (BMI < 25);
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18 287 overweight $25 \leq \text{BMI} < 30$; and obese (BMI > 30) [44].

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20
21 289 As a second step, univariate regression analysis was performed to estimate the
22
23 290 associations between consumption of sweet products and age, sex, BMI, daytime
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25 291 sleepiness and psychological distress. Similar tests were performed to verify if the
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27 292 consumption of sweet products varied by other socio-demographics (country of birth,
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29 293 time since migration, family income, education level, civil status and employment status).

30 294 For all regression analyses, consumption of sweet products was log-transformed. Age,
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32 295 daytime sleepiness and psychological scores were normally distributed and used as
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34 296 continuous measures.

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37 298 Next, we applied the Baron and Kenny [30] criteria to assess whether the relationship
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39 299 between daytime sleepiness (independent variable) and consumption of sweet products
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41 300 (dependent variable) was mediated by psychological distress (mediator). According to
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43 301 Baron and Kenny four statistical conditions need to be met in order to establish
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45 302 mediation[30]. First, univariate regression was used to test if daytime sleepiness was
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47 303 significantly associated with consumption of sweet products. Second, we assessed
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49 304 whether daytime sleepiness and psychological distress were significantly associated.
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51 305 Third, we tested whether psychological distress (mediator) was associated with the
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53 306 consumption of sweet products when both daytime sleepiness and psychological distress
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55 307 and were entered as predictors in a multivariate regression analysis. Fourth, we verified
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57 308 that the coefficient relating daytime sleepiness to consumption of sweet products was
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59 309 larger (in absolute value) than the coefficient relating both variables in the multivariate
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3 310 regression model when the mediating variable was entered. The Sobel test was used to
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5 311 statistically evaluate whether the indirect effect of the independent variable on the
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7 312 dependent variable through the mediator variable was significant[45].
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10 314 As a final step, we ran alternative mediation models to rule out plausible competing
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12 315 interpretations of the data and to verify whether our hypothesized model best fit the data.
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14 316 First, daytime sleepiness was entered as the mediator of the relationship between
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16 317 psychological distress (independent) and consumption of sweet products (dependent). In
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18 318 a second alternative model, consumption of sweet products was entered as the mediator
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20 319 of the relationship between daytime sleepiness (independent variable) and psychological
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22 320 distress (dependent variable).
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25 322 **Results**

26 323 Participants were aged between 18 and 60 years (Mean = 34.6; SD = 12.5). There were
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28 324 slightly more women (n=101) than men (n=85). Country of birth included Egypt (31.9
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30 325 %), Lebanon (25.1 %), Syria (14.7 %), and other Middle Eastern countries (5.3 %).
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32 326 Individuals migrated between 1962 and 2007, of which 86% arrived before 2000,
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34 327 meaning they have spent more than 10 years in Canada. An additional 23.0% of subjects
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36 328 were born in Canada; these were second-generation migrants (i.e., children of
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38 329 immigrating parents born in the Middle Eastern). Participant's civil status was as follows;
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40 330 married or engaged (47.3%), single (46.2%), separated/divorced (4.3%), and widowed
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42 331 (2.2%). The vast majority of respondents had at least a college diploma (88.0%), and
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44 332 most had a university degree (65.8%). Most participants had a family income above CAD
45
46 333 \$50,000 (66.9%).
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49 335 Average consumption of sweet products was of 15.5 g/day (SD=13.9; N = 186) with the
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51 336 range from 0 to 93.1 g/day. The share of each food item to the amount of total sugars
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53 337 from these products was as follows; cakes (51.3%), chocolate (24.7%), cookies (16.1%)
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55 338 and candies (7.9 %).
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3 340 The average daytime sleepiness score on ESS was 8.2 (SD= 4.5) (N=186). A third of
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5 341 individuals (30.1%) had a low daytime sleepiness score (0-5) and half (50.5%) had an
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7 342 intermediate daytime sleepiness score (6-11). One-fifth of individuals (19.5%) had a high
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9 343 daytime sleepiness score (12-24). Almost one-third of individuals met the clinical criteria
10
11 344 for excessive daytime sleepiness (EDS) (defined as ESS scores above 10). Daytime
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13 345 sleepiness did not vary by sex, age or BMI.

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15 346

16 347 The average psychological distress score on the K10 was 20.8 (SD= 6.2) (N=186).
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18 348 More than one half the respondents (55.4%) had a low distress score of 0-20; one-third
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20 349 (32.8%) had a moderate distress score of 21-30; and one-tenth had a high distress score of
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22 350 30-50 (11.8%). Psychological distress did not vary by sex, age or BMI.

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24 351

25 352 Table 1 presents descriptive data on the consumption of sweet products according to age,
26
27 353 sex, physical activity, BMI, daytime sleepiness, and psychological distress. Females
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29 354 consumed slightly more sweet products than males (1.7g/day), while patterns for age and
30
31 355 BMI were less defined. Importantly, the consumption of sweet products varied according
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33 356 to psychological distress and daytime sleepiness score levels. Individuals with high
34
35 357 distress ate an additional 5.6g of total sugars/day, 45% more than individuals with
36
37 358 moderate distress, and an additional 8.5g of total sugars/day, 68% more than individuals
38
39 359 with low distress. Individuals with high daytime sleepiness (>12) ate an additional 2.9g
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41 360 of total sugars/day, 23% more than subjects with moderate daytime sleepiness, and an
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43 361 additional 6.9g of total sugars/day, 54% more than individuals with low daytime
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45 362 sleepiness. Other socio-demographics were not related statistically to the consumption of
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47 363 sweet products.

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50 365 Table 1 also presents the results of univariate analyses between consumption of sweet
51
52 366 products (log-transformed) and age, sex, BMI, daytime sleepiness, and psychological
53
54 367 distress. Consumption of sweet products did not vary significantly by age, sex or BMI.

55 368 The consumption of sweet products was positively associated with psychological distress
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57 369 ($p<0.00$), as well with daytime sleepiness ($p<0.03$).

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3 371 Multivariate analysis (Table 2) consisted of simultaneous modeling daytime sleepiness
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5 372 and psychological distress. In this model, the association between psychological distress
6
7 373 and consumption of sweet products remained statistically significant ($p<0.01$) whereas
8
9 374 the relationship with daytime sleepiness was not significant ($p<0.08$).
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11 375

12 376 We were able to verify all four steps required by the Baron and Kenny[30] to establish
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14 377 mediation. First, daytime sleepiness was significantly associated with the consumption of
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16 378 sweet products ($p<0.03$). Second, daytime sleepiness and psychological distress were
17
18 379 significantly correlated ($r=0.197$; $p<0.04$). Third, psychological distress was associated
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20 380 with the consumption of sweet products ($p<0.01$) when both psychological distress and
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22 381 daytime sleepiness were entered as predictors in the multivariate regression model.

23 382 Fourth, the coefficient relating daytime sleepiness to consumption of sweet products was
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25 383 larger ($\beta=0.05$) than the coefficient relating daytime sleepiness to consumption of sweet
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27 384 products ($\beta=0.03$) with both daytime sleepiness and psychological distress entered in the
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29 385 multivariate regression model. Finally, the Sobel test showed that the indirect effect of
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31 386 the independent variable on the dependent variable through the mediator variable was
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33 387 significant (Sobel statistic=2.14; SE=0.01; $p<0.03$).
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36 389 In order to strengthen the robustness of the results, two alternative mediation models
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38 390 were tested. In the first alternative model, Baron and Kenny's third criteria was not
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40 391 satisfied. Indeed, daytime sleepiness (mediator) was not associated ($p<0.15$) with
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42 392 psychological distress (dependent) when both daytime sleepiness and consumption of
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44 393 sweet products (independent) were entered as predictors in a multivariate regression
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46 394 analysis. In the second alternative model, all of Baron and Kenny's criteria were satisfied.
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48 395 However, comparing both models using Akaike information criterion (AIC) indicated
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50 396 that the hypothesized mediation model (AIC=848) is a far better fit than this second
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52 397 alternative model (AIC=1205). Furthermore, the Sobel test for the second alternative
53
54 398 mediation model showed that the indirect effect of the independent variable on the
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56 399 dependent variable through the mediator variable was not significant (Sobel statistic=1.63
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58 400 SE=0.12; $p<0.1$).
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5 4036
7 404 **Discussion**

8 405 The data presented in this paper show that the level of daytime sleepiness in the Catholic
9 406 Middle Eastern Canadian community is statistically associated with higher consumption
10 407 of sweetened products, such as chocolate, candies, cakes and cookies. Most importantly,
11 408 we found that this relationship is partially mediated by the level of psychological distress.

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17 410 The strengths of this study are the use of well-established procedures to assess mediation
18 411 - Baron and Kenny's (1986) four-step approach and the Sobel test, and the testing of
19 412 alternative mediating models. Our analysis, however, was based on assumptions of
20 413 having a correctly specified mediation model, including no misspecifications of causal
21 414 order and of causal direction, or of imperfect measurements and unmeasured variables
22 415 [46]. In reality, such assumptions are difficult or even impossible to achieve. By testing
23 416 alternative mediate models we showed that the one we described is the best fitted to
24 417 account for the relationship between these three variables. Furthermore, data from prior
25 418 research support the proposition that a mediation relation exists between these variables.

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29 420 The relationship observed between daytime sleepiness and consumption of food high in
30 421 dietary sugars is consistent with previous studies conducted in western and non-western
31 422 settings [27-29]. Similarly, previous work provides strong support that the consumption
32 423 of sweetened products is triggered by negative emotional or distress feelings in western
33 424 populations. Negative mood (as measured by anxiety, fatigue and depression scales) has
34 425 been correlated with craving intensity for sweet food [36]. Experimental studies have also
35 426 demonstrated an association between stress or negative mood and the consumption of
36 427 savory foods in emotional eaters [35, 47]. Thus one explanation in support of our
37 428 mediating model is that individuals who experience daytime sleepiness may consume
38 429 energy dense sugary rich foods to upgrade their energy level or to alleviate their negative
39 430 mood or psychological distress. This explanation fits with the fueling and emotional
40 431 functions attributed to sweetened food and drink products by members of the studied
41 432 community in semi-structured interviews [7]. Furthermore, this explanation has

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3 433 biological plausibility since sweet taste may alleviate dysphoric mood or stress through
4 434 dopaminergic and opioidergic neurotransmission in the brain [13-15].
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8 436 Our study highlights that sleep, mood and diet are interconnected, and that efforts to
9 437 improve diet quality must consider the psychosocial well-being of individuals, especially
10 438 given the known properties of sweets to temporarily alleviate fatigue, stress and anxiety.
11 439 These results have important public health implications for the prevention of obesity and
12 440 chronic diseases, which are growing concerns in the Arab Canadian community[3].
13 441 Indeed, consumption of processed products high in dietary sugars is recognized as an
14 442 important contributor to the development of these diseases[6]. As reported elsewhere, the
15 443 consumption level of total sugars (all foods considered), ~ 20% of diet, in this community
16 444 is now similar that of the Canadian and Quebec population[7]. The average daytime
17 445 sleepiness score (8.2) and the prevalence of EDS (28%) measured in this paper are within
18 446 the range noted in western countries[48]. The obesity prevalence of 15.6% is also similar
19 447 to the Canadian average and the general Arab community, when self-reported measures
20 448 are taken[3].
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33 450 The prevalence of high psychological distress (K10>30) at 11.8% is nearly half that of
34 451 the Canadian average, reported to be 20.7% [49]. It is possible that sociocultural factors
35 452 such as family social support or having a religious faith protect against anxiety and
36 453 depression. Religious affiliation, for example, is higher in the Middle Eastern community
37 454 (94%) than in the overall population (83%)[2]. Also, the strength and size of social
38 455 network shown to have tempering effect on weight gain and the general health of
39 456 individuals living in large Canadian ethnic groups [5]. The sources of psychological
40 457 distress in the Middle Eastern Canadian community are, however, unknown and warrant
41 458 future research. Socioeconomic difficulties do not seem to play an essential role in our
42 459 population sample, since employment rate, education level and household income were
43 460 found to be relatively high. The difficulties of maintaining traditional dietary practices in
44 461 the host country may be potential sources of social and economic stress [7, 21].
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3 463 This study has limitations. First, the sample size was small and thus statistical power was
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5 464 limited. However, the composition of our sample reflects the characteristics of the
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7 465 general Catholic Middle Eastern Canadian community in terms of birthplace, religious
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9 466 affiliation, education and income[2]. Our findings, however, cannot be generalized to the
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11 467 Muslim Arab Canadian community. Second, the study is based on self-reported
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13 468 subjective measures. However, both instruments we used (ESS and K10) are valid and
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15 469 reliable instruments widely used in both sleep and mood-related studies. Third, we did
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17 470 not account for other sleep problem measures, including duration of sleep and sleep
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19 471 deprivation, as well as other potential confounding disorders. Sleep duration and
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21 472 obstructive sleep apnea are the most common causes of daytime sleepiness[22], but
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23 473 studies examining the relationships between sleep duration, dietary intake and obesity has
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25 474 produced mixed results[50]. Fourth, findings are based on cross-sectional data. Therefore,
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27 475 it is impossible to know the causal order of the observed associations, and the existence
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29 476 of bi-directional effects, for example, between the consumption of foods high in dietary
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31 477 sugars and daytime sleepiness.

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33 480 **Conclusion**

35 481 This study expands the limited evidence base concerning the association between
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37 482 consumption of sweetened products, daytime sleepiness and psychological distress in any
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39 483 communities including migrants ones. One novel contribution of this study is its
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41 484 inclusion of a measure of psychological distress and the use of Baron and Kenny's
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43 485 [30]four-step approach and the Sobel test to establish that the consumption of sweetened
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45 486 products and daytime sleepiness is partially mediated by psychological distress. One
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47 487 possible explanation in support of this relationship is that individuals experiencing
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49 488 daytime sleepiness may reach for energy dense sugary rich foods in order to upgrade their
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51 489 energy level or to alleviate their psychological distress. Further work is needed to test this
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53 490 mediation hypothesis, and to identify the potential sources of anxiety and depression
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55 491 amongst the Arab Canadian population.

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493 **Table 1** Consumption of sweetened products (total sugars/day) according to psychosocial distress
 494 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 | |

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

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4 512 **Table 2** Relationships between consumption of sweetened products, daytime sleepiness and
5 513 psychological distress in the multivariate model (N=186)
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7 514

| | 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 |

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

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

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

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24 517 **Data Sharing**

25 518 Original data for this paper is available from the corresponding author

26 519

27 520

27 520 **Contributorship**

28 521 The study was developed and designed by all authors, and supervised by MD. Data
29 522 preparation and analysis was undertaken by JCM, MC, and OR. The initial draft of the
30 523 paper was prepared by JCM, following extensive discussions with MC, OR MD.

31 524 Successive drafts were developed by JCM, with inputs from the other co-authors. All
32 525 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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4 1 Psychological distress mediates the association between daytime
5 2 sleepiness and consumption of sweetened products: Cross-
6 3 sectional findings in a Catholic Middle Eastern Canadian
7 4 community.
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11 6 **Jean-Claude Moubarac^a, PhD, Margaret Cargo^b, PhD, Olivier**
12 7 **Receveur^c, PhD and Mark Daniel^b, PhD**
13 8

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15
16 9 ^a École de Santé Publique, Université de Montréal, 1420, boul.Mont-Royal, Montréal
17 10 (Québec) H2V 4P3, Canada. ^b School of Health Sciences, University of South Australia,
18 11 GPO Box 2471, Adelaide SA 5001, Australia, ^c Département de Nutrition, Université de
19 12 Montréal, 2405, Ch.de la Côte-Sainte-Catherine, Montréal (Québec) H3T 1A8, Canada.
20 13
21 14

22 15
23 16 **Institution where the work was performed:** École de Santé Publique, Université de
24 17 Montréal, 1420, boul.Mont-Royal, Montréal (Québec) H2V 4P3, Canada
25 18

26 19 **Corresponding author (Jean-Claude Moubarac): jcmoubarac@gmail.com**
27 20 Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde, Universidade de São Paulo,
28 21 Av. Dr. Arnaldo 715, 01246-904, São Paulo, SP, Brasil. Tel: 55-11-2592-2572
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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 community 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.

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85 Article focus:

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

91 Key messages

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

96 Strength and limitations

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

127 The prevalence of overweight/obesity and chronic diseases, as well as their associated
128 risk factors, vary dramatically by ethnic groups in Canada[1]. Canadians of Arab (or
129 Middle East) origin¹ represent more than 1.2% of the total Canadian population[2] and
130 comprise one of the largest non-European ethnic groups in Canada. After adjusting for
131 socioeconomic factors, Arab Canadians are less likely to be obese than Black, Latin, and
132 Aboriginal groups, however more likely to be obese than Chinese, Japanese, South Asian
133 groups, as well as the White reference group [3]. Furthermore, the prevalence of obesity
134 is much higher amongst long-term Arab migrants (≥ 11 or more years) than the more
135 recent migrants (≤ 10 years) to Canada[1]. The high prevalence of obesity amongst Arabs
136 and the finding that the prevalence increases with time may result from the adoption of
137 dietary and behavioural risk factors uncommon to the environment of their home
138 countries prior to migration and acquired during the acculturation process in Canada[1, 4,
139 5].

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

153

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.

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3 154 Middle Easterners are known for the daily consumption of sweet tea. However, other
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5 155 sweetened products have a secondary role in traditional Middle Eastern cuisine in that
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7 156 they are mostly home-prepared pastries and deserts most frequently consumed during
8
9 157 festivities and on special occasions [16, 17]. Young Egyptian women and men more often
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11 158 reported cravings for savories (meat and vegetables based dishes) than cravings for
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13 159 sweets, contrary to studies conducted in Canada and United States [18]. However, the
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15 160 quantity, use and significance of sweetened products have significantly changed in the
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17 161 last decades in Lebanon, Egypt and Syria, with a parallel increase in obesity and chronic
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19 162 diseases [16, 19, 20]. Similarly, Arabs are exposed to a new food environment when they
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21 163 migrate to Canada where sweetened products are abundant, cheap, convenient,
22
23 164 accessible, and part of the mainstream food culture. Such an experience creates a variety
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25 165 of social and economic challenges for maintaining ethnic cuisine as a marker of
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27 166 community affiliation and may be a potential source of stress and anxiety [21].
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29 167
30 168 Understanding why individuals consume sweetened products is a complex issue,
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32 169 especially given the psychological properties of these products and their effects in the
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34 170 brain. A review of the literature suggests that two sets of inter-related psychosocial
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36 171 factors are associated with the consumption of sweetened products; sleep-related
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38 172 problems and mood/stress-related problems. However, the nature of the relationships
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40 173 between these factors is not well understood [22].
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42 174
43 175 Excessive daytime sleepiness is characterized by persistent sleepiness and lack of energy,
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45 176 most often caused by sleep deprivation, obstructive sleep apnea and/or use of medication
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47 177 [23]. It is present in all individuals, regardless of age, and recognized as the first
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49 178 symptom that defines narcolepsy [24]. Both excessive daytime sleepiness [25, 26] and
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51 179 narcolepsy [24] have been associated with the development and/or exacerbation of
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53 180 obesity. One potential mechanism explaining this association is through effects on
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55 181 appetite and intake of food[22]. Indeed, excessive daytime sleepiness has been associated
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57 182 with the consumption of food high in fats, as well as refined carbohydrates[22]. A recent
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59 183 study found that excessive daytime sleepiness was associated with the consumption of
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184 refined carbohydrate-rich snacks amongst Japanese children[27]. A very-low

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3 185 carbohydrate, high-protein diet has shown improvement in daytime alertness in adults
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5 186 patients with narcolepsy[28]. In another study, subjects fed a carbohydrate liquid diet
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7 187 scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet
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9 188 [29]. Hormonal, metabolic, and inflammatory mechanisms could explain why a diet high
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11 189 in fats and/or sugars could induce somnogenic effects in the body [22].
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14 191 There is evidence that the association between daytime sleepiness and sweetened
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16 192 products may be explained by the mediating effects of mood/stress problems, such as
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18 193 psychological distress. This mediating effect is supported in the literature for some of
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20 194 Baron and Kenny's criteria to establish mediation[30]. First, there is supporting evidence
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22 195 that daytime sleepiness is associated with consumption of processed food high in dietary
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24 196 sugars [27,28]. Second, daytime sleepiness is correlated with depression and
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26 197 psychological distress in both Western and Arab populations [31-34]. Third, a preference
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28 198 for chocolate and other sweetened products is well documented in depressed and
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30 199 psychological distressed individuals[35, 36]. This preference could be explained by the
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32 200 effects of sweets on relieving mood or stress [13-15]. If sleepy individuals also tend to
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34 201 feel distressed, and psychological distress induces the consumption of sweetened
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36 202 products, then the relationship between daytime sleepiness and the consumption of these
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38 203 products could be, at least, partially mediated by psychological distress.
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41 205 Daytime sleepiness and psychological distress, and their relationship to the consumption
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43 206 of sweetened products have never been studied in Arab Canadians. Addressing this gap
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45 207 could shed light on the prevention/management of obesity in the Canadian Arab
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47 208 community. The burden of obesity in this community has important human and economic
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49 209 consequences for the Canadian public health system because Arabs are one of the fastest
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51 210 growing migrant groups in Canada, constituting more than 4% of the urban population of
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53 211 Montreal and Ottawa[2]. Understanding the relationship between daytime sleepiness,
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55 212 psychological distress and diet could provide useful information to improve daytime
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57 213 alertness, psychological well-being and diet quality, all of which are known risk factors
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59 214 to obesity and chronic diseases. From this perspective, this paper has two objectives: 1) to
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215 assess the prevalence of excessive daytime sleepiness and psychological distress in an

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3 216 Arab community living in Montreal[2], and 2) to test whether the relationship between
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5 217 daytime sleepiness and consumption of sweetened products is mediated by psychological
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7 218 distress using Baron and Kenny's [30] criteria and the Sobel test.
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9 219

10 220 **Methods:**

11 221 *Participants*

12 222 The Middle Eastern or Arab community living in Canada is heterogeneous in terms of its
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14 223 country of birth and religious affiliation. The main groups are Lebanese (41%), Egyptian
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16 224 (12%), Syrian (6%), Moroccan (6%), and Iraqi (6%)[2]. Canadians of Arab origin are
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18 225 equally divided between Muslims and Christians, of which the majority is Catholic[2].
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20 226 The sociocultural heterogeneity within the Middle Eastern community is essential to
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22 227 acknowledge, especially because religious beliefs impose dietary restrictions and may
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24 228 influence psychosocial factors related to health in Arab Muslims [21, 37].
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28 230 The target population of this study is an established Catholic Middle Eastern community
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30 231 living in Montreal, Canada. This population is composed of first and second generation
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32 232 migrants, mostly from Egypt, Lebanon and Syria. Recruitment and data collection
33
34 233 occurred at three Catholic Middle Eastern churches located in Montreal. Participation
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36 234 was solicited through public announcements and was limited to one respondent per
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38 235 household to avoid bias related to family customs. Subjects were all volunteers and could
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40 236 withdraw from the study at any point.
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42 237

43 238 The research protocol was submitted and approved by the ethics committee of the Centre
44
45 239 Hospitalier de l'Université de Montréal (SL 06-063). All participants provided informed
46
47 240 written consent.
48

49 241

50 242 *Instruments*

51 243 Socio-demographic characteristics were collected using a self-reported questionnaire
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53 244 adapted from Health Canada[38]. Physical activity was assessed by asking the question
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55 245 "how many times per week do you exercise enough to sweat? " Five response categories
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57 246 were provided ranging from 0 to 4 or more times per week. Participants also self-reported
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3 247 height and weight. BMI was calculated as weight (kg)/ height (m)² and categorized as
4 248 normal weight (BMI < 25); overweight 25 ≤ BMI < 30; and obese (BMI > 30) [39].
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9 250 Food consumption was assessed using a food frequency questionnaire (FFQ) previously
10 251 developed and pretested with the study community to measure consumption of 26
11 252 different sweet food and drink products [7]. This questionnaire is easy to read and to
12 253 understand, and culturally relevant to the study community. To answer the FFQ,
13 254 respondents reported the average number of days per week, in a typical week, in which
14 255 each listed product was eaten or drank (i.e., excluding festivities). Participants were also
15 256 asked to report how many portions of the food item they typically ate. Examples of
16 257 portions sizes were taken from the Canadian Nutrient File (CNF) and provided to
17 258 participants[40]. For the purpose of this study, we selected food items representing
18 259 sweetened products, which include cookies, chocolate, cakes and candies.
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28 261 Daytime sleepiness was measured using the self-report *Epworth Sleepiness Scale* (ESS)
29 262 [41]. Respondents used a four-point scale (0 to 3) to express their perceived likelihood of
30 263 falling asleep during the day in eight different situations (sitting and reading, watching
31 264 television, sitting inactive in a public place, as a passenger in a car for an hour without a
32 265 break, lying down to rest in the afternoon when circumstances permit, sitting and talking
33 266 to someone, and sitting quietly after a lunch without alcohol). The ESS instrument has a
34 267 high internal consistency (Cronbach's alpha = 0.88) and a high test-retest reliability after
35 268 5 months (r = 0.82)[42]. For descriptive purposes, daytime sleepiness scores on the ESS
36 269 were coded into three levels of increasing daytime sleepiness: low (ESS scores 0-5),
37 270 intermediate (ESS scores 6-11) and high (ESS scores 12-24). Intermediate (6-11) and
38 271 high (12-24) ESS scores were shown to have a 30% and 69% increased risk for sleep
39 272 onset during the Multiple Sleep Latency Test (MSLT), an objective measure of daytime
40 273 sleep tendency [43].
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53 275 Psychological distress was measured using the *Kessler Psychological Distress Scale*
54 276 (K10) [44]. This instrument is composed of 10 questions on anxiety and depressive
55 277 symptomology. Respondents self-reported the degree to which they had these feelings for
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3 278 the month prior to completing the instrument using a five-point Likert scale (all the time,
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5 279 often, sometimes, rarely, never). Scores, ranging from 10 to 50, represent an increasing
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7 280 gradient of psychological distress. The K10 instrument has a high internal consistency
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9 281 (Cronbach's alpha = 0,92) [44]. For descriptive purposes, psychological distress scores
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11 282 on the K10 were grouped into standard groups as low (10-20), moderate (21-29) and high
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13 283 levels of psychological distress (30-50) [44].
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285 *Analysis*

17 286 Data were analyzed using SPSS (Version 18.0). As a first step, we present descriptive
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19 287 data on the consumption of sweetened products according to sex, age, body mass index
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21 288 (BMI), physical activity, daytime sleepiness, and psychological distress. Consumption of
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23 289 sweetened products corresponded to the daily amount of total sugars eaten from cakes,
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25 290 cookies, chocolate, and candies. This was calculated using data on the frequency and
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27 291 portions consumed from these products obtained from the FFQ, and the estimated amount
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29 292 of total sugars contained in mean portions of these products using CNF.
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31 294 As a second step, univariate regression analysis was performed to estimate the
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33 295 associations between consumption of sweetened products and age, sex, physical activity,
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35 296 BMI, daytime sleepiness and psychological distress. Similar tests were performed to
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37 297 verify if the consumption of sweetened products varied by other socio-demographics
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39 298 (country of birth, time since migration, family income, education level, civil status and
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41 299 employment status). For all regression analyses, consumption of sweetened products was
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43 300 log-transformed. Physical activity was used as a ordinal measure using the five answer
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45 301 choices (0-4 times or more per week). All other variables were used as continuous
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47 302 measures.
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49 304 Next, we applied the Baron and Kenny [30,45] criteria to assess whether the relationship
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51 305 between daytime sleepiness (independent variable) and consumption of sweetened
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53 306 products (dependent variable) was mediated by psychological distress (mediator).
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55 307 According to Baron and Kenny four statistical conditions need to be met in order to
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57 308 establish complete mediation and three conditions to establish partial mediation [30, 45].
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3 309 First, univariate regression was used to test if daytime sleepiness was significantly
4 associated with consumption of sweetened products. Second, we assessed whether
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6 daytime sleepiness and psychological distress were significantly associated. Third, we
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8 tested whether psychological distress (mediator) was associated with the consumption of
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10 sweetened products when both daytime sleepiness and psychological distress were
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12 entered as predictors in a multivariate regression analysis. Fourth, to establish that
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14 psychological distress completely mediates the relationship between daytime sleepiness
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16 and consumption of sweetened products, we examined whether the effect of daytime
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18 sleepiness on consumption of sweetened products controlling for psychological distress
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20 was zero. If the first three steps are met but the Step 4 is not, then partial mediation is
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22 indicated [45]. The Sobel test was used to statistically evaluate whether the indirect effect
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24 of the independent variable on the dependent variable through the mediator variable was
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26 significant[46].
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29 323 As a final step, we ran alternative mediation models to rule out plausible competing
30 324 interpretations of the data and to verify whether our hypothesized model best fit the data.
31 325 First, daytime sleepiness was entered as the mediator of the relationship between
32 326 psychological distress (independent) and consumption of sweetened products
33 327 (dependent). In a second alternative model, consumption of sweetened products was
34 328 entered as the mediator of the relationship between daytime sleepiness (independent
35 329 variable) and psychological distress (dependent variable).
36 330

331 **Results**

332 Participants were aged between 18 and 60 years (Mean = 34.6; Standard deviation (SD) =
333 12.5). There were slightly more women (*n* 101) than men (*n* 85). Country of birth
334 included Egypt (31.9 %), Lebanon (25.1 %), Syria (14.7 %), and other Middle Eastern
335 countries (5.3 %). Individuals migrated between 1962 and 2007, of which 86% arrived
336 before 2000, meaning they have spent more than 10 years in Canada. An additional
337 23.0% of subjects were born in Canada; these were second-generation migrants (i.e.,
338 children of immigrating parents born in the Middle Eastern). Participant's civil status was
339 as follows; married or engaged (47.3%), single (46.2%), separated/divorced (4.3%), and

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3 340 widowed (2.2%). The vast majority of respondents had at least a college diploma
4 (88.0%), and most had a university degree (65.8%). Most participants had a family
5 341 income above CAD \$50,000 (66.9%).
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10 344 Average consumption of sweetened products was of 15.5 g/day (SD=13.9; *n* 186) with
11 the range from 0 to 93.1 g/day. The share of each food item to the amount of total sugars
12 345 from these products was as follows; cakes (51.3%), chocolate (24.7%), cookies (16.1%)
13 346 and candies (7.9 %).
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19 349 The average daytime sleepiness score on ESS was 8.2 (SD= 4.5) (*n* 186). A third of
20 350 individuals (30.1%) had a low daytime sleepiness score (0-5) and half (50.5%) had an
21 intermediate daytime sleepiness score (6-11). One-fifth of individuals (19.5%) had a high
22 351 daytime sleepiness score (12-24). Almost one-third of individuals met the clinical criteria
23 352 for excessive daytime sleepiness (EDS) (defined as ESS scores above 10). Daytime
24 353 sleepiness did not vary by sex, age or BMI.
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32 356 The average psychological distress score on the K10 was 20.8 (SD= 6.2) (*n* 186).
33 357 More than one half the respondents (55.4%) had a low distress score of 0-20; one-third
34 358 (32.8%) had a moderate distress score of 21-30; and one-tenth had a high distress score of
35 359 30-50 (11.8%). Psychological distress did not vary by sex, age or BMI.
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40
41 361 Table 1 presents descriptive data on the consumption of sweetened products according to
42 age, sex, physical activity, BMI, daytime sleepiness, and psychological distress. Females
43 362 consumed slightly more sweetened products than males (1.7g/day), while patterns for age
44 363 and BMI were less defined. Importantly, the consumption of sweetened products varied
45 364 according to psychological distress and daytime sleepiness score levels. Individuals with
46 365 high distress ate an additional 5.6g of total sugars/day, 45% more than individuals with
47 366 moderate distress, and an additional 8.5g of total sugars/day, 68% more than individuals
48 367 with low distress. Individuals with high daytime sleepiness (>12) ate an additional 2.9g
49 368 of total sugars/day, 23% more than subjects with moderate daytime sleepiness, and an
50 369 additional 6.9g of total sugars/day, 54% more than individuals with low daytime
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3 371 sleepiness. Other socio-demographics were not related statistically to the consumption of
4
5 372 sweetened products.
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9 374 Table 1 also presents the results of univariate regression analyses between consumption
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11 375 of sweetened products (log-transformed) and age, sex, BMI, daytime sleepiness, and
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13 376 psychological distress. Consumption of sweetened products did not vary significantly by
14
15 377 age, sex or BMI. The consumption of sweetened products was positively associated with
16
17 378 psychological distress ($p<0.00$), as well with daytime sleepiness ($p<0.04$).
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20 380 Multivariate analysis (Table 2) consisted of simultaneous modeling daytime sleepiness
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22 381 and psychological distress. In this model, the association between psychological distress
23
24 382 and consumption of sweetened products remained statistically significant ($p<0.01$),
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26 383 whereas the relationship with daytime sleepiness was no longer significant ($p<0.09$).
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28 384

29 385 We were able to verify the first three steps of Baron and Kenny[30] to establish
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31 386 mediation. First, daytime sleepiness was significantly associated with the consumption of
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33 387 sweetened products ($p<0.04$). Second, daytime sleepiness and psychological distress were
34
35 388 significantly correlated ($r=0.15$; $p<0.04$). Third, psychological distress was associated
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37 389 with the consumption of sweetened products ($p<0.01$) when both psychological distress
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39 390 and daytime sleepiness were entered as predictors in the multivariate regression model.
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41 391 However, the fourth step was not met. In our analysis, the effect of daytime sleepiness on
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43 392 consumption of sweetened products controlling for psychological distress was reduced
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45 393 but it was not zero. Finally, the Sobel test showed that the indirect effect of the
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47 394 independent variable on the dependent variable through the mediator variable was
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49 395 significant (Sobel statistic=2.14; SE=0.01; $p<0.03$).
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52 397 In order to strengthen the robustness of the results, two alternative mediation models
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54 398 were tested. In the first alternative model, Baron and Kenny's third criteria was not
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56 399 satisfied. Indeed, daytime sleepiness (mediator) was not associated ($p<0.15$) with
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58 400 psychological distress (dependent) when both daytime sleepiness and consumption of
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60 401 sweetened products (independent) were entered as predictors in a multivariate regression

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3 402 analysis. In the second alternative model, all first three Baron and Kenny's criteria were
4 403 satisfied. However, comparing both models using Akaike information criterion (AIC)
5 404 indicated that the hypothesized mediation model (AIC=848) is a far better fit than this
6 405 second alternative model (AIC=1205). Furthermore, the Sobel test for the second
7 406 alternative mediation model showed that the indirect effect of the independent variable on
8 407 the dependent variable through the mediator variable was not significant (Sobel
9 408 statistic=1.63 SE=0.12; $p < 0.1$).

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17 410 Lastly, the robustness of our analyses could be biased by the moderate association that
18 411 exists between daytime sleepiness and the K10 instrument first item (K1) that assesses
19 412 fatigue/tiredness ($r = 0.18$; $p < 0.02$). To verify this, we repeated our analyses by using a
20 413 total score of K9 (i.e., K10 after excluding item #1). This did not change the nature of our
21 414 results because 1) daytime sleepiness and K9 were still significantly correlated ($r = 0.14$;
22 415 $p < 0.04$); 2) K9 was associated with the consumption of sweetened products ($\beta = 0.17$;
23 416 $p < 0.02$) when both K9 and daytime sleepiness were entered as predictors in the
24 417 multivariate regression model, and 3) the effect of daytime sleepiness on consumption of
25 418 sweetened products controlling for psychological distress was reduced but it was not
26 419 zero.

420 421 **Discussion**

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

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53 430 The strengths of this study are the use of well-established procedures to assess mediation
54 431 - Baron and Kenny's (1986) four-step approach and the Sobel test, and the examination
55 432 of alternative mediating models. Our analysis, however, was based on assumptions of
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3 433 having a correctly specified mediation model, including no misspecifications of causal
4 434 order and of causal direction, or of imperfect measurements and unmeasured variables
5 435 [47]. In reality, such assumptions are difficult or even impossible to achieve. By testing
6 436 alternative mediate models we showed that the one we described is the best fitted to
7 437 account for the relationship between these three variables. Furthermore, data from prior
8 438 research support the proposition that a mediation relation exists between these variables.
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10 440 The relationship observed between daytime sleepiness and consumption of food high in
11 441 dietary sugars is consistent with previous studies conducted in western and non-western
12 442 settings [27-29]. Similarly, previous work provides strong support that the consumption
13 443 of sweetened products is triggered by negative emotional or distress feelings in western
14 444 populations. Negative mood (as measured by anxiety, fatigue and depression scales) has
15 445 been correlated with craving intensity for sweet food [36]. Experimental studies have also
16 446 demonstrated an association between stress or negative mood and the consumption of
17 447 savory foods in emotional eaters [35, 48]. Thus one explanation in support of our
18 448 mediating model is that individuals who experience daytime sleepiness may consume
19 449 energy dense sugary rich foods to upgrade their energy level or to alleviate their negative
20 450 mood or psychological distress. This explanation fits with the fueling and emotional
21 451 functions attributed to sweetened food and drink products by members of the studied
22 452 community in semi-structured interviews [49]. Furthermore, this explanation has
23 453 biological plausibility since sweet taste may alleviate dysphoric mood or stress through
24 454 dopaminergic and opioidergic neurotransmission in the brain [13-15].
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26 456 It would be interesting to explore which of anxiety or depression correlate stronger with
27 457 daytime sleepiness since the K10 instrument contains items that assesses both symptoms.
28 458 However, this instrument is used as a single scale because anxiety and depression items
29 459 are highly correlated. There is nevertheless evidence that both anxiety and depression are
30 460 highly correlated with excessive daytime sleepiness and fatigue [34].
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3 462 Our study highlights that sleep, mood and diet are interconnected, and that efforts to
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5 463 improve diet quality must consider the psychosocial well-being of individuals, especially
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7 464 given the known properties of sweets to temporarily alleviate fatigue, stress and anxiety.
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9 465 These results have important public health implications for the prevention of obesity and
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11 466 chronic diseases, which are growing concerns in the Arab Canadian community[3].
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13 467 Indeed, consumption of processed products high in dietary sugars is recognized as an
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15 468 important contributor to the development of these diseases[6]. As reported elsewhere, the
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17 469 consumption level of total sugars (all foods considered), ~ 20% of diet, in this community
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19 470 is now similar that of the Canadian and Quebec population[7]. The average daytime
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21 471 sleepiness score (8.2) and the prevalence of EDS (28%) measured in this paper are within
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23 472 the range noted in western countries[50]. The obesity prevalence of 15.6% is also similar
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25 473 to the Canadian average and the general Arab community, when self-reported measures
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27 474 are taken[3].
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30 476 The prevalence of high psychological distress (K10>30) at 11.8% is nearly half that of
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32 477 the Canadian average, reported to be 20.7% [51]. It is possible that sociocultural factors
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34 478 such as family social support or having a religious faith protect against anxiety and
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36 479 depression. Religious affiliation, for example, is higher in the Middle Eastern community
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38 480 (94%) than in the overall population (83%)[2]. Also, the strength and size of social
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40 481 network shown to have tempering effect on weight gain and the general health of
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42 482 individuals living in large Canadian ethnic groups [5]. The sources of psychological
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44 483 distress in the Middle Eastern Canadian community are, however, unknown and warrant
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46 484 future research. Socioeconomic difficulties do not seem to play an essential role in our
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48 485 population sample, since employment rate, education level and household income were
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50 486 found to be relatively high. The difficulties of maintaining traditional dietary practices in
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52 487 the host country may be potential sources of social and economic stress [21].
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55 489 In our analysis, BMI had a positive, but not significant association with daytime
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57 490 sleepiness. In a previous paper, we observed an inverse (but not significant) relationship
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59 491 between consumption of sweetened products and BMI in the same community [7]. These
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492 results, however, must be interpreted by taking into account that overweight and obese

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3 493 subjects may have under-reported their weight or under-reported their consumption of
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5 494 sweetened products, but also the cross-sectional design.
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9 496 This study has limitations. First, the sample size was small and thus statistical power was
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11 497 limited. However, the composition of our sample reflects the characteristics of the
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13 498 general Catholic Middle Eastern Canadian community in terms of birthplace, religious
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15 499 affiliation, education and income[2]. Our findings, however, cannot be generalized to the
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17 500 Muslim Arab Canadian community. Second, the study is based on self-reported
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19 501 measures. However, both instruments we used (ESS and K10) are valid and reliable
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21 502 instruments widely used in both sleep and mood-related studies. Third, we did not
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23 503 account for other sleep problem measures, including duration of sleep and sleep
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25 504 deprivation, as well as other potential confounding disorders. Sleep duration and
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27 505 obstructive sleep apnea are the most common causes of daytime sleepiness[22], but
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29 506 studies examining the relationships between sleep duration, dietary intake and obesity has
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31 507 produced mixed results[52]. Fourth, findings are based on cross-sectional data. Therefore,
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33 508 it is impossible to know the causal order of the observed associations, and the existence
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35 509 of bi-directional effects, for example, between the consumption of foods high in dietary
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37 510 sugars and daytime sleepiness.
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39 511

39 512 **Conclusion**

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41 513 This study expands the limited evidence base concerning the association between
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43 514 consumption of sweetened products, daytime sleepiness and psychological distress in any
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45 515 communities including migrants ones. One novel contribution of this study is its
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47 516 inclusion of a measure of psychological distress and the use of Baron and Kenny's [30,
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49 517 44] four-step approach and the Sobel test to establish that the consumption of sweetened
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51 518 products and daytime sleepiness is partially mediated by psychological distress. One
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53 519 possible explanation in support of this relationship is that individuals experiencing
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55 520 daytime sleepiness may reach for energy dense sugary rich foods in order to upgrade their
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57 521 energy level or to alleviate their psychological distress. Further work is needed to test this
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59 522 mediation relationship in larger samples and to verify the potential effects of sleep
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61 523 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 <* |
|-------------------------------------|----------|------|----------------------------|-----|------|
| | <i>n</i> | % | 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.

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

| | β | SE | S β | 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 |

543 β = Beta coefficient; S β = standardized Beta coefficient; SE= standard error

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

546 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
 547 psychological distress (mediator) and age.

548 549 550 551 552 553 554 **Contributorship**

555
556 The study was developed and designed by all authors, and supervised by MD. Data
 557 preparation and analysis was undertaken by JCM, MC, and OR. The initial draft of the
 558 paper was prepared by JCM, following extensive discussions with MC, OR MD.
 559 Successive drafts were developed by JCM, with inputs from the other co-authors. All
 560 authors have reviewed and approved the final version.
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For peer review only

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

5
6 **Jean-Claude Moubarac^a, PhD, Margaret Cargo^b, PhD, Olivier
7 Receveur^c, PhD and Mark Daniel^b, PhD**

8
9 ^a École de Santé Publique, Université de Montréal, 1420, boul.Mont-Royal, Montréal
10 (Québec) H2V 4P3, Canada. ^b School of Health Sciences, University of South Australia,
11 GPO Box 2471, Adelaide SA 5001, Australia, ^c Département de Nutrition, Université de
12 Montréal, 2405, Ch.de la Côte-Sainte-Catherine, Montréal (Québec) H3T 1A8, Canada.

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15 **Institution where the work was performed:** École de Santé Publique, Université de
16 Montréal, 1420, boul.Mont-Royal, Montréal (Québec) H2V 4P3, Canada

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18 **Corresponding author (Jean-Claude Moubarac): jcmoubarac@gmail.com**
19 Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde, Universidade de São Paulo,
20 Av. Dr. Arnaldo 715, 01246-904, São Paulo, SP, Brasil. Tel: 55-11-2592-2572

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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 community 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.

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85 Article focus:

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

91 Key messages

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

96 Strength and limitations

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

126 Introduction

127 The prevalence of overweight/obesity and chronic diseases, as well as their associated
128 risk factors, vary dramatically by ethnic groups in Canada[1]. Canadians of Arab (or
129 Middle East) origin¹ represent more than 1.2% of the total Canadian population[2] and
130 comprise one of the largest non-European ethnic groups in Canada. **After adjusting for
131 socioeconomic factors, Arab Canadians are less likely to be obese than Black, Latin, and
132 Aboriginal groups, however more likely to be obese than Chinese, Japanese, South Asian
133 groups, as well as the White reference group** [3]. Furthermore, the prevalence of obesity
134 is much higher amongst long-term Arab migrants (≥ 11 or more years) than the more
135 recent migrants (≤ 10 years) to Canada[1]. The high prevalence of obesity amongst Arabs
136 and the finding that the prevalence increases with time may result from the adoption of
137 dietary and behavioural risk factors uncommon to the environment of their home
138 countries prior to migration and acquired during the acculturation process in Canada[1, 4,
139 5].

140
141 A modifiable dietary risk factor contributing to the development of obesity is the
142 consumption of ultra-processed products high in dietary sugars, or sweet food and drink
143 products [6]. Such products include soft drinks, sweetened juices and beverages, candies
144 and chocolates, sugary baked goods, ice creams, and other desserts[7]. These products
145 share many nutritional characteristics that make them unhealthy; they are energy dense
146 (for solids), they have an excessive content in free sugars, and some are also high in fats
147 and saturated fats[8]. Furthermore, they are sold in large portion sizes and are commonly
148 consumed as snacks both of which may contribute to energy imbalance[9]. Even more
149 problematic is the fact that sweetened products have specific psychological properties
150 that trigger consumption; they are hyper-palatable [10-12] and their sweet taste works to
151 alleviate dysphoric mood or stress through dopaminergic and opioidergic neuro-
152 transmission in the brain[13-15].

153

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.

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3 154 Middle Easterners are known for the daily consumption of sweet tea. However, other
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5 155 sweetened products have a secondary role in traditional Middle Eastern cuisine in that
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7 156 they are mostly home-prepared pastries and deserts most frequently consumed during
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9 157 festivities and on special occasions [16, 17]. Young Egyptian women and men more often
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11 158 reported cravings for savories (meat and vegetables based dishes) than cravings for
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13 159 sweets, contrary to studies conducted in Canada and United States [18]. However, the
14
15 160 quantity, use and significance of sweetened products have significantly changed in the
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17 161 last decades in Lebanon, Egypt and Syria, with a parallel increase in obesity and chronic
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19 162 diseases [16, 19, 20]. Similarly, Arabs are exposed to a new food environment when they
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21 163 migrate to Canada where sweetened products are abundant, cheap, convenient,
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23 164 accessible, and part of the mainstream food culture. Such an experience creates a variety
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25 165 of social and economic challenges for maintaining ethnic cuisine as a marker of
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27 166 community affiliation and may be a potential source of stress and anxiety [21].
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30 167
31 168 Understanding why individuals consume sweetened products is a complex issue,
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33 169 especially given the psychological properties of these products and their effects in the
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35 170 brain. A review of the literature suggests that two sets of inter-related psychosocial
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37 171 factors are associated with the consumption of sweetened products; sleep-related
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39 172 problems and mood/stress-related problems. However, the nature of the relationships
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41 173 between these factors is not well understood [22].
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44 174
45 175 Excessive daytime sleepiness is characterized by persistent sleepiness and lack of energy,
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47 176 most often caused by sleep deprivation, obstructive sleep apnea and/or use of medication
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49 177 [23]. It is present in all individuals, regardless of age, and recognized as the first
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51 178 symptom that defines narcolepsy [24]. Both excessive daytime sleepiness [25, 26] and
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53 179 narcolepsy [24] have been associated with the development and/or exacerbation of
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55 180 obesity. One potential mechanism explaining this association is through effects on
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57 181 appetite and intake of food[22]. Indeed, excessive daytime sleepiness has been associated
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59 182 with the consumption of food high in fats, as well as refined carbohydrates[22]. A recent
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183 study found that excessive daytime sleepiness was associated with the consumption of
184 refined carbohydrate-rich snacks amongst Japanese children[27]. A very-low

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3 185 carbohydrate, high-protein diet has shown improvement in daytime alertness in adults
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5 186 patients with narcolepsy[28]. In another study, subjects fed a carbohydrate liquid diet
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7 187 scored higher for subjective fatigue than those fed with a high-fat or a high-protein diet
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9 188 [29]. Hormonal, metabolic, and inflammatory mechanisms could explain why a diet high
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11 189 in fats and/or sugars could induce somnogenic effects in the body [22].
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14 191 There is evidence that the association between daytime sleepiness and sweetened
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16 192 products may be explained by the mediating effects of mood/stress problems, such as
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18 193 psychological distress. This mediating effect is supported in the literature for **some of**
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20 194 Baron and Kenny's criteria to establish mediation[30]. First, there is supporting evidence
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22 195 that daytime sleepiness is associated with consumption of processed food high in dietary
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24 196 sugars [27,28]. Second, daytime sleepiness is correlated with depression and
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26 197 psychological distress in both Western and Arab populations [31-34]. Third, a preference
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28 198 for chocolate and other sweetened products is well documented in depressed and
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30 199 psychological distressed individuals[35, 36]. This preference could be explained by the
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32 200 effects of sweets on relieving mood or stress [13-15]. If sleepy individuals also tend to
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34 201 feel distressed, and psychological distress induces the consumption of sweetened
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36 202 products, then the relationship between daytime sleepiness and the consumption of these
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38 203 products could be, at least, partially mediated by psychological distress.
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41 205 Daytime sleepiness and psychological distress, and their relationship to the consumption
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43 206 of sweetened products have never been studied in Arab Canadians. Addressing this gap
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45 207 could shed light on the prevention/management of obesity in the Canadian Arab
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47 208 community. The burden of obesity in this community has important human and economic
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49 209 consequences for the Canadian public health system because Arabs are one of the fastest
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51 210 growing migrant groups in Canada, constituting more than 4% of the urban population of
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53 211 Montreal and Ottawa[2]. Understanding the relationship between daytime sleepiness,
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55 212 psychological distress and diet could provide useful information to improve daytime
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57 213 alertness, psychological well-being and diet quality, all of which are known risk factors
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59 214 to obesity and chronic diseases. From this perspective, this paper has two objectives: 1) to
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215 **assess** the prevalence of excessive daytime sleepiness and psychological distress in an

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3 216 Arab community living in Montreal[2], and 2) to test whether the relationship between
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5 217 daytime sleepiness and consumption of sweetened products is mediated by psychological
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7 218 distress using Baron and Kenny's [30] criteria and the Sobel test.
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10 220 **Methods:**

11 221 *Participants*

12 222 The Middle Eastern or Arab community living in Canada is heterogeneous in terms of its
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14 223 country of birth and religious affiliation. The main groups are Lebanese (41%), Egyptian
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16 224 (12%), Syrian (6%), Moroccan (6%), and Iraqi (6%)[2]. Canadians of Arab origin are
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18 225 equally divided between Muslims and Christians, of which the majority is Catholic[2].
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20 226 The sociocultural heterogeneity within the Middle Eastern community is essential to
21
22 227 acknowledge, especially because religious beliefs impose dietary restrictions and may
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24 228 influence psychosocial factors related to health in Arab Muslims [21, 37].
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27
28 230 The target population of this study is an established Catholic Middle Eastern community
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30 231 living in Montreal, Canada. This population is composed of first and second generation
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32 232 migrants, mostly from Egypt, Lebanon and Syria. Recruitment and data collection
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34 233 occurred at three Catholic Middle Eastern churches located in Montreal. Participation
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36 234 was solicited through public announcements and was limited to one respondent per
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38 235 household to avoid bias related to family customs. Subjects were all volunteers and could
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40 236 withdraw from the study at any point.
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42 237

43 238 The research protocol was submitted and approved by the ethics committee of the Centre
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45 239 Hospitalier de l'Université de Montréal (SL 06-063). All participants provided informed
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47 240 written consent.
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50 242 *Instruments*

51 243 Socio-demographic characteristics were collected using a self-reported questionnaire
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53 244 adapted from Health Canada[38]. Physical activity was assessed by asking the question
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55 245 "how many times per week do you exercise enough to sweat? " **Five response categories**
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57 246 **were provided ranging from 0 to 4 or more times per week.** Participants also self-reported
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3 247 height and weight. BMI was calculated as weight (kg)/ height (m)² and categorized as
4 248 normal weight (BMI < 25); overweight 25 ≥ BMI < 30); and obese (BMI > 30) [39].
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8 250 Food consumption was assessed using a food frequency questionnaire (FFQ) previously
9 251 developed and pretested with the study community to measure consumption of 26
10 252 different sweet food and drink products [7]. This questionnaire is easy to read and to
11 253 understand, and culturally relevant to the study community. To answer the FFQ,
12 254 respondents reported the average number of days per week, in a typical week, in which
13 255 each listed product was eaten or drank (i.e., excluding festivities). Participants were also
14 256 asked to report how many portions of the food item they typically ate. Examples of
15 257 portions sizes were taken from the Canadian Nutrient File (CNF) and provided to
16 258 participants[40]. For the purpose of this study, we selected food items representing
17 259 sweetened products, which include cookies, chocolate, cakes and candies.
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28 261 Daytime sleepiness was measured using the self-report *Epworth Sleepiness Scale* (ESS)
29 262 [41]. Respondents used a four-point scale (0 to 3) to express their perceived likelihood of
30 263 falling asleep during the day in eight different situations (sitting and reading, watching
31 264 television, sitting inactive in a public place, as a passenger in a car for an hour without a
32 265 break, lying down to rest in the afternoon when circumstances permit, sitting and talking
33 266 to someone, and sitting quietly after a lunch without alcohol). The ESS instrument has a
34 267 high internal consistency (Cronbach's alpha = 0.88) and a high test-retest reliability after
35 268 5 months (r = 0.82)[42]. For descriptive purposes, daytime sleepiness scores on the ESS
36 269 were coded into three levels of increasing daytime sleepiness: low (ESS scores 0-5),
37 270 intermediate (ESS scores 6-11) and high (ESS scores 12-24). Intermediate (6-11) and
38 271 high (12-24) ESS scores were shown to have a 30% and 69% increased risk for sleep
39 272 onset during the Multiple Sleep Latency Test (MSLT), an objective measure of daytime
40 273 sleep tendency [43].
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53 275 Psychological distress was measured using the *Kessler Psychological Distress Scale*
54 276 (K10) [44]. This instrument is composed of 10 questions on anxiety and depressive
55 277 symptomology. Respondents self-reported the degree to which they had these feelings for
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3 278 the month prior to completing the instrument using a five-point Likert scale (all the time,
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5 279 often, sometimes, rarely, never). Scores, ranging from 10 to 50, represent an increasing
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7 280 gradient of psychological distress. The K10 instrument has a high internal consistency
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9 281 (Cronbach's alpha = 0,92) [44]. For descriptive purposes, psychological distress scores
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11 282 on the K10 were grouped into standard groups as low (10-20), moderate (21-29) and high
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13 283 levels of psychological distress (30-50) [44].
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285 *Analysis*

17 286 Data were analyzed using SPSS (Version 18.0). As a first step, we present descriptive
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19 287 data on the consumption of sweetened products according to sex, age, body mass index
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21 288 (BMI), physical activity, daytime sleepiness, and psychological distress. Consumption of
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23 289 sweetened products corresponded to the daily amount of total sugars eaten from cakes,
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25 290 cookies, chocolate, and candies. This was calculated using data on the frequency and
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27 291 portions consumed from these products obtained from the FFQ, and the estimated amount
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29 292 of total sugars contained in mean portions of these products using CNF.
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31 294 As a second step, univariate regression analysis was performed to estimate the
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33 295 associations between consumption of sweetened products and age, sex, physical activity,
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35 296 BMI, daytime sleepiness and psychological distress. Similar tests were performed to
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37 297 verify if the consumption of sweetened products varied by other socio-demographics
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39 298 (country of birth, time since migration, family income, education level, civil status and
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41 299 employment status). For all regression analyses, consumption of sweetened products was
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43 300 log-transformed. Physical activity was used as a ordinal measure using the five answer
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45 301 choices (0-4 times or more per week). All other variables were used as continuous
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47 302 measures.
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49 304 Next, we applied the Baron and Kenny [30,45] criteria to assess whether the relationship
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51 305 between daytime sleepiness (independent variable) and consumption of sweetened
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53 306 products (dependent variable) was mediated by psychological distress (mediator).
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55 307 According to Baron and Kenny four statistical conditions need to be met in order to
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57 308 establish complete mediation and three conditions to establish partial mediation [30, 45].
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3 309 First, univariate regression was used to test if daytime sleepiness was significantly
4 associated with consumption of sweetened products. Second, we assessed whether
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6 daytime sleepiness and psychological distress were significantly associated. Third, we
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8 tested whether psychological distress (mediator) was associated with the consumption of
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10 sweetened products when both daytime sleepiness and psychological distress were
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12 entered as predictors in a multivariate regression analysis. **Fourth, to establish that**
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14 **psychological distress completely mediates the relationship between daytime sleepiness**
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16 **and consumption of sweetened products, we examined whether the effect of daytime**
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18 **sleepiness on consumption of sweetened products controlling for psychological distress**
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20 **was zero. If the first three steps are met but the Step 4 is not, then partial mediation is**
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22 **indicated [45].** The Sobel test was used to statistically evaluate whether the indirect effect
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24 of the independent variable on the dependent variable through the mediator variable was
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26 significant[46].
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28 323 As a final step, we ran alternative mediation models to rule out plausible competing
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30 interpretations of the data and to verify whether our hypothesized model best fit the data.
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32 First, daytime sleepiness was entered as the mediator of the relationship between
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34 psychological distress (independent) and consumption of sweetened products
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36 (dependent). In a second alternative model, consumption of sweetened products was
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38 entered as the mediator of the relationship between daytime sleepiness (independent
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40 variable) and psychological distress (dependent variable).
41 330

42 331 **Results**

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44 Participants were aged between 18 and 60 years (Mean = 34.6; Standard deviation (SD) =
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46 12.5). There were slightly more women (*n* 101) than men (*n* 85). Country of birth
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48 included Egypt (31.9 %), Lebanon (25.1 %), Syria (14.7 %), and other Middle Eastern
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50 countries (5.3 %). Individuals migrated between 1962 and 2007, of which 86% arrived
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52 before 2000, meaning they have spent more than 10 years in Canada. An additional
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54 23.0% of subjects were born in Canada; these were second-generation migrants (i.e.,
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56 children of immigrating parents born in the Middle Eastern). Participant's civil status was
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58 as follows; married or engaged (47.3%), single (46.2%), separated/divorced (4.3%), and
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3 340 widowed (2.2%). The vast majority of respondents had at least a college diploma
4 (88.0%), and most had a university degree (65.8%). Most participants had a family
5 341 income above CAD \$50,000 (66.9%).
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10 344 Average consumption of sweetened products was of 15.5 g/day (SD=13.9; *n* 186) with
11 the range from 0 to 93.1 g/day. The share of each food item to the amount of total sugars
12 345 from these products was as follows; cakes (51.3%), chocolate (24.7%), cookies (16.1%)
13 346 and candies (7.9 %).
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19 349 The average daytime sleepiness score on ESS was 8.2 (SD= 4.5) (*n* 186). A third of
20 350 individuals (30.1%) had a low daytime sleepiness score (0-5) and half (50.5%) had an
21 intermediate daytime sleepiness score (6-11). One-fifth of individuals (19.5%) had a high
22 351 daytime sleepiness score (12-24). Almost one-third of individuals met the clinical criteria
23 352 for excessive daytime sleepiness (EDS) (defined as ESS scores above 10). Daytime
24 353 sleepiness did not vary by sex, age or BMI.
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32 356 The average psychological distress score on the K10 was 20.8 (SD= 6.2) (*n* 186).
33 357 More than one half the respondents (55.4%) had a low distress score of 0-20; one-third
34 358 (32.8%) had a moderate distress score of 21-30; and one-tenth had a high distress score of
35 359 30-50 (11.8%). Psychological distress did not vary by sex, age or BMI.
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40
41 361 Table 1 presents descriptive data on the consumption of sweetened products according to
42 age, sex, physical activity, BMI, daytime sleepiness, and psychological distress. Females
43 362 consumed slightly more sweetened products than males (1.7g/day), while patterns for age
44 363 and BMI were less defined. Importantly, the consumption of sweetened products varied
45 364 according to psychological distress and daytime sleepiness score levels. Individuals with
46 365 high distress ate an additional 5.6g of total sugars/day, 45% more than individuals with
47 366 moderate distress, and an additional 8.5g of total sugars/day, 68% more than individuals
48 367 with low distress. Individuals with high daytime sleepiness (>12) ate an additional 2.9g
49 368 of total sugars/day, 23% more than subjects with moderate daytime sleepiness, and an
50 369 additional 6.9g of total sugars/day, 54% more than individuals with low daytime
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3 371 sleepiness. Other socio-demographics were not related statistically to the consumption of
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5 372 sweetened products.
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9 374 Table 1 also presents the results of univariate regression analyses between consumption
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11 375 of sweetened products (log-transformed) and age, sex, BMI, daytime sleepiness, and
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13 376 psychological distress. Consumption of sweetened products did not vary significantly by
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15 377 age, sex or BMI. The consumption of sweetened products was positively associated with
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17 378 psychological distress ($p<0.00$), as well with daytime sleepiness ($p<0.04$).
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20 380 Multivariate analysis (Table 2) consisted of simultaneous modeling daytime sleepiness
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22 381 and psychological distress. In this model, the association between psychological distress
23
24 382 and consumption of sweetened products remained statistically significant ($p<0.01$),
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26 383 whereas the relationship with daytime sleepiness **was no longer** significant ($p<0.09$).
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29 385 **We were able to verify the first three steps of Baron and Kenny[30] to establish**
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31 386 **mediation.** First, daytime sleepiness was significantly associated with the consumption of
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33 387 **sweetened** products ($p<0.04$). Second, daytime sleepiness and psychological distress were
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35 388 significantly correlated ($r=0.15$; $p<0.04$). Third, psychological distress was associated
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37 389 with the consumption of **sweetened** products ($p<0.01$) when both psychological distress
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39 390 and daytime sleepiness were entered as predictors in the multivariate regression model.
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41 391 **However, the fourth step was not met. In our analysis, the effect of daytime sleepiness on**
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43 392 **consumption of sweetened products controlling for psychological distress was reduced**
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45 393 **but it was not zero. Finally,** the Sobel test showed that the indirect effect of the
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47 394 independent variable on the dependent variable through the mediator variable was
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49 395 significant (Sobel statistic=2.14; SE=0.01; $p<0.03$).
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52 397 In order to strengthen the robustness of the results, two alternative mediation models
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54 398 were tested. In the first alternative model, Baron and Kenny's third criteria was not
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56 399 satisfied. Indeed, daytime sleepiness (mediator) was not associated ($p<0.15$) with
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58 400 psychological distress (dependent) when both daytime sleepiness and consumption of
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60 401 sweetened products (independent) were entered as predictors in a multivariate regression

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3 402 analysis. In the second alternative model, all first three Baron and Kenny's criteria were
4 403 satisfied. However, comparing both models using Akaike information criterion (AIC)
5 404 indicated that the hypothesized mediation model (AIC=848) is a far better fit than this
6 405 second alternative model (AIC=1205). Furthermore, the Sobel test for the second
7 406 alternative mediation model showed that the indirect effect of the independent variable on
8 407 the dependent variable through the mediator variable was not significant (Sobel
9 408 statistic=1.63 SE=0.12; $p < 0.1$).

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17 410 Lastly, the robustness of our analyses could be biased by the moderate association that
18 411 exists between daytime sleepiness and the K10 instrument first item (K1) that assesses
19 412 fatigue/tiredness ($r = 0.18$; $p < 0.02$). To verify this, we repeated our analyses by using a
20 413 total score of K9 (i.e., K10 after excluding item #1). This did not change the nature of our
21 414 results because 1) daytime sleepiness and K9 were still significantly correlated ($r = 0.14$;
22 415 $p < 0.04$); 2) K9 was associated with the consumption of sweetened products ($\beta = 0.17$;
23 416 $p < 0.02$) when both K9 and daytime sleepiness were entered as predictors in the
24 417 multivariate regression model, and 3) the effect of daytime sleepiness on consumption of
25 418 sweetened products controlling for psychological distress was reduced but it was not
26 419 zero.

420 421 **Discussion**

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

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53 430 The strengths of this study are the use of well-established procedures to assess mediation
54 431 - Baron and Kenny's (1986) four-step approach and the Sobel test, and the examination
55 432 of alternative mediating models. Our analysis, however, was based on assumptions of
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3 433 having a correctly specified mediation model, including no misspecifications of causal
4 434 order and of causal direction, or of imperfect measurements and unmeasured variables
5 435 [47]. In reality, such assumptions are difficult or even impossible to achieve. By testing
6 436 alternative mediate models we showed that the one we described is the best fitted to
7 437 account for the relationship between these three variables. Furthermore, data from prior
8 438 research support the proposition that a mediation relation exists between these variables.
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10 440 The relationship observed between daytime sleepiness and consumption of food high in
11 441 dietary sugars is consistent with previous studies conducted in western and non-western
12 442 settings [27-29]. Similarly, previous work provides strong support that the consumption
13 443 of sweetened products is triggered by negative emotional or distress feelings in western
14 444 populations. Negative mood (as measured by anxiety, fatigue and depression scales) has
15 445 been correlated with craving intensity for sweet food [36]. Experimental studies have also
16 446 demonstrated an association between stress or negative mood and the consumption of
17 447 savory foods in emotional eaters [35, 48]. Thus one explanation in support of our
18 448 mediating model is that individuals who experience daytime sleepiness may consume
19 449 energy dense sugary rich foods to upgrade their energy level or to alleviate their negative
20 450 mood or psychological distress. This explanation fits with the fueling and emotional
21 451 functions attributed to sweetened food and drink products by members of the studied
22 452 community in semi-structured interviews [49]. Furthermore, this explanation has
23 453 biological plausibility since sweet taste may alleviate dysphoric mood or stress through
24 454 dopaminergic and opioidergic neurotransmission in the brain [13-15].
25 455

26 456 *It would be interesting to explore which of anxiety or depression correlate stronger with*
27 457 *daytime sleepiness since the K10 instrument contains items that assesses both symptoms.*
28 458 *However, this instrument is used as a single scale because anxiety and depression items*
29 459 *are highly correlated. There is nevertheless evidence that both anxiety and depression are*
30 460 *highly correlated with excessive daytime sleepiness and fatigue [34].*
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3 462 Our study highlights that sleep, mood and diet are interconnected, and that efforts to
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5 463 improve diet quality must consider the psychosocial well-being of individuals, especially
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7 464 given the known properties of sweets to temporarily alleviate fatigue, stress and anxiety.
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9 465 These results have important public health implications for the prevention of obesity and
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11 466 chronic diseases, which are growing concerns in the Arab Canadian community[3].
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13 467 Indeed, consumption of processed products high in dietary sugars is recognized as an
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15 468 important contributor to the development of these diseases[6]. As reported elsewhere, the
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17 469 consumption level of total sugars (all foods considered), ~ 20% of diet, in this community
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19 470 is now similar that of the Canadian and Quebec population[7]. The average daytime
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21 471 sleepiness score (8.2) and the prevalence of EDS (28%) measured in this paper are within
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23 472 the range noted in western countries[50]. The obesity prevalence of 15.6% is also similar
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25 473 to the Canadian average and the general Arab community, when self-reported measures
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27 474 are taken[3].
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30 476 The prevalence of high psychological distress (K10>30) at 11.8% is nearly half that of
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32 477 the Canadian average, reported to be 20.7% [51]. It is possible that sociocultural factors
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34 478 such as family social support or having a religious faith protect against anxiety and
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36 479 depression. Religious affiliation, for example, is higher in the Middle Eastern community
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38 480 (94%) than in the overall population (83%)[2]. Also, the strength and size of social
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40 481 network shown to have tempering effect on weight gain and the general health of
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42 482 individuals living in large Canadian ethnic groups [5]. The sources of psychological
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44 483 distress in the Middle Eastern Canadian community are, however, unknown and warrant
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46 484 future research. Socioeconomic difficulties do not seem to play an essential role in our
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48 485 population sample, since employment rate, education level and household income were
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50 486 found to be relatively high. The difficulties of maintaining traditional dietary practices in
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52 487 the host country may be potential sources of social and economic stress [21].
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55 489 **In our analysis, BMI had a positive, but not significant association with daytime**
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57 490 **sleepiness. In a previous paper, we observed an inverse (but not significant) relationship**
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59 491 **between consumption of sweetened products and BMI in the same community [7]. These**
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61 492 **results, however, must be interpreted by taking into account that overweight and obese**

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3 493 subjects may have under-reported their weight or under-reported their consumption of
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5 494 sweetened products, but also the cross-sectional design.
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9 496 This study has limitations. First, the sample size was small and thus statistical power was
10 497 limited. However, the composition of our sample reflects the characteristics of the
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12 498 general Catholic Middle Eastern Canadian community in terms of birthplace, religious
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14 499 affiliation, education and income[2]. Our findings, however, cannot be generalized to the
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16 500 Muslim Arab Canadian community. Second, the study is based on self-reported
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18 501 measures. However, both instruments we used (ESS and K10) are valid and reliable
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20 502 instruments widely used in both sleep and mood-related studies. Third, we did not
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22 503 account for other sleep problem measures, including duration of sleep and sleep
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24 504 deprivation, as well as other potential confounding disorders. Sleep duration and
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26 505 obstructive sleep apnea are the most common causes of daytime sleepiness[22], but
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28 506 studies examining the relationships between sleep duration, dietary intake and obesity has
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30 507 produced mixed results[52]. Fourth, findings are based on cross-sectional data. Therefore,
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32 508 it is impossible to know the causal order of the observed associations, and the existence
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34 509 of bi-directional effects, for example, between the consumption of foods high in dietary
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36 510 sugars and daytime sleepiness.

37 511

38 512 **Conclusion**

39 513 This study expands the limited evidence base concerning the association between
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41 514 consumption of sweetened products, daytime sleepiness and psychological distress in any
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43 515 communities including migrants ones. One novel contribution of this study is its
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45 516 inclusion of a measure of psychological distress and the use of Baron and Kenny's [30,
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47 517 44] four-step approach and the Sobel test to establish that the consumption of sweetened
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49 518 products and daytime sleepiness is partially mediated by psychological distress. One
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51 519 possible explanation in support of this relationship is that individuals experiencing
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53 520 daytime sleepiness may reach for energy dense sugary rich foods in order to upgrade their
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55 521 energy level or to alleviate their psychological distress. Further work is needed to test this
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57 522 mediation relationship in larger samples and to verify the potential effects of sleep
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59 523 duration and quality of sleep in this relationship.
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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 <* |
|-------------------------------------|----------|------|----------------------------|-----|------|
| | <i>n</i> | % | 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.

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

| | β | SE | $S\beta$ | 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 |

543 β = Beta coefficient; $S\beta$ = standardized Beta coefficient; SE= standard error

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

546 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
 547 psychological distress (mediator) and age.

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