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Article

Social desirability, dietary intakes, and variables related to attitudes and behaviours towards eating among French-speaking adults from Quebec, Canada: The PREDISE study

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Abstract

The primary objective of this study was to examine how social desirability is associated with self-reported measures of dietary intakes and variables related to attitudes and behaviours towards eating. This analysis was conducted in 1083 adults (50.0% women) from the PREDISE study. Social desirability was assessed using the Balanced Inventory of Desirable Responding (BIDR) questionnaire, which includes two subscales: (1) self-deceptive enhancement (SDE), i.e., having an overly positive self-image and (2) impression management (IM), i.e., intentional response distortion to please. BIDR total score and IM subscore were positively associated with the Canadian Healthy Eating Index (C-HEI) ($ß = 0.24$ and $ß = 0.50$; $p \leq 0.0003$), calculated using data from three self-administered 24 h food recalls. All BIDR scores were positively associated with self-determined motivation for eating regulation ($0.03 \leq ß \leq 0.06$; $p < 0.0001$), measured by the Regulation of Eating Behavior Scale, and with the intuitive eating score ($0.02 \leq ß \leq 0.05$; $p < 0.0001$). Also, all BIDR scores were negatively associated with hunger and disinhibition scores measured by the Three-Factor Eating Questionnaire ($-0.17 \leq ß \leq -0.09$; $p < 0.0001$). All these associations were adjusted for age, sex, BMI, and the education level. Furthermore, controlling for both dimensions of social desirability did not impact the magnitude of the association between self-determined motivation (the strongest predictor of healthy eating in the PREDISE study) and C-HEI. According to our results, associations are observed with diet quality, as well as with attitudes and behaviours towards eating; therefore, a measurement of social desirability responding would be pertinent in studies using those or related variables.

Key words: social desirability, Balanced Inventory of Desirable Responding questionnaire, self-administered food recall, diet quality, eating behaviours, PREDISE study

Introduction

By definition, social desirability is the tendency of respondents to answer questions in a manner that is influenced by social norms and in a way that they will be perceived more favourably by themselves and by others. Studies have documented differences in social desirability according to socio-demographic variables. Accordingly, it was found that women and older persons had higher social desirability than men and younger persons (Börnhorst et al. 2013; Mossavar-Rahmani et al. 2013; Foster and Bradley 2018). Also, studies suggest that a higher education level and a higher body mass index (BMI) are both associated with a higher level of social desirability (Hebert et al. 2002; Poínhos et al. 2015; Foster and Bradley 2018).

Social desirability has often been identified as a significant source of bias in studies including variables related to reported dietary intakes or other variables evaluating behaviours and attitudes towards eating, creating doubt about the validity of results obtained in such studies (Hébert et al. 2014). In fact, social desirability may impact the dietary recall by over-reporting what is perceived as a favourable dietary habit and under-reporting what is perceived as an unfavourable dietary habit (Hebert et al. 1995; Lissner 2002). In fact, it was found in epidemiological studies that a large number of dietary variables such as the total energy intake, non-fat calories, vegetable intake, and cholesterol were significantly associated with social desirability (Hebert et al. 1995, 2002, 2008; Horner et al. 2002; Lissner 2002). Moreover, some studies have tried to determine whether all dietary assessment methods (i.e., foods recalls, food frequency questionnaires, and food diaries) were equally influenced by social desirability, but inconsistent results were observed (Hebert

et al. 2002; Miller et al. 2008; Mossavar-Rahmani et al. 2013). However, some studies suggested a greater influence of social desirability on interviewer-administered tools than on self-administered tools (Kreuter et al. 2009; Brassard et al. 2018).

Social desirability can also bias the responses to questionnaires measuring attitudes and behaviours related to eating such as cognitive restraint, uncontrolled eating, and emotional eating (Poínhos et al. 2015; Kowalkowska and Poínhos 2021), although, this has been less studied than the effect of social desirability on self-reported dietary intakes. A study from Poínhos et al. (2015) found that social desirability was negatively associated with emotional, external, and binge eating, and positively associated with eating self-efficacy in both men and women. Furthermore, Kowalkowska and Poínhos (2021) found that social desirability was negatively associated with both uncontrolled eating and emotional eating. These results support the relevance of considering social desirability when assessing eating behaviours (Freitas et al. 2017; Kowalkowska and Poínhos 2021). To our knowledge, no study has linked social desirability to motivation for the regulation of eating. This needs to be documented since diet quality is strongly associated with motivation in our population and in other studies (Pelletier et al. 2004; Leong et al. 2012; Guertin et al. 2020; Carbonneau, Pelletier et al. 2021). Furthermore, to our knowledge, no study has evaluated if social desirability could influence the associations relating attitudes and behaviours towards eating to diet quality.

The primary objective of this study was to measure for the first time in a French-speaking sample from the Province of Quebec, Canada, the associations of social desirability, as measured by the Balanced Inventory of Desirable Responding (BIDR), with reported intakes from self-administered web-based 24 h dietary recalls and with other variables assessing attitudes and behaviours related to eating, also measured by self-administered web-based questionnaires. Our main hypothesis is that social desirability is positively associated to diet quality and to attitudes and behaviours related to eating such as intuitive eating and self-determined motivation, as they are seen as favourable by health professionals and presented in a favourable light in public health messages. As an exploratory objective, we also wanted to examine whether social desirability influences the associations between well-known determinants of dietary intakes and diet quality. In the PREDISE study, regulation styles of motivation for eating behaviours (i.e., self-determined and non-self-determined motivation variables) were found to be the psychosocial variables that were the most strongly associated with diet quality (Carbonneau et al. 2021). Therefore, we wanted to test whether controlling for social desirability influences the associations between regulation styles for eating behaviours and diet quality.

Methods

This analysis was conducted in a sample of 1083 adults (50.0% women; mean [SD] age, 42.7 [13.6] years; mean [SD] BMI, 27.4 [6.2] kg/m^2) from the cross-sectional web-based PREDISE study (PRÉDicteurs Individuels, Sociaux et Environnementaux). The PREDISE sample was an age (18–34 years, 35–49 years, 50–65 years) and sex (men, women) representative sample of French-speaking adults from five administrative regions of the Province of Quebec, in Canada: Capitale-Nationale/Chaudière-Appalaches, Montréal, Estrie, Saguenay Lac-St-Jean, and Mauricie, based on predetermined quotas. To be eligible, participants had to be between 18 and 65 years of age, to speak French as the primary language at home, to have access to the Internet, and to have a valid email address. Participants with intestinal malabsorption and pregnant or breastfeeding women were excluded. Participants had to answer 13 questionnaires in a random order and three web-based 24 h recalls, on 3 days generated at random by the tool within a 3-week timeframe. Then, they had to visit one of the five research centres involved in the PREDISE study for blood sampling and measurements of blood pressure and anthropometric variables.

Balanced Inventory of Desirable Responding questionnaire

Participants completed the BIDR questionnaire which was developed for the measurement and control of response bias (Paulhus 1991). It includes two subscales: (1) self-deceptive enhancement (SDE), which means to have an overly positive self-image, and (2) impression management (IM), which refers to intentional response distortion to please. The scale has 40 items and uses a 7-point Likert scale (not true = 1, very true = 7). We reversed the negatively keyed items and used the bifactor model, in which 1 point was given for every answer corresponding to 6 or 7 on the scale and 0 points when answers were from 1 to 5. The social desirability total score has a maximum of 40 points (a higher score corresponds to a higher social desirability) while the maximum is 20 points for each subscale. This scale has been previously validated using different strategies (Cournoyer and Sabourin 1991; Holden et al. 2000; Paulhus 2002). For researchers to test their hypotheses, the bifactor model proposes less ambiguous interpretations of effects (one point or zero) compared to continuous scoring (Stöber et al. 2002).

Although the Marlowe–Crowne Desirability Scale, a 33-item, true–false summated rating scale (Crowne and Marlowe 1960), is more often used to assess social desirability in nutrition studies, we have decided to use the BIDR questionnaire in the present study. This decision is supported by the work of Paulhus (Paulhus 1984) who has examined the uni-dimensionality of the Marlowe–Crowne Desirability Scale and has suggested that this scale may be best represented by two factors: SDE and IM, as described above. Considering the importance of assessing the effects of these two factors, Paulhus has then developed the BIDR questionnaire (Paulhus 1991). Although both the Marlowe–Crowne Desirability Scale and the BIDR may be relevant for any self-report research, the selection of the most appropriate scale could depend, in part, on the projected role of social desirability behaviour in a study. If the tendency to respond in socially desirable ways is considered within the research context to be a variable of theoretical interest, as this is the case for the present study, then, having information about two different dimensions of social desirability, as offered by the BIDR, may be more appro-

priate as it allows to gather data that could eventually lead to the reduction of social desirability impact in future research.

Socio-demographic variables

A socio-demographic questionnaire was also completed by the participants. Regarding age, it was categorized in three groups according to recruitment strata (i.e., 18–34 years, 35–49 years, and 50–65 years). Then, using the highest education degree obtained, education levels were also classified in three groups i.e., high school or less, CEGEP, and university. In the Quebec education system, CEGEP is the first level of post-secondary education and includes pre-university and technical programs. Annual household income in Canadian dollars of participants were reported and categorized into four groups: <30 000 (low), ≥30 000 to <60 000 (moderate), ≥60 000 to <90 000 (high), and ≥90 000 (very high) (Institut de la statistique du Québec 2017).

Web based 24 h food recalls

On three occasions, in a 3-week window, a validated self-administered 24 h food recall (R24W) was completed (Lafrenière et al. 2018). The R24W was based upon the USDA's Automated Multiple Pass Method (AMPM) (Moshfegh et al. 2008), but is using a meal-based approach. The R24W is using pictures representing up to eight portion sizes and the sequence of questions has been determined to help participants remember frequently forgotten foods (toppings, sauces, spices, etc.). Before completing the first R24W, participants had to watch a mandatory tutorial. R24W has been described in detail elsewhere (Jacques et al. 2016).

The plausibility of reported energy intake was assessed using the ratio of calculated energy intake using R24W, on predicted energy requirements using the formulas of the Institute of Medicine (Meyers et al. 2006) and assuming that all participants were sedentary as previously suggested by Garriguet when reporting results from the Canadian Community Health Survey (Garriguet 2018). A ratio of 1.00 indicates an exact correspondence between both estimates.

The Canadian Healthy Eating Index

The Canadian Healthy Eating Index (C-HEI) that we used evaluates overall diet quality and adherence to the 2007 Canada's Food Guide (Garriguet 2009). It was calculated based on the three 24 h food recalls (Lafrenière et al. 2019). We used the 2007 version of the Canada's Food Guide because, when data were collected for this study, the new recommendations for the 2019 Canada's Food Guide were not published yet. The C-HEI is composed of eight adequacy components (total fruits and vegetables, whole fruits, dark green and orange vegetables, total grain products, whole grains products, milk and alternatives, meat and alternatives, and unsaturated fat) and three moderation components (saturated fat, sodium, and "other foods"). The "other foods" component corresponds to energy intake from all foods that were not recommended in the 2007 Canada's Food Guide, namely foods high in sodium, fat or free sugars. The maximum score is 100 points and components are evaluated on 5, 10, or 20 points each. In the present study, the C-HEI score was used as a continuous variable (Lafrenière et al. 2019).

Regulation of Eating Behavior Scale

The Regulation of Eating Behavior Scale, developed by Pelletier et al. was completed by all participants (Pelletier et al. 2004). This is a 24-item validated questionnaire that is assessing motivational orientations for the regulation of eating, with two separate scores for self-determined motivation and non-self-determined motivation. According to the Self-Determined Theory, the ways individuals regulate their behaviours vary on a self-determined continuum (Deci and Ryan 2013). Scores of non-self-determined motivation and self-determined motivation were calculated using specific items from the least to the most self-determined forms of regulations of eating styles. In the non-self-determined motivation scale, amotivation refers to a state where individuals fail to perceive that their actions (e.g., eating) can lead to significant outcomes, external regulation refers to a behaviour engaged in to obtain a reward, or avoid negative consequences, and introjected regulation typically refers to a behaviour performed to avoid feelings of guilt or anxiety. As for self-determined motivation, identified regulation represents a behaviour that is viewed as important and/or valuable by a person, integrated regulation occurs when a behaviour is perceived as being in congruence with a person's core values, and intrinsically motivated behaviours are engaged in for the pleasure, the interest, and the satisfaction derived from participation itself. For each question, participants had to provide an answer based on a Likert scale from (1) "Does not correspond at all" to (7) "Corresponds exactly," as previously described elsewhere (Hamilton et al. 2018; Carbonneau et al. 2021).

Food liking questionnaire

The food liking questionnaire was developed and validated by our research team to determine whether a high liking for savory, sweet, and fatty foods is a barrier to healthy eating (Carbonneau et al. 2017). Foods rich in salt, sugar, or fat, mostly ultra-processed, were classified into two main categories: sweet and savory. Participants were asked to rate their liking for 32 items listed (12 savory, 20 sweet) on a 9-point scale, from (1) "I really don't like" to (9) "I really like." The option "I never tasted this food" was included for all items on the list. A higher score indicates a higher liking for savory or sweet, mostly ultra-processed foods.

Intuitive eating scale

Participants answered the Intuitive Eating Scale (IES-2) that measures a total intuitive eating score and four subscores that are "Unconditional permission to eat," "Eating for physical rather than emotional reasons," "Reliance on internal hunger/satiety cues," and "Body–food choice congruence" (Tylka and Kroon Van Diest 2013). The IES-2 has been validated in our population (Carbonneau et al. 2016). Participants rated 23 items on a 5-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree," and we thereafter reversed the negatively keyed items. For the present study,

only the total intuitive eating score was reported. A higher score indicates a more intuitive eating.

Three-Factor Eating Questionnaire

Participants also completed the 51-item Three-Factor Eating Questionnaire (TFEQ), which evaluates cognitive dietary restraint (21 items) that refers to restricting food intake to control body weight, disinhibition (16 items) which is the loss of control over eating in response to emotional or social cues, and susceptibility to hunger (14 items) that can be defined as the food intake in response to feelings and perceptions of hunger. The questionnaire has 36 "true" or "false" statements, 14 items evaluated on a 4-point Likert scale (e.g., 1 = never/not at all, 4 = always/very much), and one item with a 6-point Likert scale. We reversed negative items, then 1 point was assigned for every "true" answer and every answer greater than 3 for all items rated on a Likert scale (Stunkard and Messick 1985; Bond et al. 2001).

Nutrition knowledge

Nutrition knowledge questionnaire was developed by Bradette-Laplante et al. (2017) and validated for the French-speaking population of the Province of Quebec (Bradette-Laplante et al. 2017). This is a 20-item tool covering four domains of nutrition knowledge. Three were related to the familiarity with the 2007 Canada's Food Guide (CFG) (e.g., "How many portions a day do you think CFG recommends, for an individual of your age and gender for each of the following food groups? ", "For each of the four CFG groups, five food items are listed. Identify whether or not these items are included in the food group"). The fourth domain was related to general nutrition knowledge (e.g., "Indicate whether you agree or disagree with the following statements: All spices are high in sodium (salt)."). The total score for this questionnaire is 13.5 points, which is then converted into a percentage. Nutrition knowledge measurement was used to reach our exploratory objective.

Social support for healthy eating

Social support for healthy eating was assessed with The Social Support for Healthy Eating Questionnaire, validated and developed for the French-speaking adult population of the Province of Quebec (Carbonneau et al. 2018). Participants were asked to rate how frequently, in the past month, close others had taken 20 particular actions (or said particular statements) related to healthy and unhealthy eating. The questionnaire is composed of four subscales (i.e., supportive actions at home; non-supportive actions at home; supportive actions outside of home; and non-supportive actions outside of home). For the purpose of the present study, only "at home" subscales were used as the "outside of home" subscales were previously found to be not significantly associated with diet quality (Carbonneau et al. 2019). Twelve items relate to supportive actions (sample item includes: "… proposed that we eat healthier") and eight items relate to non-supportive actions (sample item includes: "… said that healthy foods do not taste good"). With a maximum of 5 points, scores were calculated with the mean of each item. A higher score for both scales means a higher frequency of these types of action. Measurements of supportive and non-supportive actions from close others were used to reach our exploratory objective.

Anthropometric measurements

During their visit to the research centre, a trained professional measured height (to the nearest millimetre) and weight (to the nearest 0.1 kg on a calibrated balance) of participants according to standardized procedures (Callaway et al. 1988).

Ethics

The PREDISE study was conducted according to the guidelines laid down in the Declaration of Helsinki. The project received approval from the Research Ethics Committee at Université Laval and all participants gave implied consent for the completion of online questionnaires and written informed consent for anthropometric measurements.

Statistical analysis

SAS OnDemand version 3.81 (Copyright © 2012–2020, SAS Institute Inc., Cary, NC, USA) was used to perform statistical analyses. Unless otherwise specified, a p value ≤ 0.05 was considered as significant. We used simple imputation for missing data, i.e., imputation by person mean values (Eekhout et al. 2014) when less than 10% of data were missing. If more than 10% of missing data were found in a participant for a given questionnaire, the participant's score was not imputed and therefore not included in the analyses.

Abnormal data distributions were identified using values of skewness and kurtosis. Accordingly, liking for savory foods, liking for sweet foods, and energy intake were transformed successfully using log transformation, and amotivation and BMI using reverse transformation.

Analysis of variance (ANOVA) was used to examine differences in social desirability according to regions, age, BMI, income, and education levels. When a significant main effect was found, post hoc between group comparisons were performed using Duncan's test. For sex comparison, the t test statistic was used.

We performed Pearson's correlation analyses to examine the relationships between social desirability and dietary intakes/attitudes and behaviours towards eating. We then performed generalized linear model, with the variable related to dietary intakes/attitudes and behaviours towards eating as the dependent variable, social desirability as the independent variable, and sex, age, BMI, and education level as covariables. These covariables were chosen as they were found to be significantly associated with social desirability or with dietary intakes and/or attitudes and behaviours towards eating in our sample or in previous studies (Adong et al. 2019; Poínhos et al. 2015; Hebert et al. 2002; Löffler et al. 2017; Kelly et al. 2013; Muyindike et al. 2017). We tested our error term for heteroskedasticity and results showed that the variance of the error term was constant (homoskedastic) for each analysis. Accordingly, we did not adjust our standard errors for heteroskedasticity. Considering the various comparisons,

Bonferroni correction for multiple comparisons was applied to adjust p value for these analyses. Accordingly, a p value < 0.001 was considered as significant.

To reach our exploratory objective, which was to verify whether controlling for social desirability influences the associations between regulation styles for eating behaviours and diet quality, we used a multiple regression model similar to the one we previously described in a study documenting the determinants of healthy eating (Carbonneau et al. 2021), with the exception that we added BIDR subscales as covariates. Specifically, the dependent variable was the C-HEI score, the independent variables were self-determined and non-self-determined motivation, and covariates were sex, age, education level, income, smoking (current smokers or non-smokers), energy reported, nutrition knowledge, supportive and non-supportive actions from close others to eat healthily, and social desirability variables (BIDR-IM and BIDR-SDE).

Results

A total of 1083 participants had valid data for the BIDR questionnaire (i.e., had answered at least 90% of questions) and were therefore included in our study sample. Participant characteristics are presented in Table 1. Mean age of the sample was 42.7 ± 13.6 years old (range 18.0–66.0) and women represented 50.0% of participants. Mean BMI was 27.4 ± 6.2 kg/m^2 and 75.4% participants completed above high school education level. Their mean BIDR total score was 15.6 ± 6.6 on a maximum of 40 points while mean values for BIDR-SDE and BIDR-IM were 6.8 ± 3.6 and 8.8 ± 4.2, respectively, on a maximum of 20 points per subscale. BIDR total score, BIDR-SDE, and BIDR-IM were not different between administrative regions and income level groups (not shown). Also, no difference in BIDR total scores were observed among education levels (Fig. 1). As indicated in Fig. 2, some sex differences were observed, BIDR total score and BIDR-IM score being higher in women than in men. However, no sex difference was found for BIDR-SDE score. As shown in Fig. 3, BIDR total score and BIDR-IM were higher in older groups than in younger groups. BIDR total score, BIDR-SDE, and BIDR-IM were inversely associated with BMI (Table 2).

Table 3 shows that after adjusting for sex, age, BMI, and the education level, BIDR total score and BIDR-IM were positively associated with the C-HEI total score and only BIDR-IM was associated with the C-HEI other foods component. The C-HEI—Fruits and vegetables, whole grains, whole fruits, green and orange vegetables, and sodium components—were no longer associated after adjustments (see supplementary Table S1 for univariate associations). Also, no C-HEI component was associated with BIDR-SDE. Neither BIDR total score, BIDR-SDE nor BIDR-IM was correlated with the ratio of reported energy intake on estimated energy expenditure, which is an indicator of the plausibility of reported energy intake.

BIDR total score, BIDR-IM, and BIDR-SDE were positively associated with self-determined motivation and negatively with non-self-determined motivation in multivariate models. Similarly, all BIDR scores were inversely associated with disinhibition and susceptibility to hunger and positively associated with intuitive eating score. None of the BIDR scores were associated with dietary restraint (see supplementary Table S2 for univariate associations). Finally, none of the BIDR scores were associated with liking for savory foods, while BIDR-SDE but not BIDR total score nor BIDR-IM remained inversely associated with liking for sweet foods after adjustments (see supplementary Table S2 for univariate associations).

Table 4 shows that self-determined motivation was positively associated with C-HEI ($ß = 3.61$; $p < 0.0001$) while non-self-determined motivation was negatively associated with C-HEI ($ß = -1.55$; $p = 0.0043$) in a model including BIDR-SDE ($ß = -0.30$; $p = 0.0209$) and BIDR-IM ($ß = 0.48$; $p < 0.0001$) as covariates. Other factors associated with C-HEI in this model were sex (lower C-HEI in men, $ß = -2.44$; $p = 0.0088$), smoking status (lower C-HEI in smokers, $ß = -5.05$; $p < 0.0001$), and nutrition knowledge ($ß = 0.09$; $p = 0.0193$).

Table 1. Participant characteristics ($n = 1083$).

Variables	Mean or n	SD or (%)
Women	541	(50.0)
Age group, years	42.7	13.6
18–34	398	(36.8)
35–49	315	(29.1)
50–65	370	(34.2)
BMI, kg/m^2	27.4	6.2
<18.5 kg/m^2	18	(1.8)
18.5–25.0 kg/m^2	381	(38.1)
25.0–29.9 kg/m^2	330	(33.0)
≥30.0 kg/m^2	272	(27.2)
Missing values	82	
Ethnicity		
Caucasian	972	(91.9)
Missing values/prefer to not answer	25	
Level of education		
High school or less	261	(24.6)
CEGEP*	326	(30.7)
University	475	(44.7)
Missing values	21	
Household income, $CAD		
<30 000	157	(16.3)
≥30 000 to <60 000	275	(28.5)
≥60 000 to <90 000	191	(19.8)
≥90 000	342	(35.4)
Missing values/prefer to not answer	118	
BIDR total score (/40)	15.6	6.6
SDE (/20)	6.8	3.6
IM (/20)	8.8	4.2
Score C-HEI (/100)	57.0	14.2
Missing values	11	

*In the Quebec education system, CEGEP is the first level of post-secondary education and includes pre-university programs and technical programs.

Fig. 1. Social desirability total score and subscores according to education levels ($N = 1062$). High school, CEGEP, university levels using the highest education degree obtained. In the Quebec education system, CEGEP is the first level of post-secondary education and includes pre-university programs and technical programs. BIDR, Balanced Inventory of Desirable Responding; IM, impression management; SDE, self-deceptive enhancement.

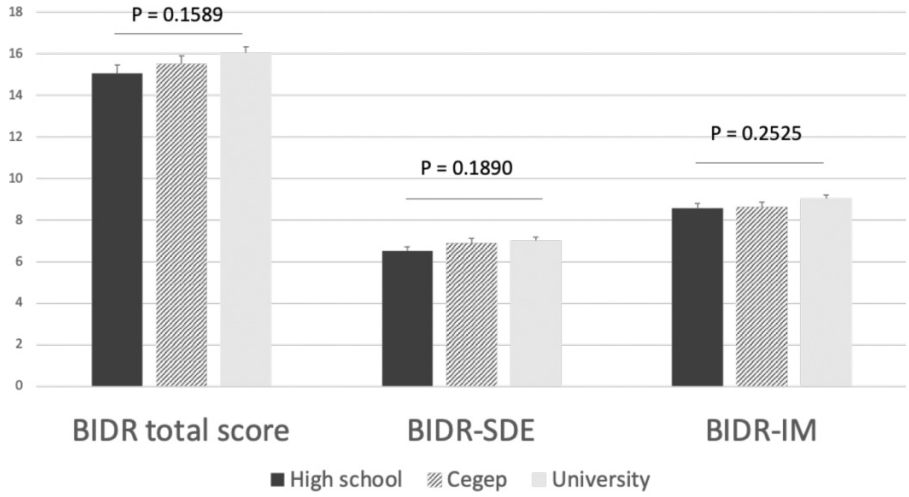
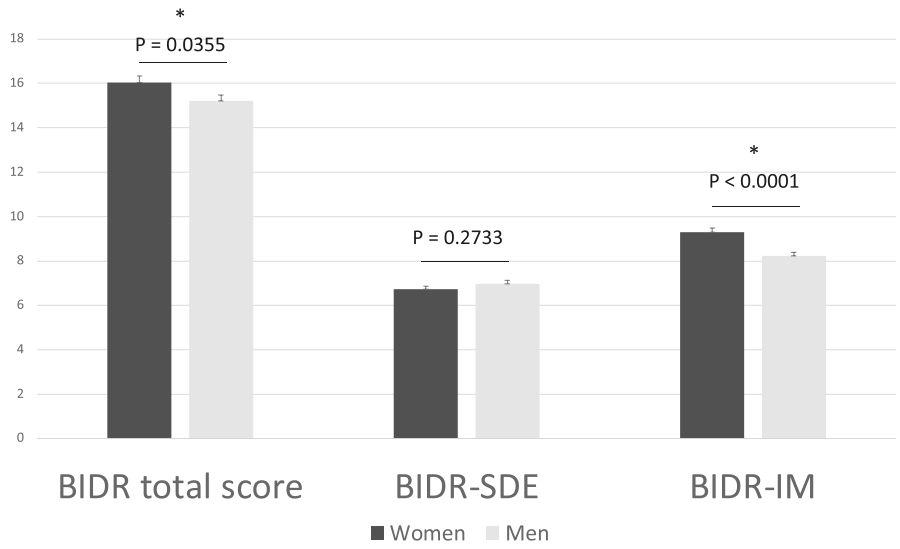


Fig. 2. Social desirability total score and subscores according to sex ($N = 1083$). $^{*}p < 0.05$ between men and women. BIDR, Balanced Inventory of Desirable Responding; IM, impression management; SDE, self-deceptive enhancement.



Discussion

To our knowledge, the present study is the first to document the associations between social desirability and variables related to dietary intakes and to attitudes and behaviours towards eating in a population from Quebec, Canada. We found that the level of social desirability was significantly associated with diet quality and with many variables related to attitudes and behaviours towards eating, even after controlling for confounding variables. In line with past research, women and older participants in our sample had significantly higher social desirability levels than men and younger participants (Börnhorst et al. 2013; Mossavar-Rahmani et al. 2013; Foster and Bradley 2018; Tang et al. 2022). Furthermore, a higher BMI was associated with lower social desirability. This finding is not consistent with Hebert's findings (Hebert et al. 2008) as they found no association, and in contrast with a previous study showing a positive association between social desirability and BMI (Foster and Bradley 2018). This discrepancy could be partially explained by the fact that we used a different tool to measure social desirability (BIDR questionnaire) than the one used in the study by Foster and Bradley (the Marlowe–Crowne questionnaire). To further understand the association between BMI and social desirability, it would be interesting to study the change in social desirability levels in a long-term weight loss intervention, and to verify if the variation in body weight is associated with changes in social desirability. In addition, we found no association between social desirability and education level.

Fig. 3. Social desirability total score and subscores according to age groups ($N = 1083$). $^{*}p < 0.05$ between age groups. BIDR, Balanced Inventory of Desirable Responding; IM, impression management; SDE, self-deceptive enhancement.

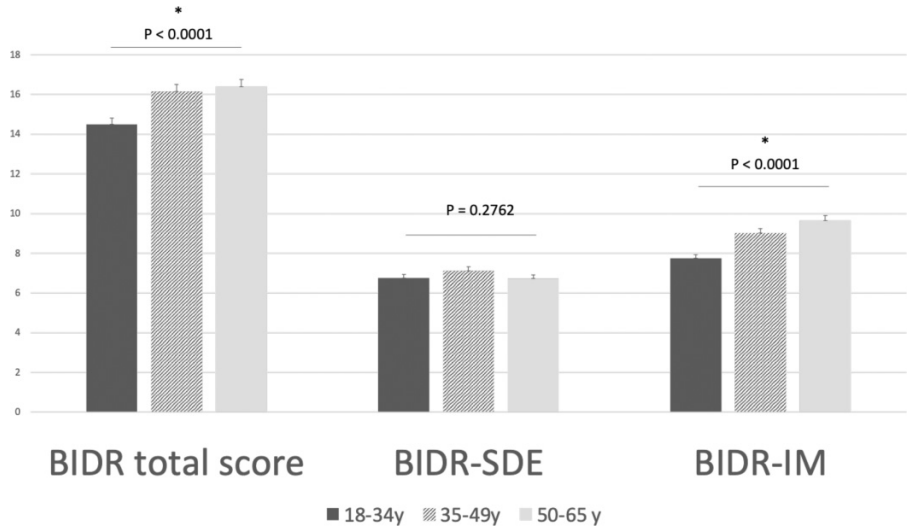


Table 2. Pearson's correlation coefficients for the associations of BMI with BIDR total score, BIDR-SDE, and BIDR-IM ($n = 1001$).

	Correlation with BMI		
	BIDR total score	BIDR-SDE	BIDR-IM
r	−0.10	−0.06	−0.11
p	0.0012	0.0454	0.0006

Note: BMI, body mass index; BIDR, Balanced Inventory of Desirable Responding; IM, impression management; SDE, self-deceptive enhancement.

In previous studies, social desirability has often been associated with a higher education level (Hebert et al. 2002; Poínhos et al. 2015). The different results obtained compared to our study could be explained by our relatively large prevalence of highly educated participants, or the use of a different social desirability questionnaire. In fact, both studies on the topic have used the Marlowe–Crowne social desirability questionnaire while the BIDR questionnaire was used in the present study.

Variables related to dietary intakes

In this study, we used a self-administered 24 h recall web-based application that was developed for the specific purpose of limiting the impact of bias, including social desirability. We used a self-administered format as studies suggested that the presence of an interviewer can enhance social desirability (Kreuter et al. 2009). The 24 h recall application also presents a wide range of portion sizes, since studies have shown that having large portion sizes of "unhealthy foods" and small portion sizes of "healthy foods" can help reduce social desirability (Amoutzopoulos et al. 2020). Despite these precautions, higher social desirability scores were associated with a higher diet quality in our study. C-HEI subcomponents were not associated with BIDR scores, except for the other foods component (foods very high in fat, sugar, or salt) (Garriguet 2009), which was associated with BIDR-IM. The fact that this diet component is clearly stated as being unfavourable for healthy eating in the media might explain why it can be related to social desirability bias. Other studies are needed to better understand the relation between social desirability and other C-HEI components. Our results also showed that the BIDR-SDE subscore was not associated with diet quality. This can be explained by the fact that SDE is probably less likely to affect our perception of the quality of our diet as we are conscious of what we eat, and that it is harder to "lie to ourselves" about factual dietary intakes.

Under-reporting of energy intake is a well-documented issue in nutritional studies (Garriguet 2008). Social desirability is often pointed out as one of the main factors explaining under-reporting behaviours (Hebert et al. 1995; Lissner 2002; Tooze et al. 2004; Scagliusi et al. 2009). The fact that we used 24 h food recalls might explain why we found no association between social desirability and the under-reporting of energy intake. In fact, other studies have suggested that social desirability is more likely to bias self-reported energy intake when measured using food frequency questionnaires (Horner et al. 2002; Mossavar-Rahmani et al. 2013). Also, the fact that 24 h recalls are not subjected to a reactivity bias (i.e., making different food choices knowing you are part of a study) as participants are asked retrospectively about their food intake may also have helped prevent the under-reporting of energy intake.

Variables related to attitudes and behaviours towards eating

The current study also suggests that social desirability is associated with various variables related to attitudes and behaviours towards eating. Most of the associations between social desirability scores and reported liking for savory and sweet foods were not significant, except for BIDR-SDE, which was associated with liking for sweet. To our knowledge, our results are the first to document such an association and this suggests that the more overly positive self-image you

Table 3. Multivariate regression analysis for the associations between social desirability with dietary intakes and variables related to attitudes and behaviours towards eating adjusting for age, sex, BMI, and the education level.

	BIDR total score			BIDR-SDE			BIDR-IM		
	ß	(95%CI)	*p*	ß	(95%CI)	*p*	ß	(95%CI)	*p*
C-HEI score	0.24	[0.11, 0.37]	0.0003	0.17	[−0.07, 0.41]	0.1615	0.50	[0.29, 0.70]	<0.0001
C-HEI—fruits and vegetables*	0.03	[0.00, 0.05]	0.0345	0.02	[−0.03, 0.06]	0.4700	0.06	[0.02, 0.10]	0.0054
C-HEI—whole grains*	0.02	[0.00, 0.04]	0.0138	0.01	[−0.02, 0.04]	0.4161	0.05	[0.02, 0.07]	0.0011
C-HEI—other foods†	0.09	[0.04, 0.15]	0.0011	0.08	[−0.02, 0.18]	0.1331	0.18	[0.09, 0.27]	<0.0001
C-HEI—whole fruits*	0.01	[−0.01, 0.03]	0.3492	0.00	[−0.04, 0.03]	0.7823	0.03	[0.00, 0.05]	0.0809
C-HEI—green and orange vegetables*	0.02	[0.00, 0.04]	0.0134	0.02	[−0.01, 0.05]	0.1889	0.04	[0.01, 0.07]	0.0046
C-HEI total grain products*	−0.01	[−0.02, 0.00]	0.2728	−0.02	[−0.04, 0.00]	0.0341	0.00	[−0.02, 0.02]	0.9137
C-HEI sodium†	0.03	[0.00, 0.06]	0.0346	0.04	[−0.01, 0.09]	0.1474	0.05	[0.00, 0.10]	0.0337
Ratio of energy intake/energy expenditure	0.00	[−0.01, 0.00]	0.1361	0.00	[−0.01, 0.00]	0.2405	0.00	[−0.01, 0.00]	0.1737
Self-determined motivation	0.03	[0.02, 0.04]	<0.0001	0.06	[0.04, 0.08]	<0.0001	0.04	[0.03, 0.06]	<0.0001
Non-self-determined motivation	−0.02	[−0.03, −0.02]	< 0.0001	−0.05	[−0.06, −0.03]	< 0.0001	−0.03	[−0.04, −0.01]	<0.0001
TFEQ dietary restraint	−0.01	[−0.05, 0.03]	0.7642	−0.03	[−0.10, 0.04]	0.4159	0.01	[−0.06, 0.07]	0.8112
TFEQ disinhibition	−0.09	[−0.11, −0.06]	<0.0001	−0.17	[−0.22, −0.13]	<0.0001	−0.09	[−0.13, −0.05]	<0.0001
TFEQ hunger	−0.09	[−0.12, −0.06]	<0.0001	−0.16	[−0.21, −0.11]	<0.0001	−0.10	[−0.15, −0.05]	<0.0001
Intuitive eating score	0.02	[0.02, 0.03]	<0.0001	0.05	[0.04, 0.05]	<0.0001	0.02	[0.02, 0.03]	<0.0001
Liking for savory foods	0.00	[−0.01, 0.00]	0.0080	0.00	[−0.01, 0.00]	0.0248	0.00	[−0.01, 0.00]	0.0226
Liking for sweet foods	0.00	[−0.01, 0.00]	0.0026	−0.01	[−0.01, 0.00]	0.0001	0.00	[−0.01, 0.00]	0.1402

Note: BIDR, Balanced Inventory of Desirable Responding; IM, impression management; SDE, self-deceptive enhancement; C-HEI, Canadian Healthy Eating Index
C-HEI score and components $N = 1072$; self-determined and non-self-determined motivation $N = 991$; TFEQ restraint $N = 987$; TFEQ disinhibition $N = 985$; TFEQ hunger $N = 990$; intuitive eating score $N = 990$; liking for savory N = 971; liking for sweet N = 979. ß values are not standardized. *p* value for statistical significance after Bonferroni correction was <0.001.
*A higher score for the "fruits and vegetables," the "whole grains," "whole fruits," "green and orange vegetables," and "total grain products" components means a higher consumption.
†A higher score in the "other foods" and "sodium" component means a lower consumption.

Table 4. Multivariate regression analysis for the associations relating regulation styles for eating behaviours to C-HEI score adjusting for BIDR-IM, BIDR-SDE, and other covariates ($N = 920$).

	C-HEI score		
Independent variables	ß	(95%CI)	*p*
Self-determined motivation (continuous score, 1–7)	3.61	[2.86, 4.36]	<0.0001
Non-self-determined motivation (continuous score, 1–7)	−1.55	[−2.61, −0.49]	0.0043
Covariates			
BIDR score			
BIDR-SDE (continuous score, 0–20)	−0.30	[−0.56, −0.05]	0.0209
BIDR-IM (continuous score, 0–20)	0.48	[0.25, 0.71]	<0.0001
Sex (1 = women, 2 = men)	−2.44	[−4.27, −0.62]	0.0088
Age groups (1 = 18–34 years, 2 = 35–49 years, 3 = 50–65 years)	−0.56	[−1.58, 0.45]	0.2765
Education level (1 = high school or less, 2 = CEGEP* or university)	1.01	[−1.02, 3.03]	0.3290
Household annual income groups (1 = under low-income cut-off, 2 = over low-income cut-off)	1.62	[−0.73, 3.98]	0.1760
Smoking Status (1 = non-smoker/former smoker, 2 = current smoker)	−5.05	[−7.46, −2.65]	<0.0001
Energy reporting status			
Under-reporting (1 = no, 2 = yes)	−0.19	[−2.63, 2.26]	0.8808
Over-reporting (1 = no, 2 = yes)	1.70	[−0.11, 3.52]	0.0660
Nutrition knowledge (continuous score, 1–100)	0.09	[0.02, 0.17]	0.0193
Supportive actions from close others to eat healthily (continuous score, 1–5)	0.17	[−0.76, 1.10]	0.7210
Non-supportive actions from close others to eat healthily (continuous score, 1–5)	−1.33	[−3.00, 0.33]	0.1161

Note: BIDR, Balanced Inventory of Desirable Responding; IM, impression management; SDE, self-deceptive enhancement; C-HEI, Canadian Healthy Eating Index.

have, the less you are going to admit a preference for sweet food choices. In fact, the food items presented in the sweet food liking questionnaire (e.g., ice cream, candies, and chocolate spread) are generally considered as "unfavourable food choices" and their under-reported status is well documented in the literature. In fact, an inverse association between social desirability and unfavourable food reporting was observed in some studies (Worsley et al. 1984; Börnhorst et al. 2013), which is consistent with the association we observed with food liking.

To the best of our knowledge, our study is the first to examine the associations between social desirability and variables related to the motivation towards the regulation of eating behaviours. Our results suggest that some elements of the questionnaire on the regulation of eating behaviours are likely to be perceived as being more socially desirable than others. For example, some of the items associated with self-determined motivation are emphasizing health as a value e.g., "Because healthy eating is a way to ensure long-term health benefits" (Pelletier et al. 2004). As it is well perceived in our society to care about our health (Sun 2008; Wong-Li 2017), answering positively at some of the self-determined motivation items might be seen as favourable and so linked with social desirability score.

As for variables evaluated by the Three-Factor Eating Questionnaire and the Intuitive Eating Scale, we found that social desirability scores were associated inversely with disinhibition and susceptibility to hunger and positively with intuitive eating. Our results are concordant with those of Freitas et al. (Freitas et al. 2017), who found that social desirability was inversely associated with emotional, external, and binge eating among women. In other studies performed in young women, social desirability was also inversely associated with uncontrolled eating and emotional eating (Kowalkowska and Poínhos 2021). The fact that disinhibition might be seen as a lack of control or lack of hold, and susceptibility to hunger as someone gluttonous or coarse might explain why these eating behavioural traits are less socially desirable. As for dietary restraint, the absence of association can be explained by the fact that, on the one hand, social norms around restrictive eating could be influenced by the glorification of diet culture. On the other hand, there is an increasing awareness of the downside of those diets and there is also a rise in the popularity of non-diet movement or other alternatives, such as intuitive eating (IFIC 2019). Accordingly, all BIDR scores were positively associated with intuitive eating score in our sample. To our knowledge, this is the first time that this association between these two variables is documented, which precludes comparisons with other studies.

Overall, our results highlighted that the two dimensions of the BIDR were not similarly associated with variables evaluated in this study. Only BIDR-IM showed significant associations with variables related to diet quality, while for attitudes and behaviours towards eating, associations with BIDR-IM and BIDR-SDE were observed for most variables. This underlines the interest of using a social desirability questionnaire with two dimensions, such as the BIDR, rather than a unidimensional scale such as the Marlowe–Crowne scale. In fact, this can help to deepen the understanding of how social desirability can impact responding and to eventually develop relevant and specific strategies to decrease the influence of social desirability for different types of self-report questionnaires. Although social desirability was associated with many variables in the present study, it is important to keep in mind that associations observed were not strong. In fact, half of them can be considered as very weak ($r = 0.00$–0.19) and the other half can be considered as weak ($r = 0.20$–0.39) (Swinscow 1997).

With regards to our exploratory objective, it is also important to emphasize that despite these significant associations with social desirability discussed above, we found that the associations relating important determinants of dietary intakes with diet quality were not impacted when we controlled for social desirability. In fact, β coefficients for self-determined ($\beta = 3.61$) and non-self-determined motivation ($\beta = -1.55$) in our multiple regression model, which included BIDR scores as covariates, were similar to β values not including BIDR scores (β value of 3.61 for self-determined motivation and β value of -1.49 for non-self-determined motivation) that we previously reported (Carbonneau et al. 2021). Altogether, these results suggest that in the PREDISE study, social desirability could lead to a slight under or overestimation of the mean values of variables related to dietary intakes and to attitudes and behaviours towards eating. In such a context, we believe that a measurement of social desirability is needed to appreciate the impact of social desirability on results obtained and to deepen the interpretation of results. However, according to our analyses, social desirability does not seem to significantly influence the association between these variables.

Strengths and limitations

A limitation of our study is that we did not have "true" measurements of our dependent variables such as biomarkers values for energy and nutrient intakes. These types of measurements could be useful to relate objective indicators of nutrient intakes to self-reported ones and to deepen the understanding of the role played by social desirability when reporting dietary intakes. Another limitation of our study is that our sample is relatively highly educated (44.7% having a university degree) despite recruitment procedures using random phone numbers to reach a vast variety of participants.

Our randomized, age- and sex-representative sample from five administrative regions of the French-speaking population in the Province of Quebec, in Canada, is a major strength of the PREDISE study, enhancing the generalizability of the results. The five administrative regions allowed for rural and urban diversity of lifestyle found in Quebec (Pampalon et al. 2006). Also, ethnic diversity in the study sample (91.9% Caucasian) was quite representative of the population of Quebec (88.2% Caucasian) (Statistics Canada 2017). In addition, the fact that we used questionnaires that were especially developed for and validated in the study population is a strength of our study. Finally, the use of the BIDR questionnaire, which includes two social desirability subscales, allowed us to deepen our understanding of the role that can be played by different dimensions of social desirability in influencing

the response to questionnaires evaluating dietary intakes and variables related to attitudes and behaviours towards eating.

Conclusion

Although social desirability is often identified as a potential source of bias in results derived from self-reported questionnaires, it is rarely measured in nutrition studies. In the present study, we measured social desirability and found that BIDR total score and BIDR-IM subscore were positively associated with dietary intakes, while BIDR total score as well as the two BIDR subscales (IM and SDE) were all associated with many variables related to attitudes and behaviours towards eating. However, controlling for the presence of socially desirable biases does not appear to affect the associations of variables related to attitudes and behaviours towards eating with diet quality reported in a previous study using the same cohort. In conclusion, these observations suggest that researchers should keep in mind that social desirability is associated with many self-reported variables that are likely to be measured in nutrition studies. Even though these associations appear to be weak, if these variables are central to a study, we recommend including a measure of social desirability that could then be used to examine whether or not such biases affect the quality of their results.

Take-home message

The results of this study suggest that social desirability is associated with many self-reported variables that are likely to be measured in nutrition studies. Therefore, we recommend incorporating a measure of social desirability in such studies.

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Data availability

Data generated or analyzed during this study are available from the corresponding author upon reasonable request.

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Supplementary material

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References

Adong, J., Fatch, R., Emenyonu, N.I., Cheng, D.M., Muyindike, W.R., Ngabirano, C., et al. 2019. Social desirability bias impacts self-reported alcohol use among persons with HIV in Uganda. Alcohol Clin. Exp. Res. **43**(12): 2591–2598. doi:10.1111/acer.14218. PMID: 31610017.

Amoutzopoulos, B., Page, P., Roberts, C., Roe, M., Cade, J., Steer, T., et al. 2020. Portion size estimation in dietary assessment: a systematic review of existing tools, their strengths and limitations. Nutr. Rev. **78**(11): 885–900. doi:10.1093/nutrit/nuz107. PMID: 31999347.

Bond, M.J., McDowell, A.J., and Wilkinson, J.Y. 2001. The measurement of dietary restraint, disinhibition and hunger: an examination of the factor structure of the Three Factor Eating Questionnaire (TFEQ). Int. J. Obes. Relat. Metab. Disord. **25**(6): 900–906. doi:10.1038/sj.ijo.0801611. PMID: 11439306.

Börnhorst, C., Huybrechts, I., Ahrens, W., Eiben, G., Michels, N., Pala, V., et al., 2013. Prevalence and determinants of misreporting among European children in proxy-reported 24 h dietary recalls. Br. J. Nutr. **109**(7): 1257–1265. doi:10.1017/S0007114512003194.

Bradette-Laplante, M., Carbonneau, É., Provencher, V., Bégin, C., Robitaille, J., Desroches, S., Vohl, M.C., Corneau, L., and Lemieux, S. 2017. Development and validation of a nutrition knowledge questionnaire for a Canadian population. Public Health Nutr. **20**(7): 1184–1192. doi:10.1017/S1368980016003372.

Brassard, D., Lemieux, S., Charest, A., Lapointe, A., Couture, P., Labonté, M., and Lamarche, B. 2018. Comparing Interviewer-Administered and Web-Based Food Frequency Questionnaires to predict energy requirements in adults. Nutrients, **10**(9). doi:10.3390/nu10091292. PMID: 30213092.

Callaway, C., Chumlea, W., and Bouchard, C. 1988. Standardization of anthropometric measurements. *In* The Airlie (VA) Consensus Conference. *Edited by* T. Lohman, A. Roche and R. Martorel. Human Kinetics Publishers, Champaign, Ill., USA. pp. 39–80.

Carbonneau, E., Bradette-Laplante, M., Lamarche, B., Provencher, V., Bégin, C., Robitaille, J., et al., 2017. Development and validation of the Food Liking Questionnaire in a French–Canadian population. Nutrients, **9**(12).

Carbonneau, E., Bradette-Laplante, M., Lamarche, B., Provencher, V., Bégin, C., Robitaille, J., et al., 2018. Social support for healthy eating: development and validation of a questionnaire for the French-Canadian population. Public Health Nutr. **21**(13): 2360–2366. doi:10.1017/S1368980018001209.

Carbonneau, E., Carbonneau, N., Lamarche, B., Provencher, V., Bégin, C., Bradette-Laplante, M., et al. 2016. Validation of a French-Canadian adaptation of the Intuitive Eating Scale-2 for the adult population. Appetite, **105**: 37–45. doi:10.1016/j.appet.2016.05.001. PMID: 27179938.

Carbonneau, E., Lamarche, B., Lafrenière, J., Robitaille, J., Provencher, V., Desroches, S., et al. 2019. Are French Canadians able to accurately self-rate the quality of their diet? Insights from the PREDISE study. Appl. Physiol. Nutr. Metab. **44**(3): 293–300. doi:10.1139/apnm-2018-0293. PMID: 30157384.

Carbonneau, E., Pelletier, L., Bégin, C., Lamarche, B., Bélanger, M., Provencher, V., et al. 2021. Individuals with self-determined motivation for eating have better overall diet quality: results from the PREDISE study. Appetite, **165**: 105426. doi:10.1016/j.appet.2021.105426. PMID: 34044038.

Cournoyer, L.-G., and Sabourin, S. 1991. Autoduperie et Hétéroduperie: Facteurs Contaminant l'Evaluation de la Détresse Psychologique et de la Satisfaction de la Clientèle en Relation d'Aide. [Deception of self and others: factors associated with psychological distress and client satisfaction in relation to help.]. Can. J. Behav. Sci./Revue canadienne des sciences du comportement, **23**(1): 41–52.

Crowne, D.P., and Marlowe, D. 1960. A new scale of social desirability independent of psychopathology. J. Consult. Psychol. **24**: 349–354. doi:10.1037/h0047358. PMID: 13813058.

Deci, E.L., and Ryan, R.M. 2013. Intrinsic motivation and self-determination in human behavior. Springer Science & Business Media, Berlin.

Eekhout, I., de Vet, H.C., Twisk, J.W., Brand, J.P., de Boer, M.R., and Heymans, M.W. 2014. Missing data in a multi-item instrument were best handled by multiple imputation at the item score level. J. Clin. Epidemiol. **67**(3): 335–342. doi:10.1016/j.jclinepi.2013.09.009. PMID: 24291505.

Foster, E., and Bradley, J. 2018. Methodological considerations and future insights for 24-hour dietary recall assessment in children. Nutr Res. **51**: 1–11. doi:10.1016/j.nutres.2017.11.001. PMID: 29673539.

Freitas, D., Oliveira, B.M., Correia, F., Pinhão, S., and Poínhos, R. 2017. Eating behaviour among nutrition students and social desirability as a confounder. Appetite, **113**: 187–192. doi:10.1016/j.appet.2017.02.036. PMID: 28242313.

Garriguet, D. 2008. Under-reporting of energy intake in the Canadian Community Health Survey. Health Rep. **19**(4): 37–45. PMID: 19226926.

Garriguet, D. 2009. Diet quality in Canada. Health Rep. **20**(3): 41–52. PMID: 19813438.

Garriguet, D. 2018. Accounting for misreporting when comparing energy intake across time in Canada. Health Rep. **29**(5): 3–12.

Guertin, C., Pelletier, L., and Pope, P. 2020. The validation of the Healthy and Unhealthy Eating Behavior Scale (HUEBS): examining the interplay between stages of change and motivation and their association with healthy and unhealthy eating behaviors and physical health. Appetite, **144**: 104487. doi:10.1016/j.appet.2019.104487. PMID: 31606420.

Hamilton, T., Hoffman, J., Arsiwalla, D., Volpe, R., Schmidt, E., and Gropper, S. 2018. Gender comparisons of young adults' eating behavior regulation: re-examination of the Regulation of Eating Behavior Scale (REBS). Appetite, **126**: 80–89. doi:10.1016/j.appet.2018.03.014. PMID: 29604318.

Hebert, J.R., Clemow, L., Pbert, L., Ockene, I.S., and Ockene, J.K. 1995. Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. Int. J. Epidemiol. **24**(2): 389–398. doi:10.1093/ije/24.2.389. PMID: 7635601.

Hebert, J.R., Ebbeling, C.B., Matthews, C.E., Hurley, T.G., Ma, Y., Druker, S., and Clemow, L. 2002. Systematic errors in middle-aged women's estimates of energy intake: comparing three self-report measures to total energy expenditure from doubly labeled water. Ann. Epidemiol. **12**(8): 577–586. doi:10.1016/S1047-2797(01)00297-6. PMID: 12495831.

Hebert, J.R., Hurley, T.G., Peterson, K.E., Resnicow, K., Thompson, F.E., Yaroch, A.L., et al. 2008. Social desirability trait influences on self-reported dietary measures among diverse participants in a multicenter multiple risk factor trial. J. Nutr. **138**(1): 226s–234s. doi:10.1093/jn/138.1.226S. PMID: 18156429.

Hébert, J.R., Hurley, T.G., Steck, S.E., Miller, D.R., Tabung, F.K., Peterson, K.E., et al. 2014. Considering the value of dietary assessment data in informing nutrition-related health policy. Adv. Nutr. **5**(4): 447–455. doi:10.3945/an.114.006189. PMID: 25022993.

Holden, R.R., Starzyk, K.B., McLeod, L.D., and Edwards, M.J. 2000. Comparisons among the Holden Psychological Screening Inventory (HPSI), the Brief Symptom Inventory (BSI), and the Balanced Inventory of Desirable Responding (BIDR). Assessment, **7**(2): 163–175. doi:10.1177/107319110000700208. PMID: 10868254.

Horner, N.K., Patterson, R.E., Neuhouser, M.L., Lampe, J.W., Beresford, S.A., and Prentice, R.L. 2002. Participant characteristics associated with errors in self-reported energy intake from the Women's Health Initiative food-frequency questionnaire. Am. J. Clin. Nutr. **76**(4): 766–773. doi:10.1093/ajcn/76.4.766. PMID: 12324289.

IFIC. 2019. Food & Health Survey. International Food Information Council Foundation FOODINSIGHT.ORG. Washington, DC.

Institut de la statistique du Québec. 2017. Seuils du Faible Revenu, MFR-Seuils Avant Impôt, Selon la Taille du Ménage, Québec, 2012–2015.

Jacques, S., Lemieux, S., Lamarche, B., Laramée, C., Corneau, L., Lapointe, A., et al. 2016. Development of a web-based 24-h dietary recall for a French-Canadian population. Nutrients, **8**(11). doi:10.3390/nu8110724. PMID: 27854276.

Kelly, C.A., Soler-Hampejsek, E., Mensch, B.S., and Hewett, P.C. 2013. Social desirability bias in sexual behavior reporting: evidence from an interview mode experiment in rural Malawi. Int. Perspect. Sex Reprod. Health, **39**(1): 14–21. doi:10.1363/3901413. PMID: 23584464.

Kowalkowska, J., and Poínhos, R. 2021. Eating behaviour among university students: relationships with age, socioeconomic status, physical activity, body mass index, waist-to-height ratio and social desirability. Nutrients, **13**(10). doi:10.3390/nu13103622.

Kreuter, F., Presser, S., and Tourangeau, R. 2009. Social desirability bias in CATI, IVR, and web surveys: the effects of mode and question sensitivity. Public Opin. Q. **72**(5): 847–865. doi:10.1093/poq/nfn063.

Lafrenière, J., Carbonneau, É., Laramée, C., Corneau, L., Robitaille, J., Labonté, M., et al. 2019. Is the Canadian Healthy Eating Index 2007 an appropriate diet indicator of metabolic health? Insights from dietary pattern analysis in the PREDISE Study. Nutrients, **11**(7). doi:10.3390/nu11071597.

Lafrenière, J., Laramée, C., Robitaille, J., Lamarche, B., and Lemieux, S. 2018. Assessing the relative validity of a new, web-based, self-administered 24 h dietary recall in a French-Canadian population. Public Health Nutr. **21**(15): 2744–2752. doi:10.1017/S1368980018001611. PMID: 29976261.

Lafrenière, J., Laramée, C., Robitaille, J., Lamarche, B., and Lemieux, S. 2019. Relative validity of a web-based, self-administered, 24-h dietary recall to evaluate adherence to Canadian dietary guidelines. Nutrition, **57**: 252–256. doi:10.1016/j.nut.2018.04.016. PMID: 30195246.

Leong, S.L., Madden, C., Gray, A., and Horwath, C. 2012. Self-determined, autonomous regulation of eating behavior is related to lower body mass index in a nationwide survey of middle-aged women. J. Acad. Nutr. Diet. **112**(9): 1337–1346. doi:10.1016/j.jand.2012.04.018. PMID: 22939438.

Lissner, L. 2002. Measuring food intake in studies of obesity. Public Health Nutr. **5**(6a): 889–892. doi:10.1079/PHN2002388. PMID: 12638596.

Löffler, A., Luck, T., Then, F.S., Luck-Sikorski, C., Pabst, A., Kovacs, P., et al. 2017. Effects of psychological eating behaviour domains on the association between socio-economic status and BMI. Public Health Nutr. **20**(15): 2706–2712. doi:10.1017/S1368980017001653. PMID: 28735590.

Meyers, L.D., Hellwig, J.P., and Otten, J.J. 2006. Dietary reference intakes: the essential guide to nutrient requirements. National Academies Press, Washington, DC.

Miller, T.M., Abdel-Maksoud, M.F., Crane, L.A., Marcus, A.C., and Byers, T.E. 2008. Effects of social approval bias on self-reported fruit and vegetable consumption: a randomized controlled trial. Nutr J. **7**: 18. doi:10.1186/1475-2891-7-18. PMID: 18588696.

Moshfegh, A.J., Rhodes, D.G., Baer, D.J., Murayi, T., Clemens, J.C., Rumpler, W.V., et al. 2008. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. Am. J. Clin. Nutr. **88**(2): 324–332. doi:10.1093/ajcn/88.2.324. PMID: 18689367.

Mossavar-Rahmani, Y., Tinker, L.F., Huang, Y., Neuhouser, M.L., McCann, S.E., Seguin, R.A., et al. 2013. Factors relating to eating style, social desirability, body image and eating meals at home increase the precision of calibration equations correcting self-report measures of diet using recovery biomarkers: findings from the Women's Health Initiative. Nutr. J. **12**: 63. doi:10.1186/1475-2891-12-63. PMID: 23679960.

Muyindike, W.R., Lloyd-Travaglini, C., Fatch, R., Emenyonu, N.I., Adong, J., Ngabirano, C., et al. 2017. Phosphatidylethanol confirmed alcohol use among ART-naïve HIV-infected persons who denied consumption in rural Uganda. AIDS Care, **29**(11): 1442–1447. doi:10.1080/09540121.2017.1290209. PMID: 28278568.

Pampalon, R., Martinez, J., and Hamel, D. 2006. Does living in rural areas make a difference for health in Québec? Health Place, **12**(4): 421–435. doi:10.1016/j.healthplace.2005.04.002. PMID: 15955720.

Paulhus, D.L. 1984. Two-component models of socially desirable responding. J. Pers. Soc. Psychol. **46**(3): 598. doi:10.1037/0022-3514.46.3.598.

Paulhus, D.L. 1991. Measurement and control of response bias. *In* Measures of personality and social psychological attitudes. *Edited by* J. P. Robinson, P. R. Shaver and L. S. Wrightsman. Academic Press, San Diego, CA. pp. 17–59.

Paulhus, D.L. 2002. Socially desirable responding: the evolution of a construct. The role of constructs in psychological and educational measurement. Lawrence Erlbaum Associates Publishers, Mahwah, NJ. pp. 49–69.

Pelletier, L.G., Dion, S.C., Slovinec-D'Angelo, M., and Reid, R. 2004. Why do you regulate what you eat? Relationships between forms of regulation, eating behaviors, sustained dietary behavior change, and psychological adjustment. Motiv. Emot. **28**(3): 245–277. doi:10.1023/B:MOEM.0000040154.40922.14.

Poínhos, R., Oliveira, B.M., and Correia, F. 2015. Eating behavior in Portuguese higher education students: the effect of social desirability. Nutrition, **31**(2): 310–314. doi:10.1016/j.nut.2014.07.008. PMID: 25592009.

Scagliusi, F.B., Ferriolli, E., Pfrimer, K., Laureano, C., Cunha, C.S., Gualano, B., et al. 2009. Characteristics of women who frequently under report their energy intake: a doubly labelled water study. Eur. J. Clin. Nutr. **63**(10): 1192–1199. doi:10.1038/ejcn.2009.54. PMID: 19603055.

Statistics Canada. 2017. Immigration et diversité ethnoculturelle—Faits saillants en tableaux, Recensement de 2016. **98-402-X2016007**.

Stöber, J., Dette, D.E., and Musch, J. 2002. Comparing continuous and dichotomous scoring of the balanced inventory of desirable responding. J. Pers. Assess. **78**(2): 370–389. doi:10.1207/S15327752JPA7802_10. PMID: 12067199.

Stunkard, A.J., and Messick, S. 1985. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. J. Psychosom. Res. **29**(1): 71–83. doi:10.1016/0022-3999(85)90010-8. PMID: 3981480.

Sun, Y.H. 2008. Health concern, food choice motives, and attitudes toward healthy eating: the mediating role of food choice motives. Appetite, **51**(1): 42–49. doi:10.1016/j.appet.2007.11.004. PMID: 18187232.

Swinscow, T.D.V. 1997. Statistics at Square One. BMJ Publishing Group, London.

Tang, J.S., Haslam, R.L., Ashton, L.M., Fenton, S., and Collins, C.E. 2022. Gender differences in social desirability and approval biases, and associations with diet quality in young adults. Appetite, **175**: 106035. doi:10.1016/j.appet.2022.106035. PMID: 35405222.

Tooze, J.A., Subar, A.F., Thompson, F.E., Troiano, R., Schatzkin, A., and Kipnis, V. 2004. Psychosocial predictors of energy underreporting in a large doubly labeled water study. Am. J. Clin. Nutr. **79**(5): 795–804. doi:10.1093/ajcn/79.5.795. PMID: 15113717.

Tylka, T.L., and Kroon Van Diest, A.M. 2013. The Intuitive Eating Scale-2: item refinement and psychometric evaluation with college women and men. J. Couns. Psychol. **60**(1): 137–153. doi:10.1037/a0030893. PMID: 23356469.

Wong-Li, C. 2017. Attitudes toward healthy eating in Canada. Mintle, London.

Worsley, A., Baghurst, K.I., and Leitch, D.R. 1984. Social desirability response bias and dietary inventory responses. Hum. Nutr. Appl. Nutr. **38**(1): 29–35. PMID: 6706682.