TITLE PAGE

Development and Validation of a Nutrition Knowledge Questionnaire for a Canadian Population

Canadian Nutrition Knowledge Questionnaire

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ABSTRACT

Objective: The aim of this study was to develop and validate a nutrition knowledge questionnaire in a sample of French Canadians from the province of Quebec, taking into account dietary guidelines.

Design: A 38-item questionnaire was developed by the research team and evaluated for content validity by an expert panel, and then administered to respondents. Face validity and construct validity were measured in a pretest. Exploratory factor analysis and covariance structure analysis were performed to verify the structure of the questionnaire and identify problematic items. Internal consistency and test-retest reliability were evaluated through a validation study.

Setting: Online survey

Subjects: Six nutrition and psychology experts, fifteen registered dietitians (RDs) and 180 lay people participated in the study.

Results: Content validity evaluation resulted in the removal of two items and reformulation of one item. Following face validity, one item was reformulated. Construct validity was found to be adequate, with higher scores for RDs when compared non-RDs (21.5/24 (SD=2.1) vs 15.7/24 (SD=3.0), $p<0.001$). Exploratory factor analysis revealed that the questionnaire contained only one factor. Covariance structure analysis led to removal of 16 items. Internal consistency for the overall questionnaire was adequate (Cronbach alpha coefficient = 0.73). Assessment of test-retest reliability resulted in significant associations for the total knowledge score ($r=0.59$, $p<0.001$).

Conclusions: This nutrition knowledge questionnaire was found to be a suitable instrument which can be used to measure levels of nutrition knowledge in a Canadian population. It could also and serve as a model for the development of similar instruments in other populations.

Keywords:
Healthy eating
Nutrition knowledge
Questionnaire validation
Dietary recommendations

Canada's Food Guide

INTRODUCTION

Food intake has been largely investigated, and found to be determined by a combination of multiple factors on different levels, namely individual, social, and environmental[1]. Among individual determinants, nutrition knowledge is considered as one of the factors affecting food intake[2]. A recent systematic review has reported a significant positive association between high nutrition knowledge and consumption of fruits and vegetables [3]. Since it has been shown in the literature that a high intake of fruits and vegetables is an excellent indicator of a healthy diet [4; 5], this suggests that a high level of nutrition knowledge would be linked with overall healthy food intakes. Improving nutrition knowledge can also favor the development of healthier eating behaviors. For instance, it was recently demonstrated that greater nutrition knowledge was linked with higher odds of engaging in healthy weight loss behaviors[6]. Nutrition knowledge also plays an important role in public health campaigns promoting healthy eating. In fact, in most of these campaigns, improving nutrition knowledge is a target to favor better dietary intakes within the populations [3]. In that context, nutrition knowledge is therefore an important indicator to measure the impact of these public health interventions [7; 8; 9].

In view of the importance of assessing nutrition knowledge in nutrition education programs and in other contexts, it appears essential to use questionnaires that accurately evaluate the constructs intended to be measured. The relevance of valid instruments for measurement of nutrition knowledge has been raised as a key aspect to ensure legitimacy of results obtained from studies using nutrition knowledge as a determinant of food intake. It has even been shown that when thoroughly validated questionnaires were used to measure nutrition knowledge, positive associations were more likely to be observed between nutrition knowledge and diet quality, which reinforces the importance of the validation process[3].

Parmenter and Wardle [10] are the instigators of the General Nutrition Knowledge Questionnaire (GNKQ), which was validated with a variety of methods to ensure its accuracy. Some studies have used a modified version of the GNKQ adapted to their population and observed that the differences in recommendations between their own food guide and the one from the GNKQ necessitated many modifications, which affected the validity of the modified instruments [11; 12]. According to Parmenter

and Wardle [13], a new instrument should be developed if no existing questionnaire relevant to the particular study can be found. In the context of the present research, the questionnaire was to be used in a study to evaluate whether knowledge of the latest 2007 version of Canada's Food Guide (CFG)[14] was associated with actual adherence to CFG recommendations. CFG is a tool designed by Canadian government to translate the science of nutrition into a healthy eating pattern adapted to the Canadian population's reality. It has the shape of a rainbow and is divided into four food groups (vegetable and fruit, grain products, milk and alternatives, meat and alternatives), including recommended number of servings from each food group for each sex and age category. CFG also includes specific guidelines for each food group to help consumers make most of their servings. This tool is intended for healthy Canadians and is readily available to the population, particularly in schools. Most Canadians (86.5%) report having general awareness of CFG [15]. For the design of a questionnaire related to CFG recommendations, specific items were required. To our knowledge, no such questionnaire exists and a new questionnaire was necessary to assess nutrition knowledge in a Canadian context.

The purpose of this study was to develop and validate a nutrition knowledge questionnaire specifically designed for a French-Canadian population. More precisely, this study aimed at designing a questionnaire based on literature and existing questionnaires to evaluate mainly knowledge of CFG, but also general nutrition knowledge, and measuring both its validity and reliability using several validation methods, in a French-Canadian sample from the province of Quebec.

METHODS

Development of the items

The steps proposed by Parmenter and Wardle [13] were used for guidance in the design of the questionnaire, ensuring a valid method of development of the items. First step was to define the scope of measure and included ensuring that the items assessed knowledge rather than beliefs. Second step was generation of the items, including reviewing the literature, nutrition information documents and Canadian surveys on food and nutrition, to create items included in the questionnaire. For the third step, as suggested by Parmenter and Wardle [13], a sample of people similar to the main sample completed the questionnaire, and we named this step the pretest in our study. Fourth step, assessment of reliability was performed through different methods such as test-retest reliability. Last step was assessing validity of the instrument, namely by evaluating content and construct validity.

The aim of the questionnaire was to assess nutrition knowledge using the concept of healthy eating as seen in the CFG and in recent guidelines [16]. Based on previous questionnaires assessing the topic, two specific areas of knowledge most adapted to this questionnaire were identified *a priori*: (1) *Familiarity with CFG* (*e.g.* food groups, portions, guidelines), and (2) *General Nutrition Knowledge* (*e.g.* knowledge about food, food-disease relationship).

Items, design and format of the questionnaire

Questionnaire items were developed by a RD and a researcher in the field of nutrition. *Familiarity with CFG* items were designed using existing questionnaires and surveys for the Canadian population on food and nutrition [17; 18]. Items were created to cover different aspects of the CFG, namely food groups, portions, and specific guidelines. A total of 25 items were developed for this section. Four items on knowledge of number of portions recommended for each food group were assessed with a short open-ended question (*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?). Four multiple choice items were included to assess knowledge of the amount of food in a portion of the different groups of the CFG (*e.g.* To how many CFG portions do you think the following food quantities correspond?). A series of ten "yes or no" items assessed knowledge of specific guidelines from the CFG (*e.g.* Indicate whether the following statements are included in CFG recommendations: Eat at least one green vegetable every day). For each item, an 'I don't know' option was available, as it has been shown to remove pressure from participants and also to ensure answers were not randomly assigned [13]. One multiple choice item assessed understanding of the meaning of CFG.

General nutrition knowledge items were developed using existing questionnaires [19; 20; 21]. An initial pool of 13 items were developed to address either knowledge of food (*e.g.* All spices have a high sodium (salt) content.) or food/nutrient-disease relationship (*e.g.* Anemia can be caused by an iron deficiency). All items were presented as "agree or disagree" question type. An 'I don't know' option was also available for these items.

155
156
157 **Validity and reliability testing**
158 The validation of the nutrition knowledge questionnaire was achieved within the context of a larger
159 study, which took place between February and August 2015. Biomarkers of fruit and vegetable intake
160 were also measured but these analyses are beyond the scope of the present paper. Validation of the
161 nutrition knowledge questionnaire was divided into three subsequent parts, namely an expert panel
162 evaluation, a pretest, and a validation study.
163
164 *Expert panel*
165 *Participants and procedures*
166 An expert panel consisting of six members of the research team and including four nutrition
167 researchers, a registered dietitian (RD) and a psychology researcher was formed to evaluate different
168 the nutrition knowledge questionnaire. The panel evaluated the questionnaire for content validity, either
169 pen-and-paper or online.
170
171 *Content validity*
172 Content validity involves a rigorous assessment of the items to ensure representation of the construct,
173 in this case nutrition knowledge. The panel evaluated the content validity of the questionnaire by
174 commenting on the items and questionnaire format, and a content validity index was calculated for
175 each item. The index used is based on four criteria, namely relevance (not relevant (1) to very relevant
176 (4)), clarity (not clear (1) to very clear (4)), simplicity (not simple (1) to very simple (4)), and
177 ambiguity (doubtful (1) to meaning is clear (4)). Each criterion is evaluated on a four-point scale.
178 Experts rated each item of the questionnaire, and the evaluations were combined to yield a percentage
179 of content validity. The acceptable level was set as >80% since this is generally considered to be the
180 minimum value for adequate content validity [22].
181
182 *Pretest*
183 *Participants and procedures*
184 The pretest sample consisted of 30 individuals recruited from an internal list of people willing to
185 participate in clinical studies. They were asked to comment about the acceptability and understanding
186 of the items. Fifteen registered dietitians (RDs) were also recruited for the pretest. Participants were

men and women from the region of Quebec and had to be aged between 18 and 65 years old. Participants were required to have at least a minimal skill level in informatics since the questionnaire was completed on an online survey website.

Face validity

Face validity indicates whether the items seem to measure what the developers claim they measure [22]. Face validity was assessed in the pretest by asking participants to comment specifically on the ambiguity of the items and questionnaire. Participants commented using online forms and commented in a comments box after each item.

Construct validity

The assessment of construct validity ensures that the construct intended to be measured is indeed measured by the questionnaire. In the present study, construct validity was measured using scores from the pretest participants, and comparing them to scores obtained by the RD sample, with the latter group expected to perform higher than those having no nutrition qualifications. Student's *t*-tests were used to compare results from both groups.

Validation study

Participants and procedures

Participants from the validation study were recruited using electronic messages sent to Laval University employees and students from over five hundred study programs, as well as to the electronic newsletter of the Institute of Nutrition and Functional Foods', which includes people outside of the University scope, who had previously registered to the newsletter. The study sample included 150 participants with an equal number of men and women. Inclusion criteria were identical to those in the pretest. Participants suffering from conditions which affected intestinal absorption were excluded, since it could alter biomarker measurements. Following their recruitment in the study, participants came to the research center in a fasting state (12h) since blood samples were drawn for measuring biomarkers. Trained professionals measured height and weight and waist circumference according to standardized procedures [23]. Participants had to complete a food frequency questionnaire (FFQ)[24] on an online platform during their visit. Within a month after coming to the laboratory, eight questionnaires including the nutrition knowledge questionnaire were completed at home by the participants on the online interface. Questionnaires were assigned to each participant in a random order. Mean completion

time of all questionnaires was approximately 40 minutes. Following a two-week resting period, participants had another month to complete each questionnaire a second time (again in a random order) to assess test-retest reliability. Participants received a financial compensation of C$50 for their participation in the study.

Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was performed on the items to verify that the number of factors predicted (two subscales; familiarity with CFG and general nutrition knowledge) was accurate for the questionnaire. A scree plot was generated to evaluate the number of factors associated with the questionnaire. According to Cattell [25], in a scree plot, the "elbow" of the plot is a point below which factors explain relatively little variance and above which they explain more. Cattell advises to retain factors above said "elbow" and rejecting factors below this point [25]. The number of factors - or number of subscales - of the questionnaire was obtained using this technique.

Covariance structure analysis

Covariance structure analysis was performed, using confirmatory factor analysis, on all the items to verify t-values of the items, in order to identify which items loaded too weakly with the factor, and thus had to be removed. The criterion for retaining an item was to obtain a t-value above 1.96, which indicates that the item is significantly associated with the factor (p=0.05) [26].

Internal consistency

Cronbach alpha coefficients were used to measure the consistency of responses at the first completion of the questionnaire. Cronbach alpha coefficients are expected to be 0.7 or higher for a scale to be considered consistent [27].

Test-retest reliability

As indicated above, participants in the validation study completed the questionnaire twice to evaluate test-retest reliability and time interval between both completions varied for each participant. Pearson's correlations between the two completions were performed to assess reliability. Partial correlations were used to evaluate the association between scores on both completions while controlling for the effect of the time interval.

Concurrent validity

Concurrent validity was obtained by measuring the correspondence between the participants' nutrition knowledge score and their dietary intakes. Data from the FFQ were used to assess diet quality through a Canadian adaptation of the Kennedy's Healthy Eating Index (HEI)[28; 29]. The tool was further adapted by the research team to match with the recommendations of the most recent CFG according to sex and age [30]. The HEI is composed of 10 components, each evaluated on 10 points; individuals receive 10 points if the criterion is met perfectly, no point if one fails to meet the criterion, and a proportional score if between the two extremes. Fruit and vegetable servings are grouped, to adapt the criteria to the CFG recommendation[28]. A maximum of 20 points is thus attributed for this group. Component scores are summed for a total score ranging between 0 and 100 (100 being the best score possible). Concurrent validity was assessed with correlation analyses between scores for the nutrition knowledge questionnaire and HEI scores. For the concurrent validity analyses, participants who reported implausible food intakes in the FFQ were excluded. To do so, the Outlier Labeling Rule was used, with a 2.2 inter-quartile range (IQR) multiplier (Hoaglin & Iglewicz, 1987). This technique uses the sample quartiles, Q1 and Q3, and labels as "outliers" any observations below Q1 - k(IQR) or above Q3 + k(IQR), with k=2.2. Outliers were identified for energy intake, as well as for each of the four groups of the CFG (*i.e.* Vegetable and fruit, Grain products, Milk and alternatives, and Meat and alternatives). Concurrent validity was also assessed by measuring correspondence between the nutrition knowledge score and the intake of fruit and vegetables.

Statistical tests were two-sided and differences at $p<0.05$ were considered significant. All statistical analyses were performed using SAS® Studio version 3.3 (Copyright © 2012-2015, SAS Institute Inc., Cary, NC, USA).

RESULTS

Expert panel

Content validity

Following experts' evaluation of content validity, further modifications were made to the questionnaire. Calculation of the content validity index revealed an average of 88% for all items, with 3 items with indices under 80%. However, with approval from the expert committee, one of the items which obtained a content validity of 75% was reworded instead of removed to alleviate ambiguity, as it was considered important to measure nutrition knowledge ("Vitamin and mineral supplements can act as substitutes equal to fruit" reworded as "It is not necessary to eat fruit when you take vitamin and mineral supplements"). Two items were completely removed from the questionnaire because of low content validity index (respectively 50% and 75%) and questionable relevance with the nutrition constructs to be measured, as well as higher ambiguity for the responders. These items, which had to be answered as either 'I agree' or 'I disagree', were the following: "The glycemic index classifies foods according to their effect on glucose blood level" and "A balanced diet means eating all foods in equal amounts". Furthermore, compilation of comments from the experts led to reformulation of two questions ("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"; "How many CFG portions do you think are equivalent to the following quantities of food?").

Pretest

In the pretest, gender balance was different between the RD and the non-RD sample groups (93% of RDs were female compared to 55% of non-RDs). The higher percentage of female RD is representative of the Canadian population where 96% of RDs were female in 2011[31]. The mean age of participants was 46±14 years old.

Face validity

Face validity of the questionnaire was assessed by participants from the pretest, who formulated comments on ambiguity of the items and questionnaire. According to participants' comments, one item necessitated reformulating ("Drink enriched soy beverages if you do not drink milk" was reformulated as "Enriched soy beverages can be consumed as a replacement for milk"). The introduction of the questionnaire was also reworded following comments from participants, to ensure they would answer with respect to their own knowledge and not feel pressured to give correct answers.

Construct validity

As shown in Table 2, when comparing the RD group with the non-RD group for construct validity, the RD group scored significantly higher than the non-RD group (21.5±2.1 and 15.7±3.0 out of 24, $p<0.001$, 23% difference in total score).

Validation study

In the validation study, two participants dropped out before completing the questionnaire and for the test-retest assessment, two more failed to perform the second completion. Participants were selected to include an equal number of men and women, but due to non-completion of questionnaires, the final sample included 50.7 % female participants and 49.3 % men. The mean age of participants was 47±13 years old for the validation study. Participants had a mean body mass index (BMI) of 25.5±4.4kg/m^2. Table 1 presents the sample characteristics in more details.

Exploratory Factor Analysis

Following analysis of the scree plot from EFA, it was observed that the number of factors which was above the "elbow", and thus the number of factors that should be considered in the questionnaire, was one. Therefore, in contrast to the *a priori* categorization of the questionnaire into two subscales (*familiarity with CFG* and *general nutrition knowledge*), this analysis suggested that the questionnaire consisted in fact of only one global nutrition knowledge scale.

Covariance structure analysis

T-values obtained for factor loading using covariance structure analysis ranged from -0.84 to 7.17. Using this analysis, 16 items were identified as loading too poorly with the nutrition knowledge factor. Therefore, these items were removed from the questionnaire. Supplementary material table presents all the items and t-values associated.

Internal consistency

When considering the questionnaire after removal of the weakly loading items, internal consistency was adequate, with Cronbach alpha of 0.73. Note that this value was improved compared to prior analysis performed with all items, including those with a weak loading (Cronbach alpha=0.68).

Test-retest reliability

Average time between the two completions of the questionnaire was 40±12 days (from 15 to 110 days). Pearson's correlation between both completions was moderate but significant for overall score (r=0.59, p<0.0001). When adjusted for time interval between completions, partial correlation between both completions was stronger (r=0.72, p<0.0001). When the sample was split into two groups based on the median value of the time interval between both completions (i.e. 39.0 days), there was a stronger correlation between completions for values above (r=0.74) vs below the median value (r=0.41).

Concurrent validity

The HEI was used as a proxy of the diet quality to assess concurrent validity through correlations with the scores obtained for the nutrition knowledge questionnaire. For these analyses, 10 participants (four women and six men) were excluded because of unrealistic food intake, based on the Outlier Labeling Rules explained in the statistical analyses section. Correlation obtained for concurrent validity with HEI score was moderate, at r=0.39, p<0.0001 as was the correlation with fruit and vegetables intake (r=0.31, p=0.0002).

Analyses according to BMI

Although the aim of this study was to validate the questionnaire in a sample representing the whole population, we used the opportunity provided by the wide BMI range of our sample to conduct additional analyses within subgroups separated on the basis of BMI. Accordingly, some analyses were conducted within the subgroup of participants with a normal weight (i.e. BMI lesser than 25 kg/m^2, n=74) as well as within a subsample with a BMI of at least 25 kg/m^2 (overweight and obese participants, n=74). We did observe some variability in T-values obtained, but it did not have any major impact on the test-retest values (r=0.64 for participants with normal weight and r=0.55 for overweight/obese participants vs. r=0.59 for overall sample). As for internal consistency, the value for participants with normal weight was somewhat lower than in the overall sample (0.61 vs. 0.73) and in overweight/obese participants, it was somewhat higher than in the overall sample (0.78 vs. 0.73).

376 DISCUSSION

377

378 The purpose of the present study was to develop and validate a nutrition knowledge questionnaire for a
379 French-Canadian population. The questionnaire was developed with the aim of examining knowledge
380 of CFG guidelines, as well as more general nutrition knowledge, for a French-Canadian population.
381 Items were designed or chosen either for their relevance with CFG or for their assessment of nutrition
382 knowledge in general, focussing on nutrients and on links between nutrition and health.

383

384 Face validity was useful to assess participants' understanding of the items and their comments,
385 although they did not cause any major change to the questionnaire, improved wording of questions
386 which caused ambiguity, as seen in other studies [32; 33]. To measure construct validity, the "known-
387 groups approach" was used, where the researcher tests the hypothesis that of two or more groups of
388 participants, one group is expected to score higher on the construct of interest compared to another
389 group [22]. In this case, it was anticipated that RDs would obtain higher scores compared to participants
390 from the pretest, having no nutrition schooling background, and, significant differences were indeed
391 observed between both groups, indicating satisfactory construct validity. RDs scored consistently
392 higher on overall nutrition knowledge score (23% difference). This validates the questionnaire's ability
393 to distinguish between groups with different nutrition knowledge levels. Compared to other studies
394 comparing a community sample with either final year nutrition students or RDs, the difference in
395 scores observed in the present study was higher than a nutrition knowledge questionnaire administered
396 in an Australian sample (12% difference, last year dietetics students[11]) , also higher than a knowledge
397 questionnaire about salt for adults (17% difference, RDs[34]) but lower than the GNKQ (35%
398 difference, last-year dietetics students[10]).

399

400 Assessment of internal consistency revealed adequate overall Cronbach alpha value ($\alpha = 0.73$). Similar
401 values have been obtained in other studies [11; 19]. Although test-retest reliability was significant for the
402 questionnaire, Pearson's r value obtained was not particularly high, at 0.59 compared to other studies
403 [10; 35; 36]. However, time interval between both completions was longer than observed in other studies,
404 where generally two weeks separated completions [10; 11; 12; 35; 36; 37]. In the present study, due to
405 constraint linked with the context of the study, time interval varied from 15 to 110 days. According to
406 the literature, more than two weeks could be enough to modify nutrition knowledge due to the constant
407 flow of information in this domain [22]. The partial correlation analysis that controlled for time interval

between completions led to an increased correlation coefficient. More specifically, it was found that the correlation between both completions was stronger when time interval was longer. Therefore, the longer time interval between questionnaire completions in the present study compared to others is apparently not contributing to the relatively lower test-retest reliability observed. Moreover, it was observed that the mean score for participants was slightly higher in the second completion, which could be explained by a general improvement in nutrition knowledge of the participants. Another explanation could be that, although it was advised not to, some participants would have made research following the first completion out of curiosity, and would therefore have improved their scores on second completion of the questionnaire, which could have contributed to reduce the test-retest reliability. Results conducted in subgroups separated on the basis of BMI showed that values obtained in normal weight participants were not exactly the same as those obtained in overweight/obese participants for internal consistency and test-retest values. These results demonstrate the importance of validating the questionnaire again in order to measure nutrition knowledge in a specific population. Concurrent validity was measured by examining the association between food intake and nutrition knowledge. Our results showed that subjects with higher knowledge had better diet quality. In other studies, a significant correlation was also found between nutrition knowledge and adequate food intake; although the correlation observed in the present study was higher [3; 38]. Concurrent validity for fruit and vegetable consumption also revealed a significantly higher intake in participants with higher nutrition knowledge. Correlation between nutrition knowledge and fruit and vegetable intake was comparable to that observed by Dickson-Spillman and Siegrist (r=0.29 for vegetables, r=0.18 for fruits) [38] and Wardle et al. (r=0.36) [39].

Some items were removed as they loaded too weakly with total nutrition knowledge score. When examining which items had been removed, some were identified as being representative of nutrition topics that are frequently discussed in the media, and for which information is often contradictory. These items referred to topics such as milk consumption, the concept of food portions, and the link between sugar and diabetes. In the media, these topics are often discussed, and different interest groups can disclose different information about them [40]. Individuals can be left with a feeling of confusion between those contradictory messages, between actual scientific nutrition research and the media's false interpretation of the conclusions [41]. The weakly loading items that were concerned with those topics could be explained by the confusion created around them. In fact, this shows that even within

individuals in the population with higher nutrition knowledge, which are more likely to be well informed, these themes can be unclear. Even in scientific literature, some authors disagree about topics such as dairy products and milk [42; 43; 44]. Therefore, the distinction between people with higher nutrition knowledge and lower nutrition knowledge could have been less pronounced when assessed using these items. Another important issue to consider is the ever-evolving aspect of nutrition, and that the information conveyed changes in time. Nutrition knowledge questionnaires have to be adjusted when major changes occur in the scientific literature, and validation of the questionnaire can be necessary to ensure that with passing time, the chosen items are still valid and reliable.

The major strength of this study include the method of development and evaluation of the questionnaire, which was based on the steps proposed by Parmenter and Wardle [13] in their report on nutrition knowledge measures. From generation of items to evaluation of the questionnaire, the report was used as a guide for questionnaire design and validation. Another strength is the large age and BMI range of the validation study sample. However, most participants were highly educated, which is not perfectly representative of the Canadian population. For the development of the questionnaire, it could have been interesting to begin with a larger item pool, which would have allowed stricter item difficulty cut-off points. Nonetheless, it must be mentioned that a short questionnaire was preferable for this study, and thus the item pool did not have to be as large as for other questionnaires. Moreover, the study has been conducted in a University facility, the Institute of Nutrition and Functional Foods, which is well known in the Quebec City vicinity for the studies it performs related to health and nutrition. Thus, there is a possibility that participants recruited for the study had particular interest towards nutrition, and possibly more nutrition knowledge. Also, it can be noted that the questionnaire has been validated in a French-Canadian population with specific cultural, geographical and socio-demographic characteristics, and thus it would be important to validate if used in another population.

CONCLUSION

The nutrition knowledge questionnaire developed for a French-Canadian population is a valid and reliable tool to assess nutrition knowledge and to discriminate between different knowledge levels. It should be noted that validity and reliability are acceptable but should be tested again if they are to be used in other populations. This questionnaire could serve as a model for the development of similar

tools in other populations, based on their local recommendations. For future adaptations of the questionnaire, the aspect of sustainability of diets could also be included, since it is now an important part of advocated diets apart from the healthy aspect.

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569

Table 1. Sample characteristics of the validation study participants (n=148)

	n (%)
Gender	
Male	73 (49.3)
Female	75 (50.7)
Age	
18-34	38 (25.7)
35-49	29 (19.6)
50-65	81 (54.7)
BMI (kg/m^2)	
Underweight (0-18.5)	4 (2.7)
Normal (18.5-24.9)	70 (47.3)
Overweight (25-29.9)	54 (36.5)
Obese (30 +)	20 (13.5)
Income	
0-19 999	8 (5.4)
20 000-39 999	18 (12.2)
40 000-59 999	26 (17.6)
60 000-79 999	22 (15.9)
80 000-99 999	19 (12.9)
>= 100 000	44 (32.1)
No response	11 (7.4)
Education	
No education	0
Primary school	0
High school diploma or equivalent	14 (9.5)
College graduate	45 (30.4)

University graduate	89 (60.1)
Race and ethnicity	
African	2 (1.4)
Native Americans	1 (0.7)
Arabic	2 (1.4)
Asian	0
Caribbean	0
Caucasian	142 (96.0)
Latino	1 (0.7)
No response	0
Marital status	
Single	50 (33.8)
Married	37 (25.0)
Common-law partner	45 (30.4)
Separated	4 (2.7)
Divorced	11 (7.4)
Widowed	0
No response	1 (0.7)
Primary employment status	
Student	9 (6.2)
Employed full time	85 (58.2)
Employed part time	12 (8.2)
Unemployed	3 (2.0)
Homemaker	0
Retired	32 (21.9)
Unable to work	0
Other	5 (3.4)
No response	0

573

574 Table 2. RD sample compared to non-RD sample*

575

	RD sample				Non-RD sample				Difference between group means	
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean difference	*p*-value
Total nutrition knowledge score (24)	21.5	2.1	18.1	24.0	15.7	3.0	5.0	20.6	5.8	0.0001

576

577 * After removing items that were not loading properly, mean score for RDs was still significantly
578 higher than for non-RDs (12.2±1.2/13.5 for RDs vs. 9.3±1.8/13.5 for non-RDs, $p<0.0001$).