

A Simple Method to Assess Fruit and Vegetable Intake among Obese and Non-obese Individuals

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ABSTRACT

Objectives: Fruit and vegetable (F&V) consumption is generally associated with the prevention of major chronic diseases. For monitoring purposes, public health researchers require short but reliable and valid questionnaires to assess F&V consumption. The aim of the present study was to validate a brief one-page self-administered fruit and vegetable questionnaire (FV-Q) for obese and non-obese populations.

Methods: The validation study was conducted from 2004 to 2006, among a sample of 350 obese and non-obese French-speaking participants. The six-item FV-Q was designed to measure F&V consumption over a seven-day period. It was validated against an interviewer-administered Food Frequency Questionnaire (FFQ) by means of correlation analysis and computing of epidemiologic indices. The analyses were performed separately for obese and non-obese individuals in order to account for potential different reporting patterns and the absence of such validation in obese populations. All the analyses were performed during 2007.

Results: For obese and non-obese participants, the Pearson correlation coefficients between the FV-Q and FFQ were, respectively, $r = 0.66$ ($p < 0.0001$) and $r = 0.65$ ($p < 0.0001$) for the mean daily intake. Values for sensitivity and specificity were 88.5% and 63.6% for obese individuals and 80.0% and 65.6% for non-obese individuals, respectively. Positive predictive values were moderate in both groups, whereas negative predictive values were very good. Overall, results were very similar for obese and non-obese individuals.

Conclusions: This brief F&V questionnaire can be used to identify people requiring nutritional counseling. Moreover, it can be used for both obese and non-obese populations.

Key words: Fruit; vegetables; questionnaires; validation studies

La traduction du résumé se trouve à la fin de l'article.

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Although, fruit and vegetable (F&V) consumption is associated with the prevention of major chronic diseases,¹⁻⁵ 50-55% of the Canadian population fail to achieve the recommended minimum intake.⁶⁻⁸ The percentage is even higher for obese individuals.^{9,10} Consequently, investing effort into the promotion of F&V consumption is still needed.

To assess and predict F&V intake, a number of short questionnaires characterized by different degrees of validity have been developed, validated and used in diverse populations.¹¹⁻¹⁴ From a public health perspective, these questionnaires are widely used because the main objective is to identify individuals who require nutritional counseling.

Surprisingly, however, to our knowledge short F&V questionnaires have not been validated for obese adults; or, if they have been validated, no information on the distribution of body weight was reported. Given that obese individuals appear to have different reporting patterns of total energy or food-specific intake,¹⁵⁻¹⁷ and that this population might benefit more from interventions, there is an important need to assess the performance of short F&V screening tools in obese populations.

Thus, the aim of this study was to verify the performance of a brief one-page fruit and vegetable questionnaire (FV-Q) on intake over the previous seven-day period among obese and non-obese respondents.

METHODS

This study was conducted in an urban region of Quebec, Canada, among French-speaking adults, aged between 18 and 55. Participants were volunteers who responded to public announcements in local media and were involved in a longitudinal behavioural study, conducted from the summer of 2004 through the spring of 2007. This study was aimed at predicting F&V intake in obese (≥ 30 kg/m²) and non-obese (< 30 kg/m²) populations¹⁸ and was approved by the Université Laval's Ethics Committee.

The validation study was based on the information obtained at baseline from the longitudinal study. Participants' F&V behaviour was first assessed by the FV-Q and then by the reference Food Frequency Questionnaire (FFQ).¹⁹ The FFQ was

Fruit and vegetable portion size definition

One portion of fruit or vegetable equals:

- 1 medium-size fruit or vegetable
- ½ cup of cut fruit or vegetables (125 ml)
- ½ cup of fruit juice (125 ml)
- 1 cup of green salad (250 ml)

All these foods can be fresh, frozen or canned

In the **last seven days**, how many servings of these foods did you eat?

Example: If you drank 250 ml of fruit juice during the two weekend days only, enter 0 in all weekday boxes and 2 in the Saturday and Sunday boxes.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Fruit juice	0 servings	0 servings	0 servings	0 servings	0 servings	2 servings	2 servings

Please indicate the appropriate number of servings in each box...

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Fruit juice	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings
Vegetable juice	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings
Fruit	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings
Potatoes (excluding French-fried potatoes)	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings
Green salads	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings
Other vegetables	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings	__ servings

Figure 1. The Fruit and Vegetable Questionnaire (FV-Q)

TABLE I

Sample Characteristics by Weight Status

Variables	Obese Participants N=103	Non-obese Participants N=247
Gender (%)		
Women	53.4	57.5
Men	46.6	42.5
Mean Body Mass Index (kg/m ²)	34.5 ± 4.1	24.9 ± 3.1
Mean age	40.2	36.0
Mean daily consumption of F&V (Number of servings estimated by the reference method)	7.4 ± 3.3	7.2 ± 3.1

administered face-to-face by a trained, registered dietician, whereas the FV-Q was self-administered.

The reference questionnaire assessed complete dietary habits over the last month and contained 91 items and 33 subquestions. Participants were asked about frequency of food intake in previous days, weeks or months. Administration of the FFQ took about 30 minutes, and during the interview, the dietician displayed food samples to help participants estimate portions consumed with more accuracy. This questionnaire has been previously validated with a three-day food record.¹⁹

The six-item FV-Q evaluated five categories of F&V: fruit juice; vegetable juice; fruit; potatoes (excluding French-fried potatoes); and vegetables (green salads and

other vegetables) (see Figure 1). To facilitate administration and recall, this questionnaire adopted a table format in which each day of the past week appeared in rows and food categories in columns. Participants were asked to report the number of servings by food category for each day of the week. For more accuracy, portion size was specified at the beginning of the questionnaire.

The co-variability of the scores estimated by the two questionnaires was evaluated by the Pearson correlation coefficient. Because correlation coefficients alone estimate only the strength of co-variation between two measurements,^{20,21} the level of agreement was evaluated by means of the Intraclass correlation coefficient.²² The capacity of the questionnaire to classify people correct-

ly was verified by means of standard epidemiologic indices such as sensitivity, specificity, predictive values and the ROC-curve.^{21,23,24} All analyses were performed separately for each group (i.e., obese vs. non-obese participants).

For intrinsic and predictive validity, F&V consumption was dichotomized at five servings or more per day.⁶ Sensitivity represents the capacity of the FV-Q to correctly identify participants who do not meet F&V recommendations and specificity represents the capacity of the questionnaire to rule out participants who meet the recommendations. Positive predictive value is the proportion of participants who do not 'truly' meet F&V recommendations when classified as not reaching recommendations by the FV-Q. Conversely, the negative predictive value is the proportion of participants who 'truly' eat at least five servings per day of F&V when they are classified as meeting recommendations by the FV-Q. Finally, ROC-curve analyses were computed to test the capacity of the questionnaire to classify participants correctly for different cut-off points. This test provides information on the optimal cut-off point for the identification of those who require nutritional counseling. Statistical software SAS version 9.0 was used for all the analyses performed during the winter of 2007.

RESULTS

The overall sample consisted of 350 participants with an average age of 37.2 ± 11.5. Sample characteristics by weight status are presented in Table I. The average Body Mass Index (BMI) was 27.7 ± 5.6 kg/m². According to the FFQ, the proportion of people who did not report a daily mean intake of five or more servings of F&V per day accounted for 23.1% of the total sample (this proportion was 25.2% and 22.3% in the obese and non-obese populations, respectively).

For both obese and non-obese participants, the Pearson correlation coefficients indicated significant relationships between F&V mean daily intake measured by the FFQ and the FV-Q ($r = 0.66$; $p < 0.0001$ and $r = 0.65$; $p < 0.0001$, respectively). Estimates of mean intake were not significantly different between the obese and non-obese groups for both questionnaires

($t = 0.6$; $p > 0.5$ and $t = -0.3$; $p > 0.7$, respectively). On average, however, participants reported a significantly lower mean intake of F&V estimated by the FV-Q compared to the estimation of the criterion FFQ ($t = 15.3$; $p < 0.0001$), and this was observed in both obese and non-obese participants ($t = 8.8$; $p < 0.0001$ and $t = 12.6$; $p < 0.0001$, respectively). Overall, the Intraclass correlation coefficient between the mean numbers of servings of the FV-Q and the mean intake of the FFQ was 0.45; it was 0.44 for obese and 0.46 for non-obese participants. A deeper look at the Intraclass correlation coefficients for each category of food revealed that consumption of fruit and vegetable juices seemed to be underestimated by the FV-Q (data not reported).

For intrinsic and predictive validity, participant distributions are presented in Table II. For estimations of mean daily intake, the sensitivity in the obese group was 88.5%, whereas specificity was 63.6%. The positive and negative predictive values were 45.1% and 94.2%, respectively. Among the non-obese participants, sensitivity was 80.0% and specificity was 65.6%. The positive and negative predictive values were 40.0% and 92.0%, respectively. Two-sided Fisher exact tests revealed no significant differences between the obese and non-obese groups for sensitivity and specificity. The area under the ROC-curve (presented in Figure 2) indicated that the more accurate cut-off point was the dichotomization at five or more servings per day versus less than five servings ($c = 0.74$).

DISCUSSION

As previously observed for this kind of short screening tool,¹³ the levels of correlation between the two questionnaires suggest that the FV-Q provides significant 'good enough',²⁵ but under-, estimations of F&V consumption among obese and non-obese individuals. Thus, this questionnaire could be used in obese as well as non-obese populations. One explanation for the underestimations could be that when answering the self-administered FV-Q, participants systematically considered one serving as one portion, or omitted some servings, especially for the consumption of juices. Although some definitions of portion size were provided, written definitions

TABLE II

Classification of Number of Participants According to the Mean Daily Intake of F&V among Obese and Non-obese Individuals

FV-Q Scores	FFQ Scores (Obese Individuals)			FFQ Scores (Non-obese Individuals)		
	<5 Servings	≥5 Servings	Total	<5 Servings	≥5 Servings	Total
Mean daily intake of F&V						
<5 servings	23	28	51	44	66	110
≥5 servings	3	49	52	11	126	137
Total	26	77	103	55	192	247

The percentages of correct classification among obese and non-obese individuals are 69.9% and 68.8%, respectively.

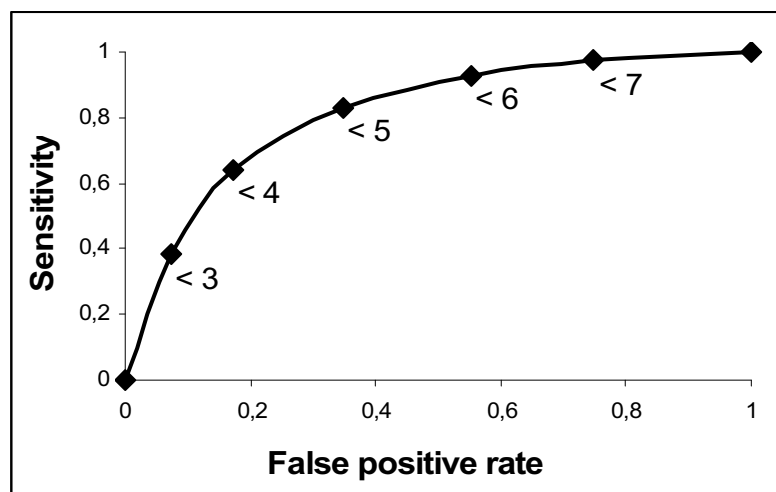


Figure 2. The ROC-curve for cut-off points from the mean daily consumption of F&V for obese and non-obese participants

are not likely to have the same impact as the visual and verbal cues provided by the interviewer when participants completed the FFQ. The inclusion of illustrations describing one serving might improve the accuracy of reporting.

Because short dietary questionnaires such as FV-Q show greater performance for ranking individuals as opposed to giving exact estimates of food consumption, the analysis of epidemiological indicators could provide better information regarding the ability of the questionnaire to identify individuals requiring nutritional counseling. Overall, the very good sensitivity supports the usefulness of the FV-Q in the proper identification of people who do not meet F&V recommendations in both obese and non-obese populations. Therefore, individuals who require more attention (without distinction according to weight status) were correctly identified with respect to their mean daily consumption. The lower, but adequate, values of specificity indicated an acceptable capacity of the FV-Q to identify individuals who do

not require intervention. The advantage of using sensitivity and specificity for the evaluation of the performance of an instrument is that these two indicators do not vary with the prevalence in behaviour. This means that the FV-Q should perform similarly in populations where the prevalence of F&V consumption is lower (and particularly for obese individuals).^{23,24}

The very high negative predictive values observed in this study indicate that for both obese and non-obese groups, individuals who were classified as compliant with F&V recommendation by the FV-Q were truly consuming at least five servings of F&V per day. The stronger negative predictive values compared to positive predictive values means that FV-Q has a greater accuracy for the detection of individuals who follow recommendations. However, it is important to note that these two indicators of predictive validity are influenced by the prevalence of the behaviour. Consequently, such results were expected because of the high prevalence of F&V consumption among the sample; likely

because participants were volunteers, and therefore more likely to have more healthful eating patterns. Indeed, 76.9% of the participants (obese and non-obese) followed health recommendations. Given that an important proportion of the Canadian population does not follow F&V recommendations, the positive predictive value that is the accuracy of the FV-Q to detect individuals who do not eat at least five servings of F&V 'truly', is expected to be greater in the general population. Finally, a deeper analysis of the areas under the ROC-curve confirmed that the use of less than five servings per day was the best cut-off.

The use of a similar short time frame for nutritional assessment has not been reported frequently for the adult population.²⁶ Because of the seasonal and intra-individual natural variations, a longer time frame might prove more appropriate in capturing habitual intake.²⁷ On the other hand, several authors argued that it is impossible for individuals to recall behaviours accurately over the last few months or past years.^{28,29} Indeed, self-reported questionnaires are subject to different types of bias and measurement errors, and one of the most important factors that may lead to distortion in self-reporting is forgetfulness.³⁰⁻³⁴ This non-deliberate error is related to the time interval elapsed and the saliency of a topic. Consequently, recent and more salient events are more easily recalled,^{28,29} and many authors recommend using a recent and short time frame to reduce this bias.^{28,30,31,35} Thus, the adequate performance of the brief F&V questionnaire in the present study supports its use and indicates that FV-Q would appear to be a good compromise, limiting the influence of the forgetfulness bias.

One limitation of the present findings is the use of an FFQ as a referent method for comparison. However, some authors argue that the use of this tool as a reference may be an acceptable alternative when no other measurement method is available.³⁶ Also, given the purpose of this tool that is discriminating between those who follow and those who do not follow daily F&V intake recommendations, the use of this short questionnaire rather than the longer FFQ for population surveys is still justified. Moreover, considering that this short questionnaire presents good performance for

obese individuals – a population that represents one of the most important targets for intervention to increase F&V consumption – this reinforces the relevance of using the FV-Q in populations where the obesity prevalence is high or on the rise. A second limitation of this study was that participants were volunteers with a probable greater awareness than the general population of their F&V consumption. Consequently, they may have reported more accurately their F&V consumption over the previous days or months. This latter point might require verification in future studies. In conclusion, this short questionnaire is useful to identify correctly most people requiring counselling, either for public health monitoring or research on the efficacy of interventions among French-speaking obese and non-obese individuals.

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RÉSUMÉ

Objectifs : La consommation de fruits et de légumes est généralement associée à la prévention des grandes maladies chroniques. Dans un but de surveillance, les chercheurs en santé publique ont besoin de questionnaires courts mais fiables pour déterminer cette consommation. Nous avons voulu valider le QFL, un questionnaire auto-administré d'une seule page permettant de mesurer la consommation de fruits et de légumes dans des populations obèses et non obèses.

Méthode : Notre étude de validation a été conduite entre 2004 et 2006 auprès de 350 participants obèses et non obèses de langue française. Le questionnaire en six points mesure la consommation de fruits et de légumes sur une période de sept jours. Il a été validé par rapport au FFQ (un questionnaire sur la fréquence de consommation des produits alimentaires administré par entrevue) au moyen d'une analyse de corrélation et d'indices épidémiologiques. Pour pallier d'éventuelles différences dans la façon de répondre au questionnaire et permettre son usage auprès d'une population obèse, les analyses ont été effectuées séparément pour les sujets obèses et non obèses. Toutes les analyses ont été effectuées pendant l'année 2007.

Résultats : En ce qui concerne la consommation quotidienne moyenne, les coefficients de Pearson entre le QFL et le FFQ étaient de $r = 0,66$ ($p < 0,0001$) pour les participants obèses et de $r = 0,65$ ($p < 0,0001$) pour les non-obèses. Les valeurs de sensibilité et de spécificité étaient, respectivement, de 88,5 % et 63,6 % pour les sujets obèses et de 80,0 % et 65,6 % pour les non-obèses. Les valeurs prédictives positives étaient modérées dans les deux groupes, tandis que les valeurs prédictives négatives étaient très bonnes. En général, les résultats étaient similaires chez les obèses et les non-obèses.

Conclusion : Ce bref questionnaire mesurant la consommation de fruits et de légumes peut être utilisé pour identifier les personnes qui nécessitent de l'assistance nutritionnelle. De plus, il peut être utilisé autant auprès de populations obèses que non obèses.

Mots clés : fruits; légumes; questionnaires; validation



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