

# Vegetable and Fruit Food Frequency Questionnaire Serves as a Proxy for Quantified Intake

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## ABSTRACT

**Background:** Public health practitioners need valid tools to survey trends in dietary intake. The Rapid Risk Factor Surveillance System (RRFSS) includes an optional six-item vegetable and fruit intake food frequency questionnaire (FFQ) module. Our objectives were 1) to compare reported vegetable and fruit consumption from the FFQ to quantified servings (portions) defined by Canada's Food Guide to Healthy Eating and ascertained by a reference method, and 2) to compare the FFQ with the reference method for their classification of the proportion of respondents consuming five or more servings of vegetables and fruit per day.

**Methods:** Dietitians administered 24-hour recalls to each of 174 adult respondents who had completed the FFQ as part of the RRFSS. Recalls were conducted over the telephone on three separate occasions using an adaptation of the multiple pass method.

**Results:** The mean total intake of vegetables and fruit for the group was 4.6 times/day from the FFQ versus 4.8 servings/day from the recalls (paired t-test;  $p=0.92$ ). Thirty-seven percent of respondents were classified as consuming five or more times/day by the FFQ versus 35% by the 24-hour recall servings.

**Conclusion:** The FFQ tool can be used as a proxy for quantified intake of vegetable and fruit consumption.

**MeSH terms:** Validation studies; fruit; vegetables; diet surveys

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

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Vegetable and fruit consumption has been shown to be inversely associated with risk for coronary heart disease,<sup>1-3</sup> blood pressure,<sup>4</sup> bone mineral density in the elderly,<sup>5</sup> and cancer at some sites.<sup>6-9</sup> Direct and indirect annual costs of cardiovascular disease and cancer are \$18.5 billion and \$15.2 billion respectively.<sup>10</sup>

The vegetable and fruit food frequency questionnaire (FFQ)<sup>11</sup> in the Rapid Risk Factor Surveillance System (RRFSS)<sup>12</sup> (Ontario, Canada) is an optional component of this survey. The FFQ has been adapted from the Behavioral Risk Factor Surveillance System (BRFSS)<sup>13</sup> used in the United States and is similar to that used in the Canadian Community Health Survey (CCHS).<sup>14</sup> Research on the validation of FFQs indicated both the over- and under-estimation of intake compared to other methods. Results are inconsistent where short FFQs, similar to the RRFSS FFQ (six-item), are compared to reference methods such as 24-hour recalls, diet records, serum carotenoids or other FFQ formats.<sup>15-19</sup>

The objectives of this study are to 1) compare the reported times/day (frequency) of vegetable and fruit intake from the RRFSS FFQ to the number of quantified servings (portions) of vegetables and fruit according to Canada's Food Guide to Healthy Eating reported through three 24-hour recalls, and 2) compare each method's assessment of the proportion of the sample averaging five or more servings or frequencies of vegetables and fruit per day.

## METHODS

Telephone interviewers at the Institute for Social Research (ISR) at York University (Ontario, Canada) approached RRFSS respondents from three Ontario public health regions – Durham Region Health Department, the Regional Municipality of Peel Health Department and Toronto Public Health – to participate in the study as an adjunct to their survey. Contact information of 537 potentially interested participants aged 18 to 64 years was provided to McGill investigators from February to August 2002. Subjects were mailed a letter of introduction to the study and a set of portion estimators.

At least seven days post mailing, respondents aged 18 to 64 were contacted by

telephone by trained dietitian interviewers to determine eligibility and collect the first 24-hour recall. Those with difficulty responding in English or who were not available for telephone interviews in the next three weeks were excluded.

The RRFSS FFQ being validated here is found in the Appendix. This RRFSS version of the FFQ asks "how many times" in all six questions, unlike the BRFSS and CCHS versions wherein the final question asks "how many servings?" The number of times or occasions vegetables and fruit are consumed daily is referred to as the frequency of consumption. Dietitians collecting 24-hour recall data were blinded to the FFQ results. Ethics approval was received from McGill University, each participating health unit and York University.

The reference method used in this validation study was three unscheduled 24-hour recalls conducted over the telephone on different weekdays including one weekend day. The 24-hour recall interviews used a modified version of the United States Department of Agriculture five-step multiple pass method.<sup>20,21</sup> Portion estimators mailed to potential respondents included a graduated cup, bowl, plate and a ruler 30 centimetres in length. Dietitian interviewers received two days training at the Food Habits of Canadians office at McGill University.

The six FFQ questions and Canada's Food Guide to Healthy Eating (CFGHE)<sup>22</sup> were used to define and quantify vegetables and fruits from the three 24-hour recalls. Legumes and fried potatoes were not part of the FFQ and therefore excluded. Foods with very little fruit or vegetable content, such as beverages, baked goods, pizza except for "vegetarian", commercial or dehydrated soups except for "vegetable", and condiments, were also excluded. All vegetables and fruit included in the analysis were coded and entered into the CAN-DAT v.5 nutrient analysis program (Godin London Inc., 1985-2000) to calculate consumption.

Portion sizes from CFGHE (e.g., 125 mL mixed fruit cut-up) were calculated into food weights using "Food Guide Facts", "Nutrient Value of Some Common Foods" and "Good Health Eating Guide Resource."<sup>23-25</sup> Because weights per CFGHE portions vary greatly, 16 weight range categories for fruit and vegetables

**TABLE I**  
Recruitment of Study Participants

|                      | Males      |            | Females    |            | Total       |
|----------------------|------------|------------|------------|------------|-------------|
|                      | 18-34      | 35-64      | 18-34      | 35-64      |             |
| Eligible respondents | 252        | 481        | 306        | 556        | 1595        |
| Asked to participate | 252        | 390        | 281        | 370        | 1293        |
| Agreed to contact    | 92         | 162        | 137        | 146        | 537         |
| Number completed*    | 20 (21.7%) | 53 (32.7%) | 41 (29.9%) | 60 (41.1%) | 174 (32.4%) |

\* percentage of those respondents who, after agreeing to be contacted, completed the study

**TABLE II**  
Comparison of Self-reported Demographic Information for All 1,595 Eligible RRFSS Respondents Compared with the 174 Study Participants

| Variable                           | Sex-age strata | Study Participants |        | RRFSS Respondents |        |
|------------------------------------|----------------|--------------------|--------|-------------------|--------|
|                                    |                | %                  | 95% CI | %                 | 95% CI |
| Income<br>≥\$50,000                | M 18-34        | 78                 | 58-97  | 67                | 61-73  |
|                                    | 35-64          | 72                 | 59-85  | 69                | 64-74  |
|                                    | F 18-34        | 56                 | 39-73  | 53                | 47-59  |
|                                    | 35-64          | 60                 | 47-73  | 67                | 63-71  |
|                                    | Total          | 65                 | 58-73  | 65                | 62-68  |
| College or<br>University<br>Degree | M 18-34        | 70                 | 50-90  | 54                | 48-60  |
|                                    | 35-64          | 66                 | 53-79  | 60                | 56-64  |
|                                    | F 18-34        | 78                 | 65-91  | 59                | 54-65  |
|                                    | 35-64          | 57                 | 44-70  | 55                | 51-59  |
|                                    | Total          | 66                 | 59-73  | 57                | 55-59  |
| English<br>Speaking                | M 18-34        | 90                 | 67-98  | 80                | 75-85  |
|                                    | 35-64          | 86                 | 77-95  | 82                | 79-85  |
|                                    | F 18-34        | 83                 | 71-94  | 78                | 73-83  |
|                                    | 35-64          | 90                 | 82-98  | 85                | 82-88  |
|                                    | Total          | 87                 | 83-92  | 82                | 80-84  |
| BMI <25                            | M 18-34        | 39                 | 16-61  | 51                | 45-58  |
|                                    | 35-64          | 29                 | 14-41  | 36                | 32-40  |
|                                    | F 18-34        | 67                 | 52-82  | 71                | 65-76  |
|                                    | 35-64          | 61                 | 48-74  | 60                | 56-64  |
|                                    | Total          | 50                 | 42-57  | 53                | 51-56  |

were created and the average weight for each category was used. No minimum portion size was set in order that a quantity as small as one slice of tomato could be used in calculations.

FFQ results representing usual daily intake of vegetables and fruit and socio-demographic variables for generalizability came from ISR based on encrypted ID numbers, after data analysis from the 24-hour recalls was completed. Only four "don't know" responses were recorded on the FFQs. They were given a value of zero and included in the analysis.

Descriptive statistics including means, standard deviations and medians were analyzed using the SAS Statistical Analysis v.8 program (Cary, NC, 1999-2000). The Spearman method, suitable for non-normally distributed data was used to determine correlation coefficients between the test FFQ and the 24-hour recall reference method. The data were normalized using square root transformation for paired t-tests used to test differences between mean intakes reported from the two methods. For the individual food components, a non-parametric Kruskal-Wallis test was used as the distributions deviated greatly

from normality. Significance was set at  $p < 0.05$ .

## RESULTS

A total of 1,595 respondents aged 18-64 were interviewed by ISR from the three health areas over this time period. A total of 1,293 were randomly selected within age-sex strata and invited to participate in this study, and 537 (42%) agreed and supplied contact information for McGill researchers (Table I). Of these 537 people, 13 (2%) were not reached because the contact information was insufficient or inaccurate and 204 (38%) were never reached after a minimum of six attempts. A further 115 (21%) once reached refused to take part. Ten people (2%) were not eligible for various reasons including age, time or language barriers, 21 (4%) were lost to follow-up and 174 (32%) completed the study. This meant that 174/320 (54%) people contacted by McGill researchers actually completed the study, but in total only 13% completed the study out of the 1,293 invited by RRFSS interviewers.

The sample was initially stratified by age group and sex, but the final sample was too

**TABLE III**  
**Descriptive Statistics for the Group by Method and Six FFQ Question Topics (n=174)**

|                      | Juice       | Fruit       | Salad       | Potatoes    | Carrots     | Other Vegetables | Total Vegetable and Fruit |
|----------------------|-------------|-------------|-------------|-------------|-------------|------------------|---------------------------|
|                      | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)   | Mean (SD)        | Mean (SD)                 |
| FFQ times/day        | 0.90 (0.86) | 1.43 (1.30) | 0.58 (0.48) | 0.29 (0.26) | 0.37 (0.32) | 0.98 (0.79)      | 4.55 (2.25)               |
| Recalls servings/day | 0.93 (1.24) | 1.48 (2.01) | 0.38 (0.70) | 0.27 (0.45) | 0.25 (0.39) | 1.45 (1.22)      | 4.76 (3.22)               |

None of the between-group differences were statistically significant using the Kruskal-Wallis test. Two-tailed paired t-test with square root transformed data for the total fruit and vegetable consumption was also used (p=0.92)

**TABLE IV**  
**Comparison of Methods in the Classification of the Proportion (%) of Respondents Consuming Five or More Servings of Vegetable and Fruit per Day**

|                 | Total (n=174) | Men (n=73) | Women (n=101) |
|-----------------|---------------|------------|---------------|
|                 | %             | %          | %             |
| Recall servings | 35.1          | 30.1       | 38.6          |
| FFQ times       | 37.4          | 28.8       | 43.6          |

**TABLE V**  
**Spearman Correlation Coefficients\* for Recall Servings/Day to FFQ Times/Day (n=174)**

| FFQ questions              | 24-hour Recall Servings/FFQ Times |
|----------------------------|-----------------------------------|
| Q1 - juice                 | 0.37                              |
| Q2 - fruit                 | 0.43                              |
| Q3 - salad                 | 0.37                              |
| Q4 - potatoes              | 0.33                              |
| Q5 - carrots               | 0.32                              |
| Q6 - other vegetables      | 0.29                              |
| Total vegetables and fruit | 0.41                              |

\* All correlation coefficients are significant at p<0.0001

small to make age comparisons. Table II shows that there were no striking socio-demographic differences between the 1,595 potentially eligible RRFSS respondents by age category and gender compared to the final 174 respondents. The average duration to complete three 24-hour recalls was 3.7 weeks and the average duration between the administrations of the FFQ and that of the third recall was 7.8 weeks.

The group’s mean vegetable and fruit consumption for the 24-hour recalls was 4.8 servings (portions) per day and 4.6 times per day from the FFQ. The difference was not significantly different using a two-tailed paired t-test with square root transformed data (p=0.92) (see Table III). The difference between the means was also not significantly different using the non-parametric Kruskal-Wallis test. The results for individual food items were similarly not statistically significantly different.

Results stratified by age and sex resembled those from the overall group. The average number of total vegetable and fruit servings (portions) from the recalls for women was 4.9 servings (portions)/day versus 4.7 times/day for the FFQ and for men it was 4.6/day versus 4.3/day, respectively. The 24-hour recall median was 4.1

servings/day. This was somewhat lower than the mean due to some very high reported intakes. The FFQ median was 4.2 times/day. Distributions for the recall servings/day and FFQ times/day were similar. The 25<sup>th</sup> percentile values for the 24-hour recall versus the FFQ were 2.5 and 2.7 respectively and 75<sup>th</sup> percentiles were 6.1 for both methods.

The proportion of respondents consuming five or more servings of vegetables and fruit per day from the recalls was 35% while 37% consumed vegetables and fruit five or more times/day as reported on the FFQ (Table IV).

To examine agreement at the individual level, Spearman correlations are reported (Table V). The correlation coefficient, which is based on values for individual respondents, was 0.41 for total recall servings to total FFQ times.

**DISCUSSION**

This validation study provides clear data that the FFQ is a good proxy for servings of vegetables and fruit at a group level. Both the mean level of intake and the proportion meeting recommended levels of five servings per day are comparable. In this sample of 174 adults aged 18-64 years,

we found a group mean of 4.8 quantified, defined servings/day from three 24-hour recalls. This was not statistically significantly different from the group mean of times (frequencies, occasions) which was 4.6/day from the FFQ.

Lower response rates among younger and male RRFSS participants as well as a trend for the more formally educated and higher-income participants to agree to participate in the validation subset may indicate that the subsample studied was differentially interested in nutrition and as such may be more accurate reporters.<sup>26</sup> For the men, but not the women, there was a tendency for participants in the substudy to be heavier. The extent to which these small differences in subject characteristics affect the accuracy of reporting on diet is not known.

Validation studies in other settings have shown similar results regarding agreement of methods. Among Hispanic mothers in Chicago (n=73), FFQ and recalls both resulted in an average of 2.1 servings/day with a Spearman correlation of recalls to FFQ results for total vegetable and fruit intake of r=0.46.<sup>15</sup> Typically, correlations between FFQs and other methods have been reported to be in the range of 0.30 to 0.56.<sup>3,16,17,19,27,28</sup> This is due, in part, to the difficulty of having a true “gold standard” for dietary measurement, as even with three repeat 24-hour recalls, one cannot fully capture habitual dietary intake.

In our study, the proportion of the group averaging five or more servings/day was 35% from the recalls. The FFQ estimated 37% consumed vegetables and fruit five or more times/day. In a population of adolescents, Field et al.<sup>17</sup> found a larger difference in proportions when comparing servings per day; 49% from an average of three recalls to 36% from usual intake on the BRFSS.

Our reference method in this validation study was the repeated 24-hour recall, shown to be more reliable than FFQs<sup>19</sup> and

to correlate well with biomarkers such as serum carotenoids and doubly labelled water.<sup>18,29</sup> The 24-hour recall is one of the preferred methods to accurately estimate average nutrient intakes for groups.<sup>20,30-34</sup> This method is not immune to potential respondent over- or under-reporting<sup>32,33</sup> but has been shown capable of reasonably capturing an individual's usual intake of vegetables and fruit.

As was done in this study, it is recommended that the test measure be administered prior to the reference method as it is normally "encountered independently" from another assessment method. This is particularly important when the reference method may enhance attention to diet.<sup>35</sup> The McGill researchers were blind to the FFQ results throughout the 24-hour recall analysis stage. FFQ results were collected at another site by a set of interviewers who had no contact with McGill researchers and FFQ results were not sent to McGill until the 24-hour recall analysis was finalized. Consequently, we are confident that no bias was introduced by any decisions on minor food item inclusion/exclusion criteria made after the 24-hour recall data were collected.

## CONCLUSION

The results from this study indicate that the optional six-item vegetable and fruit questionnaire, currently part of the Rapid Risk Factor Surveillance System, can stand as a valid proxy for commonly recognized portions of total fruit and vegetable intake at the population level.

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## Appendix

### The RRFSS Vegetable and Fruit Food Frequency Questionnaire

- How many times per day, week or month do you drink 100 percent fruit juices such as orange, grapefruit, or tomato juice?  
Interviewer: If R says "it varies", ask about a typical month.
  - If they say there is no typical month, ask about the last month.
  - If R says "a few times, a couple of times, once in a while, etc.," ask for their best guess at an exact number.
 If "R" asks what we mean by 100% fruit juice, say "a juice with no sugar or sweetener added."
- Not counting juice, how many times per day, week or month do you eat fruit?  
Interviewer: If required, this includes canned, frozen and fresh fruit, eaten on its own or with other food, cooked or raw.
- And how many times per day, week or month do you eat a green salad?  
Interviewer: A green salad includes lettuce with or without other ingredients.
- NOT including french fries, fried potatoes, or potato chips, how many times per day, week or month do you eat potatoes?  
Interviewer: If asked, sweet potatoes and yams do NOT count.
- What about carrots? How many times per day, week or month do you eat carrots?  
Interviewer: If required, includes canned, frozen and fresh, eaten on their own or with other food, cooked or raw.
- Not counting carrots, potatoes, or green salad, how many times per day, week or month do you eat other vegetables?

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## RÉSUMÉ

**Contexte :** Les intervenants en santé publique ont besoin d'outils valables pour évaluer les tendances de la consommation alimentaire. Actuellement, le Système rapide de surveillance des facteurs de risque (SRSFR) inclut un module facultatif de six questions sur la fréquence de consommation (QFC) des fruits et légumes. Nos objectifs consistaient 1) à évaluer si le QFC pouvait être un substitut raisonnable aux portions mesurées et 2) à comparer pour chaque méthode la proportion de l'échantillon consommant en moyenne au moins les cinq portions par jour recommandées dans le *Guide alimentaire canadien pour manger sainement*.

**Méthode :** Des diététistes ont fait remplir des feuilles de rappel des aliments ingérés pendant les 24 dernières heures à chacun des 174 répondants adultes qui ont rempli le QFC dans le cadre du SRSFR. Trois exercices de rappel ont été administrés par téléphone en utilisant une version modifiée de la méthode en plusieurs parcours (*Multiple-Pass Method*) utilisée par le département américain de l'Agriculture.

**Résultats :** Selon la méthode des rappels, la moyenne de la consommation totale de légumes et de fruits pour le groupe était de 4,8 portions/jour et n'était pas significativement différente des 4,6 occasions de consommer/jour obtenues par le biais du QFC (test t jumelé,  $p=0,92$ ). Trente-cinq pour cent des répondants ont été classés comme consommateurs d'au moins cinq portions par jour selon la méthode des rappels, et 37 % selon le QFC.

**Conclusion :** Les résultats indiquent que le module QFC peut être utilisé comme un substitut à la consommation mesurée.

“Vaccines are our  
best tool for preventing disease.  
Are **you** recommending vaccines?”

Charan Kaler  
Public Health Nurse, Winnipeg

Canadian Coalition for  
Immunization Awareness & Promotion  
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