ORIGINAL ARTICLE

# The relationship between health eating and overweight/obesity in Canada: cross-sectional study using the CCHS

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## Summary

### Objective

The relationship between Canada's Food Guide (CFG) adherence and overweight/obesity at the population level is unknown. Our objective was to explore the association between overweight/obesity and CFG adherence in Canada.

### Methods

Using 24-h dietary recall data from the Canadian Community Health Survey (CCHS), we conducted a cross-sectional analysis of Canadians' consumption of four predefined food types from CFG (grain products, vegetables and fruit, milk and alternatives, meat and alternatives). Respondents aged 18 to 65 years with measured BMI were included. The total number of servings in each food group was compared with the number of recommended servings in CFG to determine adherence. Linear regression was used to explore the association between overweight/obesity and CFG adherence.

### Results

Participants who met the minimum servings in vegetables and fruit had a lower measured BMI. Also, participants who met the minimum servings in meat and alternatives had a higher measured BMI. These associations were observed for the sample as a whole and for those with overweight/obesity, and, for meat and alternatives, among women.

### Conclusion

There is evidence that following the CFG recommendation is associated with measured BMI, for some food groups. This relationship needs to be validated using longitudinal data.

**Keywords:** Obesity, dietary adherence, public policy.

## Introduction: the Canada's Food Guide

Canada's Food Guide (CFG) was first introduced in July 1942 during wartime food rationing 'to prevent nutritional deficiencies and to improve the health of Canadians' (1). Since then, it has continued to serve the 'purpose of guiding food selection and promoting the nutritional health of Canadians' via different versions and themes over the years as the health concerns of the Canadian population have shifted; for example, data from the Canadian Community Health Survey (CCHS) from 2003 to 2010 showed that the prevalence of overweight and obesity among Canadians increased (2). The current Food Guide, released in 2007, provides Canadians with recommendations on the types and the amounts of food an individual should consume every day according to his/her age and sex (3). However, there is currently no study that explores the relationship between CFG adherence and overweight/obesity in adults at the national level. Existing studies focused on specific disease population (4,5), First Nations (6,7) or children and adolescents in specific regions or provinces (8–10).

The objective of this study was to explore the relationship between healthy eating and overweight/obesity at the population level. We operationalized healthy eating in terms of adherence to CFG, and in particular

Canadians' consumption of four predefined food types from CFG: grain products, vegetables and fruit, milk and alternatives and meat and alternatives.

## Methods

### Data source: the Canadian Community Health Survey

The CCHS is a national survey administered by Statistics Canada and Health Canada that collects information on Canadians' health status, health care utilization and health determinants. Cycle 2.2, administered in 2004–2005, was designed to understand Canadians' nutritional choices, and a 24-h dietary recall module was included in the survey for that purpose. The 24-h dietary recall module is an instrument developed by the US Department of Agriculture that collects information on the consumption of all foods and beverages 24 h (from midnight to midnight) before the day of the interview. Health Canada modified this instrument to better fit the Canadian context (11).

Information for CCHS Cycle 2.2 was collected between January 2004 and January 2005 in the 10 provinces. Complex probability sampling was used to obtain a nationally representative sample of persons of all ages who lived in privately occupied dwellings (11). Thirty-five thousand one hundred seven individuals were included in the initial CCHS Cycle 2.2 sample, and a subsample of 10,150 individuals received a second 24-h dietary recall. The Software for Intake Distribution Estimation (SIDE) program developed by Iowa State University was used to simulate respondents' usual intake (12). Ten percent of the sample aged 18 and over were asked to self-report their height and weight and then measured by the interviewer. The confidential microdata were accessed via the Prairie Regional Research Data Centre at the University of Calgary.

### Misreporting

Due to the self-report nature of the 24-h dietary recall, the reported energy intake (EI) is susceptible to errors when compared with other objective measures, such as observer-recorded food records. In a weight-stable individual, the EI should be similar to the energy expenditure (EE) (15). As such, some validation methods are based on measuring EE in order to estimate the accuracy of the 24-h dietary recalls. The mean daily consumption of the four food groups for the four age/sex groups from the CCHS sample should be a valid reflection of EI by all participants. However, when applying these values at an individual level in a regression analysis, attention should

be paid to the extreme values due to over-reporting/under-reporting. Therefore, the Goldberg cut-off was employed to identify potential invalid reporters from among the CCHS respondents (13). Goldberg defined the cut-off level as the ratio between the reported EI and the predicted basal metabolic rate (BMR) according to the respondents' physical activity level. Black *et al*. defined a cut-off range from the minimum of 1.2 for chair-bound or bed-bound individuals to a maximum of 4.5 for extremely active participants based on a sample of 1156 participants (16). Health Canada has suggested the lower and upper cut-off values of 0.87 and 2.75 respectively, to identify invalid reporters who completed a single 24-h dietary recall (13). Therefore, for the purpose of this study, any self-reported EI in the CCHS sample that was less than 0.87 times the estimated BMR using the algorithms derived by the World Health Organization based on age, sex, weight and height would be classified as under-reporting (17). Conversely, individuals with reported EI larger than 2.75 times BMR would be identified as over-reporters. Analyses were run with and without these under-reporters and over-reporters included (not shown), and results were substantively the same. As such, only results that excluded under-reporters and over-reporters were presented in this paper.

In addition, both the invalid reporters (i.e. under-reporters and over-reporters) and the underweight individuals behaved differently from their counterparts in terms of the diet–obesity relationship as indicated by the Chow test. Specifically, their adherence to the four food groups had a different effect on the measured BMI compared with their counterparts. As such, underweight individuals were also excluded from the analysis.

### Data analysis and regression models

Respondents aged 18 to 65 years in the CCHS 2.2 were included in the analysis. All the major food items from the 24-h dietary recall were categorized into the four predetermined food types stated in the CFG using the cfggr04 data file provided by Statistics Canada: (1) vegetables and fruit, (2) grain products, (3) milk and alternatives and (4) meat and alternatives. All the food items recorded in grams in the data were converted into number of servings per day in the previously mentioned four food groups, using the serving sizes listed in the Canadian Nutrient File (18). After summing the number of servings for all food items, the total number of servings in each food group per day was derived for each CCHS respondent, and the usual number of servings in each food group was estimated by SIDE. The SIDE software used the method developed by Nusser *et al*., which briefly

involves transforming the observed intakes to a normal distribution to predict usual intake (19).

The CFG recommends a specific number of servings in each of the four food groups according to age and sex (Figure 1). The usual number of servings in each food group predicted by SIDE was compared with the number of recommended servings in CFG for each of the four age/sex groups to determine the percentage of respondents who adhered to the guideline.

To explore the association between measured BMI and CFG adherence, measured BMI was entered into a linear regression with CFG adherence (described in the succeeding texts) in the four food groups as the primary independent variables. The following potential confounders were considered: socio-demographic variables (age, sex, marital status, race, employment status, student status, education, personal income, province of residence, living in urban/rural area), other behavioural
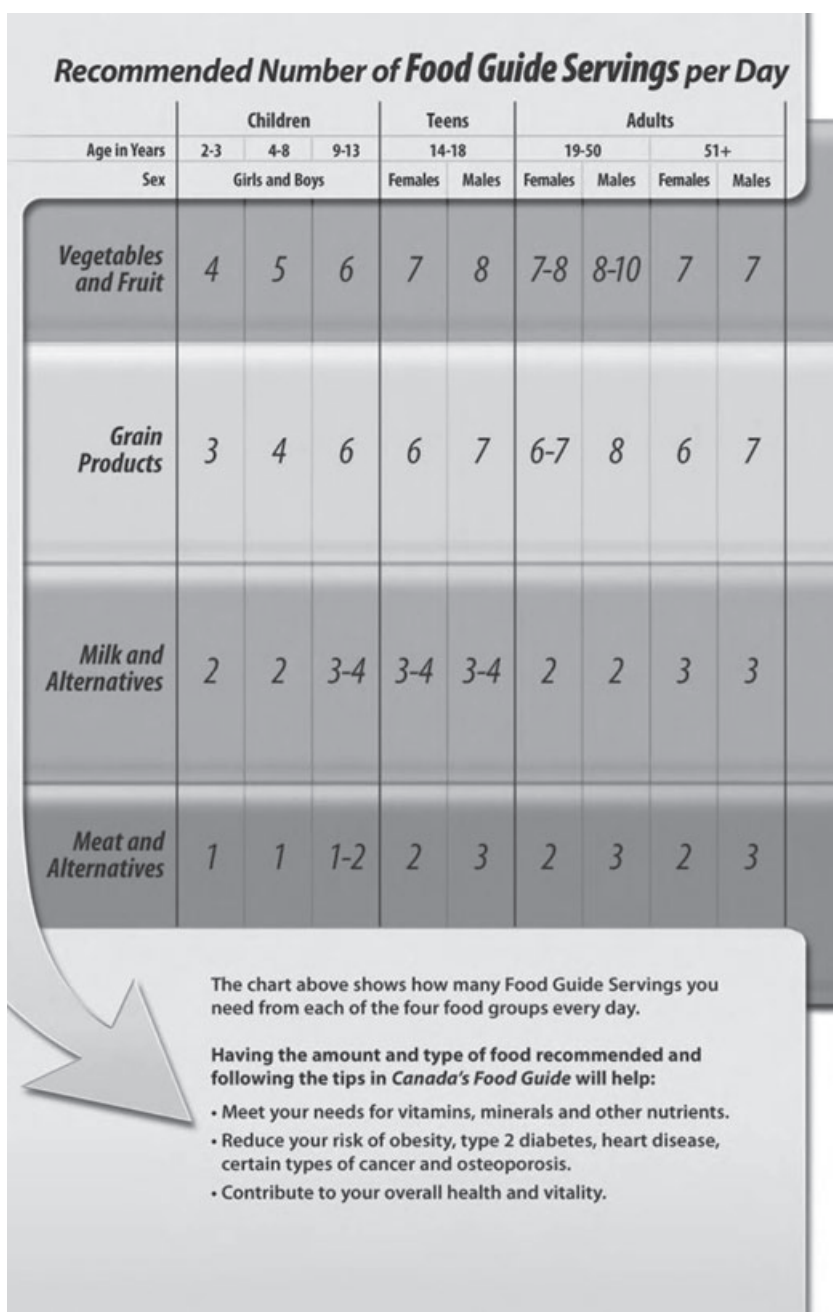


**Recommended Number of Food Guide Servings per Day**

| | Children | | | Teens | | Adults | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age in Years | 2-3 | 4-8 | 9-13 | 14-18 | | 19-50 | | 51+ | |
| Sex | Girls and Boys | | | Females | Males | Females | Males | Females | Males |
| **Vegetables and Fruit** | 4 | 5 | 6 | 7 | 8 | 7-8 | 8-10 | 7 | 7 |
| **Grain Products** | 3 | 4 | 6 | 6 | 7 | 6-7 | 8 | 6 | 7 |
| **Milk and Alternatives** | 2 | 2 | 3-4 | 3-4 | 3-4 | 2 | 2 | 3 | 3 |
| **Meat and Alternatives** | 1 | 1 | 1-2 | 2 | 3 | 2 | 3 | 2 | 3 |

The chart above shows how many Food Guide Servings you need from each of the four food groups every day.

Having the amount and type of food recommended and following the tips in *Canada's Food Guide* will help:

- Meet your needs for vitamins, minerals and other nutrients.
- Reduce your risk of obesity, type 2 diabetes, heart disease, certain types of cancer and osteoporosis.
- Contribute to your overall health and vitality.

**Figure 1** Recommended number of servings by the Canada's Food Guide. Source: Eating Well with Canada's Food Guide

**Table 1** Descriptive statistics: weighted estimates (mean or percent) for BMI classification, demographics and health status by sex.

| % | Male | Female |
|---|---|---|
| Measured BMI | | |
| Mean (95% CI) | 26.9 (26.6, 27.3) | 26.4 (26.0, 26.8) |
| Normal weight (18.5–<25)[a] | 36.7 | 50.7 |
| Overweight (25–<30) | 42.3 | 28.4 |
| Obese (≥30) | 21.0 | 20.9 |
| Age (mean, 95% CI) | 40.1 (39.4, 40.8) | 40.9 (40.3, 41.5) |
| Education level | | |
| High school or below | 16.1 | 11.9 |
| High school graduates | 16.7 | 21.6 |
| Attended post-secondary | 10.6 | 9.6 |
| Post-secondary graduates | 56.6 | 56.9 |
| Total personal income from all sources | | |
| No income | 2.6 | 9.2 |
| <$5000 | 3.4 | 8.1 |
| $5000–$9999 | 5.3 | 10.0 |
| $10,000–$14,999 | 5.4 | 9.7 |
| $15,000–$19,999 | 5.8 | 8.4 |
| $20,000–$29,999 | 15.2 | 17.5 |
| $30,000–$39,999 | 16.7 | 16.0 |
| $40,000–$49,999 | 12.7 | 9.3 |
| $50,000–$59,999 | 10.8 | 4.6 |
| $60,000–$79,999 | 13.3 | 4.7 |
| $80,000 or more | 8.8 | 2.5 |
| Smoking status | | |
| Not at all | 69.6 | 77.5 |
| Never | 41.0 | 54.3 |
| Former occasionally | 2.2 | 1.9 |
| Former daily | 26.3 | 21.3 |
| Occasionally | 5.0 | 4.7 |
| Former daily | 2.9 | 3.1 |
| Current occasionally | 2.1 | 1.6 |
| Daily | 25.5 | 17.8 |
| Frequency of drinking | | |
| Not at all | 12.2 | 18.8 |
| <Once a month | 12.2 | 21.8 |
| Once a month | 8.0 | 9.2 |
| Two to three times per month | 10.1 | 12.6 |
| Once a week | 15.6 | 15.2 |
| Two to three times a week | 24.1 | 15.2 |
| Four to six times a week | 9.0 | 3.4 |
| Everyday | 9.0 | 3.7 |
| Physical activity index | | |
| Active | 20.2 | 16.0 |
| Moderate | 26.1 | 26.5 |
| Inactive | 53.7 | 57.5 |
| Chronic diseases | | |
| Has diabetes | 2.9 | 2.3 |
| Has high blood pressure | 9.8 | 8.2 |
| Has heart disease | 3.3 | 1.4 |
| Has cancer | 1.2 | 2.0 |
| Marital status | | |
| Married | 51.1 | 53.1 |
| Common law | 13.3 | 14.5 |
| Widowed | 0.4 | 1.9 |

*Continues*

**Table 1.** *Continued*

| % | Male | Female |
|---|---|---|
| Separated | 2.1 | 3.3 |
| Divorced | 4.0 | 5.9 |
| Single | 29.2 | 21.4 |
| Cultural/racial origin | | |
| White | 84.2 | 84.0 |
| Aboriginal | 1.4 | 2.1 |
| Self-perceived health | | |
| Excellent | 25.8 | 22.6 |
| Very good | 35.3 | 39.8 |
| Good | 29.0 | 28.9 |
| Fair | 8.1 | 7.2 |
| Poor | 1.7 | 1.5 |
| Self-perceived mental health | | |
| Excellent | 41.7 | 37.5 |
| Very good | 33.1 | 37.4 |
| Good | 22.1 | 20.6 |
| Fair | 2.9 | 3.8 |
| Poor | 0.2 | 0.8 |
| Full time student | 7.8 | 8.4 |

[a]Classification based on measured BMI.

risk factors (smoking status, alcohol consumption, physical activities), chronic conditions and self-perceived health and mental health.

To define CFG adherence, each of the four food groups was coded as a dichotomous variable that indicated whether or not the respondents had met the CFG suggested minimum servings per day. For example, the recommended number of servings for vegetables and fruit for females aged 18–50 was seven to eight per day. CCHS respondents in that age/sex group who had consumed seven or more servings would be coded as adhering to the CFG. Subgroup analyses were also performed; specifically, we ran the same regression models among males and females separately, and among groups with normal weight (measured BMI $<25$ kg m$^2$) and overweight/obesity (measured BMI $\geq 25$ kg m$^2$) separately. Bootstrap and sampling weights for the measured BMI subsample were used in the aforementioned models to estimate standard errors, coefficient and confidence intervals.

## Results

### Analytic sample

After list-wise exclusion of missing values on the variables of interest (i.e. measured BMI, CFG adherence, demographics, health determinants, chronic conditions

**Table 2** Results from linear regression models: unadjusted association between measured BMI and meeting the Canada's Food Guide minimum number of servings in the four food groups of Canadians aged 18 to 65 by sex, excluding individuals who are underweight and misreported ($n$ = 6202)

| | Full sample | Male | Female |
|---|---|---|---|
| | Coefficient (confidence intervals) | | |
| Vegetables and fruit | −0.735** (−1.272, −0.198) | −0.380 (−0.986, 0.225) | −0.946* (−1.775, −0.118) |
| Grain products | −0.109 (−0.644, 0.425) | −0.065 (−0.723, 0.594) | −0.113 (−0.963, 0.737) |
| Milk and alternatives | 0.116 (−0.405, 0.637) | 0.313 (−0.334, 0.961) | −0.086 (−0.930, 0.759) |
| Meat and alternatives | 0.586* (0.073, 1.099) | 0.405 (−0.199, 1.009) | 0.743 (−0.046, 1.531) |

*and **denote statistical significance at 5 and 1% levels respectively.

**Table 3** Results from linear regression models: adjusted association between measured BMI and meeting the Canada's Food Guide minimum number of servings in the four food groups of Canadians aged 18 to 65

| Coefficient (confidence intervals) | Full sample (1) | Male (2) | Female (3) | Normal (4) | Overweight/obese (5) | Overweight/obese male (6) | Overweight/obese female (7) |
|---|---|---|---|---|---|---|---|
| Vegetables and fruit | −0.593* (−1.104, −0.082) | −0.288 (−0.812, 0.235) | −0.791 (−1.620, 0.037) | −0.066 (−0.327, 0.195) | −0.971** (−1.552, −0.391) | −0.806* (−1.436, −0.176) | −1.249* (−2.360, −0.138) |
| Grain products | 0.080 (−0.424, 0.585) | −0.055 (−0.665, 0.555) | 0.125 (−0.681, 0.931) | −0.211 (−0.462, 0.040) | 0.124 (−0.459, 0.707) | −0.238 (−0.866, 0.390) | 0.432 (−0.615, 1.480) |
| Milk and alternatives | 0.303 (−0.199, 0.804) | 0.411 (−0.180, 1.001) | 0.328 (−0.447, 1.103) | 0.037 (−0.239, 0.313) | 0.069 (−0.500, 0.639) | 0.225 (−0.350, 0.800) | −0.118 (−1.121, 0.885) |
| Meat and alternatives | 0.621* (0.128, 1.114) | 0.351 (−0.223, 0.925) | 1.015* (0.231, 1.800) | −0.204 (−0.430, 0.021) | 0.955** (0.430, 1.479) | 0.473 (−0.143, 1.089) | 1.477** (0.605, 2.349) |

Overall, stratified by sex, BMI group (normal vs. overweight/obese) and sex and overweight/obese. Confidence intervals are shown in parentheses. All of the models include the following covariates: sex, age, age squared, marital status, sex marital status interaction, diabetic, high blood pressure, race, employment status, student status, education, personal income groups, provinces, living in urban areas, self-perceived health and mental health, smoking status, drinking status, level of physical activity and time of the 24-h recall.
*and **denote statistical significance at 5 and 1% levels respectively.

and self-perceived health and mental health), invalid reporters and the underweight individuals, a final sample of 6202 was used in this study. From the 35,107 respondents in the survey, 15,347 were between the age of 18 and 65 and non-pregnant. Only 9109 of them were included in the subsample with measured BMI. Comparing the respondents with and without measured BMI, the latter were older with a higher proportion of males. There were no significant differences in terms of income level or marital status (not shown). There were also no significant differences between the excluded 657 participants due to missing data and the final sample in terms of variables of interest.

### Descriptive analysis

Descriptive statistics are presented in Table 1. The weighted mean age (years) for men and women in the CCHS 2.2 was 40.1 and 40.9 respectively, which was similar to the median age of the labour force (aged 25–64) reported in the 2006 census (20). The education level was similar to the Canadian population, with 56.6% male and 56.9% female completed post-secondary education compared with an overall rate of 60% in the 2006 census for Canadians aged between 25 and 64. Eighty-four per cent of the respondents were white, and more than half of the respondents were either married or common law (65%).

In terms of other covariates, most respondents were non-smokers and non-drinkers or occasional drinkers, with a frequency of drinking less than once a week. More than half were physically inactive, as defined by a physical activity index of EE below 1.5 kcal kg$^{-1}$ per day (21). Nine, 3 and 2% of the sample had high blood pressure, diabetes and heart disease respectively. Most respondents perceived their own health and mental health to be very good or excellent (61 and 75% respectively).

From the 24-h dietary recall, most Canadians did not meet the minimum number of servings suggested in the CFG in the food groups of vegetables and fruit, grain products and milk and alternatives. Only 29 and 46% of the CCHS respondents met the minimum number of servings in vegetables and fruit and grain products respectively. In terms of milk and alternatives, over 40% of the CCHS sample met the minimum number of servings. Sixty-two per cent of the respondents met the minimum daily servings for meat and alternatives.

### Regression analysis

Table 2 shows the unadjusted coefficients between measured BMI and the four food groups from the linear regression model. Adherence in meat and alternatives

was positively associated with measured BMI in the unadjusted linear regression model for the full sample, statistically significant at 5%. Vegetables and fruit, on the other hand, was statistically significantly inversely associated with measured BMI, among the full sample and among female respondents ($p < 0.05$).

Table 3 shows the adjusted associations between measured BMI and CFG adherence. Both vegetable and fruit and meat and alternatives were statically significant at 5% in the overall sample (column 1). Adherence in vegetables and fruit was negatively associated with measured BMI, while adherence in meat and alternatives was positively associated with measured BMI. Similar results in meat and alternatives were observed for females only, in the subgroup analyses stratified by sex (columns 2 and 3).

The subgroup analyses in the groups with normal weight and overweight/obesity are presented in columns 4 and 5. The association between vegetable and fruit and meat and alternatives and measured BMI was statistically significant among the group with overweight and obesity.

Columns 6 and 7 show the results from the linear regression in the group with overweight/obesity by sex. Adherence in vegetable and fruit was associated with lower measured BMI in both male and female participants with overweight/obesity. Adherence in meat and alternatives was associated with higher measured BMI, among females but not males.

## Discussion and conclusion

This study is the first to examine the relationship between adherence to the CFG and overweight/obesity at a population level in Canada. A strength of the study is the use of measured BMI instead of self-reported BMI to provide a more precise definition of overweight/obesity.

This paper provided an overall picture on how Canadians' dietary patterns are associated with the measured BMI. Consumption of meat and alternatives was positively associated with measured BMI, especially in the group with overweight/obesity and females. Because the CFG did not provide the maximum number of servings, this paper could not determine whether this association was due to over-consumption in meat and alternatives or not. In addition, because of the nature of survey data, there might be other factors that the survey did not account for, but still influenced the relationship between meat consumption and BMI. For example, the model did not include all social, economic, cultural and health conditions that might influence the food choice of the respondents. As such, this relationship needs to be validated in future studies using longitudinal data.

Longitudinal data on long-term dietary patterns and BMI changes need to be collected to establish the causal relationship between CFG adherence and overweight/obesity.

There is some evidence that following the CFG recommendation, especially in the groups of vegetables and fruit and meat and alternatives, was associated with overweight/obesity and BMI. Other published studies have explored the relationship between dietary guideline adherence and disease outcomes. For example, McCullough *et al*. examined the long-term effects of adherence to the Dietary Guidelines for Americans and the risk of major chronic disease in both men and women (23,24). Similar to CFG, the Dietary Guidelines for Americans provide dietary advice for Americans to 'promote health and reduce risk for major chronic diseases' (22). These guidelines provide recommendations on the number of servings per day in the seven food groups (fruits, vegetables, grains, lean meat and beans, milk, oils and discretionary calorie allowance) based on 12 different caloric levels. Instead of examining the relationship between adherence and overweight/obesity, McCullough *et al*. concluded that adherence to the guidelines was associated with a 28 and 14% reduction in cardiovascular disease risk in men and women respectively.

We did not observe any associations between the two other food groups (grain products and milk and alternatives). The reasons are not clear, but the consistency across our models suggests that the absence of association may be robust.

A main limitation of this study is the self-reported nature of most of the CCHS responses. This study attempted to address this problem by identifying misreporting in the 24-h dietary recall using the cut-off value derived by Black *et al*. In addition, due to the cross-sectional nature of the data, no causal statement can be made on the basis of these results. Longitudinal studies on diet and overweight/obesity are recommended to better understand the relationship between CFG adherence and overweight/obesity, including changes over time in both variables, and, in turn, to provide insight into the effectiveness of the CFG on nutrition and health at the population level.

## Conflict of Interest Statement

The authors declared no conflict of interest.

## Funding

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