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Abstract

Background
To calculate total intake of a nutrient and estimate inadequate intake for a population, the amounts derived from food/beverages and from vitamin/mineral supplements must be combined. The two methods Statistics Canada has suggested present problems of interpretation.

Data and methods
Data collected from 34,386 respondents to the 2004 Canadian Community Health Survey—Nutrition were used to compare four methods of combining nutrient intake from food/beverages and vitamin/mineral supplements: adding average intake from supplements to the 24-hour food/beverage recall and estimating the usual distribution in the population (Method 1); estimating usual individual intake from food/beverages and adding intake from supplements (Method 2); and dividing the population into supplement users and non-users and applying Method 1 or Method 2 and combining the estimates based on the percentages of users and non-users (Methods 3 and 4).

Results
Interpretation problems arise with Methods 1 and 2; for example, the percentage of the population with inadequate intake of vitamin C and folate equivalents falls outside the expected minimum-maximum range. These interpretation problems are not observed with Methods 3 and 4.

Interpretation
Interpretation problems that may arise in combining food and supplement intake of a given nutrient are overcome if the population is divided into supplement users and non-users before Method 1 or Method 2 is applied.

Keywords
nutrition surveys, 24-hour dietary recall, vitamin and mineral supplements, usual intake

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The 2004 Canadian Community Health Survey (CCHS)—Nutrition was the first in more than 30 years to study Canadians' eating habits. One of the goals was to determine total usual intake of selected nutrients. To that end, the CCHS collected information about food and beverage consumption, based on a 24-hour recall.

To calculate the usual distribution of intake of a nutrient in a population or to estimate the percentage of people above or below certain thresholds, within-person variations must be taken into account.[1] This is because what people eat and drink varies from day to day. If two or more dietary recalls are available for at least a subsample of the population, the daily distribution of a nutrient in the entire population can be adjusted with a computer application such as the Software for Intake Distribution Estimation (SIDE)[2,3] to derive *usual* intake. With the data collected in the CCHS, Statistics Canada and Health Canada produced usual intake from food/beverages for an extensive array of nutrients.[4-6]

However, as well as from food/beverages, many nutrients, notably vitamins and minerals, are derived from supplements. Thus, estimates of total consumption of any nutrient must include supplement intake.

Consumption of vitamin/mineral supplements was not part of the CCHS 24-hour dietary recall. This information was obtained from questions about consumption frequency during the past month, the aim of which was to directly estimate usual intake. However, calculations of usual intake of any nutrient from food/beverages must be derived from daily, not monthly, intake.

Statistics Canada has suggested two ways to combine nutrient intake from food/beverages with that from supplements.[7] The first transforms vitamin/mineral supplement intake into daily consumption using the daily average and assumes no within-individual variation, adds this to daily intake from food/beverages, and derives total usual intake of the nutrient. For the second method, usual intake distribution from food/beverages (derived from daily consumption) is added to usual intake of supplements (derived from monthly consumption).

The analysis in this study demonstrates that these two methods of combining nutrient intake from food/beverages and from supplements can create interpretation problems, for example, in estimating the prevalence of inadequacy. Two alternatives are proposed, based on partitioning the data between supplement users and non-users. Finally, the four methods are compared.

Data source

The 2004 CCHS was designed to gather data about the household population's food/beverage consumption and nutrient intake. The survey excluded members of the regular Canadian Forces; residents of the three territories, Indian reserves, institutions and some remote areas; and all residents (military and civilian) of Canadian Forces bases. A detailed description of the survey design, sample and interview procedures is available in a published report.[8]

The 2004 CCHS estimated food/beverage consumption with 24-hour dietary recalls, using the five-step automated multiple-pass method[9,10] to help respondents remember what and how much they ate and drank the previous day. A total of 35,107 people responded to an initial recall, and a subsample of 10,786 took part in a second recall three to ten days later. The response rates were 76.5% and 72.8%, respectively.

This study pertains to people aged 1 or older. Children younger than 1 (288), pregnant women (175), nursing women (92), breastfeeding children (104), and respondents with no dietary intake (16) or invalid dietary intake (45) were excluded from the analysis. A total of 34,386 people were included in the study, 10,591 of whom responded to the second 24-hour dietary recall.

Use of vitamin/mineral supplements was not part of the dietary recall. Instead, respondents were asked: "In the past month, did you take any vitamins or minerals?" If so, they were asked to get the supplement containers from which the drug identification number or product name and concentration of main ingredients could be obtained. The interviewer then asked: "In the past month, how often did you usually take this supplement?", and if not daily, the interviewer asked: "On the days that you took it, how many times did you usually take this supplement?" "How many pills or tablets, capsules or teaspoons did you usually take each time?" was asked to obtain an estimate of the quantities consumed. Based on answers to these questions, variables were derived indicating the number of days per month that supplements were taken and the average quantity consumed per day. More information about these derived variables is available in the survey documentation[11]

The nutrient content of food and beverages reported in the recalls was derived from Health Canada's Canadian Nutrient File (Supplement 2001b).[12] The composition of supplements was taken from the September 2003 Drug Product Database (DPD)[13] in the case of drug identification numbers listed at the time of collection, and from the spring 2005 DPD in the case of drug identification numbers that were missing or incorrect at the time of collection.

Methods proposed by Statistics Canada

After an examination of various means that have been used to combine nutrient intake from food and supplements and to estimate the percentage of the population below a given threshold,[1,14,15] Statistics Canada suggested two methods:

Method 1 (add, shrink)

- Add the average intake of the selected nutrient from vitamin and mineral supplements to the first 24-hour dietary recall, and if available, to the second recall.
- Adjust the first dietary recall with the second using SIDE.[2,3]
- Calculate the percentage of the population whose total intake of the selected nutrient is below a given threshold using the estimated average requirement (EAR) cut-off method.

Method 2 (shrink, add)

- Calculate usual individual dietary intake of the selected nutrient based on the two dietary recalls using SIDE.[2,3]
- Add the average intake of the selected nutrient from supplements.
- Calculate the percentage of the population with total intake of the selected nutrient below a given threshold, such as the EAR.

SIDE produces a usual intake distribution based on back-transformed Blom scores that represent a perfect theoretical normal distribution (Method 1), and the empirical distribution based on individual shrunken means (Method 2). Even if applied only to food sources, these estimates will differ. Method 2 may be more robust to the assumption of perfect normality of the usual intake distribution, but at the cost of being more variable than Method 1, especially in the tails of the distribution.

Estimates of vitamin/mineral supplement consumption represent the long-run average, or usual average intake. It is used as is in Method 2. For Method 1, within-individual variation is assumed to be null, and therefore,

Table 1
Percentage distribution of frequency of use of vitamin/mineral supplements in past month, household population aged 1 or older who used supplement, Canada excluding territories, 2004

	Days consumed in past month			
Supplement	30 or 31	20 to 29	10 to 19	1 to 9
		%		
Vitamin C	80.7	2.3	7.7	9.3
Vitamin D	83.9	2.2	7.0	6.9
Calcium	84.8	2.2	6.7	6.3
Thiamin	82.2	2.5	7.8	7.5
Riboflavin	82.4	2.5	7.7	7.5
Vitamin B6	82.2	2.5	7.7	7.5
Vitamin B12	82.0	2.4	7.7	7.8
Folic acid	82.5	2.5	7.7	7.3
Magnesium	85.9	2.0	6.4	5.7
Zinc	85.7	2.1	6.4	5.8
Phosphore	82.5	2.5	7.5	7.5
Potassium	85.8	2.3	6.3	5.6

Source: Canadian Community Health Survey - Nutrition, detailed vitamins and minerals file, 2004.

for respondents who reported taking supplements in the past month, each recall is assumed to have the same average supplement consumption on both days. Because more than 80% of people who took common supplements did so daily (Table 1), that assumption is reasonable. In fact, a simulation of daily intake based on the actual frequency of supplement consumption reveals only minor differences from results for Method 1 (data not shown).

The data were weighted to represent the Canadian population. The bootstrap method[16-18] was used to calculate standard errors and confidence intervals. The statistical significance level was set at 0.05.

Interpretation problems with Methods 1 and 2

Each method of combining intake of a selected nutrient from food/beverages and from supplements has expected minimum and maximum values for the estimate of the prevalence of inadequate intake.

Maximum value

The expected maximum value is based on the fact that adding supplements to the diet cannot change the percentage of the population with inadequate intake of the selected nutrient from *food alone.*

The maximum can be estimated with Method 1 or Method 2, although it is reasonable to use the same method to calculate the maximum and total usual intake. In addition, a single distribution for supplement users and non-users or separate distributions can be assumed. Methods 1 and 2, however, are based on a single distribution.

Minimum value

The expected minimum value of the prevalence of inadequate intake of a selected nutrient is based on the fact that adding supplements to total intake cannot change the percentage of *supplement non-users* whose intake of that nutrient is inadequate.

The minimum value of inadequate intake can be estimated with Methods 1 or 2, but it relies only on the the distribution of supplement non-users. The estimate of the minimum value of inadequate intake is based on the assumption that no one who takes the supplement has inadequate intake of that nutrient (that is, everyone who takes it has adequate intake).

Vitamin C

Vitamin C is the supplement most commonly taken by Canadians, either alone or as an ingredient of other supplements (data not shown). Depending on their age and sex, the percentage of Canadians who take vitamin C supplements ranges from about 20% to more than 40% (Table 2).

However, substantial shares of the population have relatively low total intake of vitamin C. For example, based on Method 1, an estimated 13.2% of men aged 19 to 30 had intake below the the estimated average requirement (EAR) (single distribution, data not shown). Logically, adding supplements to total intake should not increase the percentage of this group below the EAR. Assuming separate distributions for supplement users and non-users yields a maximum of 13.1% with inadequate vitamin C intake (Table 3). Among supplement non-users (74.9% of the men in this age group), 13.3% had inadequate vitamin C intake. The minimum value of the estimate of the percentage with inadequate intake is then set at 9.9%.

Table 2
Prevalence of use of supplements containing vitamin C, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

Age group	Both sexes	Male	Female
	%		
1 to 3	36.2	...	...
4 to 8	43.7	...	...
9 to 13	...	31.9	30.4
14 to 18	...	20.9	24.2
19 to 30	...	25.1	29.2
31 to 50	...	24.7	34.7
51 to 70	...	31.9	37.4
71 or older	...	31.6	38.1

... not applicable
Source: Canadian Community Health Survey - Nutrition, 2004.

If Method 2 is used to set the limits for the prevalence of inadequate vitamin C intake, the maximum values are 14.2% assuming a single distribution (data not shown) and 13.8% assuming separate distributions; the minimum value is 10.8% (Table 3). Although there are few differences between the minimum and maximum values using a single or separate distributions, an advantage of separate distributions is that the maximum will always exceed the minimum.

For analytical purposes, it is useful to determine if the 95% confidence interval for the estimate of the percentage of the population with inadequate intake falls outside the range defined by the expected minimum and maximum values. But even point estimates falling outside this range can create interpretation difficulties. Since the expected minimum and maximum values are also estimates, they have standard errors and confidence intervals. For the purpose of comparison, they will be treated as point estimates.

When Method 1 is used to combine intake from food/beverages and supplements, the 95% confidence intervals of the estimates of the prevalence of inadequate vitamin C intake among teenagers (14 to 18) and young adult women (19 to 30) are outside the expected minimum-maximum value range, clearly presenting an interpretation problem (Table 3). Three other point estimates fall outside the range, although their confidence intervals overlap it. While these last estimates may not be statistically different, questions about their interpretation still arise.

When Method 2 is used to combine vitamin C from food/beverages and supplements, none of the 95% confidence intervals for the prevalence of inadequacy is outside the expected minimum-maximum value range, but seven of the 10 publishable point estimates fall below this range, again raising questions of interpretation.

The distribution of usual intake in the total population is based on average intake and between-individual variation. Total variance for daily

Table 3
Prevalence of vitamin C intake below estimated average requirement (EAR) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	2.5[E]	1.5	3.6
Females	F	F	3.3[E]	1.9	4.7
14 to 18					
Males	6.0[E]	7.1[E]	11.2[†]	8.6	13.8
Females	4.8[E]	5.6[E]	9.5[†]	7.2	11.7
19 to 30					
Men	9.9[E]	13.1[E]	14.7[‡]	11.0	18.4
Women	10.4[E]	10.7[E]	16.3[†]	13.0	19.6
31 to 50					
Men	18.5	23.5	22.6	19.3	25.9
Women	12.8	19.7	16.0	13.4	18.5
51 to 70					
Men	18.5	24.8	20.5	17.8	23.2
Women	11.4	14.5	16.0[‡]	13.6	18.3
71 or older					
Men	25.8	32.7	24.6[‡]	20.7	28.5
Women	15.2	20.4	18.3	15.8	20.7
Method 2 (shrink, add)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	F	...	...
Females	F	F	0.9[E]*	0.0	1.8
14 to 18					
Males	8.5[E]	10.0[E]	6.9[E†*]	4.2	9.6
Females	4.6[E]	5.4[E]	4.5[E†*]	2.0	7.0
19 to 30					
Men	10.8[E]	13.8[E]	11.4[E]	6.0	16.7
Women	10.5[E]	10.6[E]	8.5[†*]	4.2	12.8
31 to 50					
Men	18.8	23.8	19.1	14.1	24.1
Women	13.4	20.3	14.7	11.3	18.1
51 to 70					
Men	18.5	25.4	17.9[†]	14.5	21.2
Women	11.6	14.5	10.1[†*]	7.5	12.7
71 or older					
Men	25.1	33.1	23.8[†]	19.3	28.4
Women	15.1	20.2	13.2[†*]	10.2	16.2

† confidence interval outside minimum-maximum value interval
‡ point estimate outside minimum-maximum value interval
* significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
... not applicable
Notes: Minimum and maximum values estimated with Method 1 using separate distributions and are combined with (1-α)*percent below EAR from non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. For those not taking supplements, maximum value represents highest possible percentage below EAR. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

intake includes between- and within-individual variation. SIDE removes within-individual variation by shrinking the daily intake distribution by the ratio of within-individual variation over the total variation ratio. When supplements are added to intake using Method 1, the skew of average intake shifts to the right; that is, the percentage of the population with relatively high levels of intake increases. Within-individual variation does not change, since the same intake from supplements is added to each recall for supplement users. However, the total variance changes because the average intake of some individuals changes. Consequently, the ratio will change (Table 4). With a smaller shrinkage factor, using the EAR cut-point method, the area beneath the curve can increase even if average intake increases. This explains the estimates above the maximum produced by Method 1. Even small changes in within-individual variation combined with different daily intake averages and normality transformations can lead to interpretation problems, as seen with Method 2.

Dividing the data

In light of the potential for interpretation problems, it is necessary to combine nutrient intake from food/beverages and from supplements in such a way that estimates of the prevalence of inadequacy fall within the expected minimum-maximum range. Methods 1 and 2 could be extended by using separate distributions.

Method 3 (divide, add, shrink):

- Divide the population according to whether they obtain the selected nutrient from supplements.
- Using SIDE and the EAR cut-point method, estimate the percentage of supplement *non-users* whose intake of the selected nutrient from food/beverages is below a given threshold.
- Using Method 1, estimate the percentage of supplement *users* whose intake of the nutrient from both food/beverages and

Table 4
Ratio of within-individual variance over total variance for vitamin C intake, by age group, sex and use of supplements, household population aged 1 or older, Canada excluding territories, 2004

	Vitamin C intake from food/beverages only						Vitamin C intake from food/beverages and supplements			
	One distribution		Supplement non-users		Supplement users		Total population (Method 1)		Supplement users	
Age group/ Sex	Ratio	Standard error	Ratio	Standard error	Ratio	Standard error	Ratio	Standard error	Ratio	Standard error
1 to 3 (both sexes)	0.53	0.03	0.53	0.04	0.52	0.06	0.42†	0.03	0.34†	0.05
4 to 8 (both sexes)	0.69	0.05	0.81*	0.05	0.57	0.07	0.54†	0.03	0.41†	0.05
9 to 13										
Males	0.68	0.03	0.69	0.04	0.66	0.06	0.48†	0.03	0.27†	0.04
Females	0.72	0.03	0.71	0.04	0.72	0.06	0.49†	0.03	0.30†	0.05
14 to 18										
Males	0.66	0.03	0.67	0.03	0.64	0.07	0.45†	0.02	0.20†	0.03
Females	0.67	0.03	0.69	0.04	0.67	0.07	0.44†	0.03	0.19†	0.03
19 to 30										
Men	0.72	0.04	0.75	0.04	0.65	0.09	0.49†	0.03	0.17†	0.04
Women	0.72*	0.04	0.65*	0.04	0.88	0.07	0.37†	0.02	0.27†	0.03
31 to 50										
Men	0.61	0.04	0.64	0.05	0.55	0.08	0.36†	0.03	0.15†	0.04
Women	0.53	0.03	0.56	0.04	0.49	0.05	0.29†	0.02	0.14†	0.03
51 to 70										
Men	0.58	0.03	0.60	0.03	0.55	0.07	0.31†	0.02	0.11†	0.03
Women	0.61	0.03	0.59	0.03	0.67	0.05	0.25†	0.02	0.15†	0.02
71 or older										
Men	0.51	0.03	0.54	0.04	0.49	0.07	0.27†	0.02	0.09†	0.03
Women	0.53	0.02	0.52	0.03	0.54	0.04	0.19†	0.01	0.12†	0.02

* significantly different from estimate for supplement users
† significantly different from estimate for food/beverages only population in same age/sex group
Source: Canadian Community Health Survey - Nutrition 2004.

supplements is below a given threshold.

- Calculate the combined overall estimate of inadequate intake of the nutrient (based on the percentages for supplement users and non-users) with the following formula:

$$P[X_T < EAR] = (1-\alpha)P[X_{SNU} < EAR] + \alpha P[X_{SU} < EAR]$$

where X_T represents total nutrient intake; X_{SNU}, supplement non-users' nutrient intake from food/beverages; X_{SU}, supplement users' total nutrient intake; and α, the percentage of supplement users.

Method 4 (divide, shrink, add):

- Divide the population according to whether they obtain the selected nutrient from supplements.
- Using SIDE, calculate supplement *non-users'* usual individual intake of the nutrient from food/beverages.
- Calculate supplement *users'* usual intake of the nutrient from food/beverages; add their average intake from supplements.
- Add the results for the two populations and calculate the percentage of the total population whose total intake of the nutrient is below a given threshold, such as the EAR.

With Method 3, the 95% confidence intervals for the prevalence of inadequate vitamin C intake are not outside the expected minimum-maximum range for any of the 10 age/sex groups with publishable results (Table 5). And only for women aged 19 to 30 was the point estimate of the prevalence of inadequate vitamin C intake outside that range (0.08% above the maximum). Even with a much smaller shrinkage factor for supplement users (Table 5), average consumption of vitamin C including supplements results in fewer than 3% of the population below the EAR. Coupled with the probability of being a consumer, most of the combined estimates of inadequate vitamin C intake depend on the percentage of supplement non-users whose intake from food/beverages is inadequate.

With Method 4 (Table 5), by design, every estimate of the prevalence of inadequate vitamin C intake is equal to or within the minimum-maximum value range.

Comparing methods

Method 1 differs significantly from the other three, among which there is no statistically significant difference. However, compared with Method 3, Method 4 yields a more variable prevalence of inadequate vitamin C intake with wider 95% confidence intervals.

Published estimates of usual intake of vitamin C from food/beverages, as

Table 5
Prevalence of vitamin C intake below estimated average requirement (EAR) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	F	...	...
Females	F	F	F	...	...
14 to 18					
Males	6.0[E]	7.1[E]	6.2[E*]	3.4	9.1
Females	4.8[E]	5.6[E]	5.2[E*]	2.7	7.7
19 to 30					
Men	9.9[E]	13.1[E]	10.5[E]	5.0	16.0
Women	10.4[E]	10.7[E]	10.8[E†]	6.2	15.4
31 to 50					
Men	18.5	23.5	19.0	14.1	23.9
Women	12.8	19.7	13.3	9.7	16.8
51 to 70					
Men	18.5	24.8	18.8	15.1	22.6
Women	11.4	14.5	11.7*	8.5	14.8
71 or older					
Men	25.8	32.7	26.7	22.1	31.3
Women	15.2	20.4	15.4	12.0	18.7
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	F	...	...
Females	F	F	F	...	...
14 to 18					
Males	8.5[E]	10.0[E]	8.5[E]	3.6	13.4
Females	4.6[E]	5.4[E]	4.6[E*]	2.0	7.3
19 to 30					
Men	10.8[E]	13.8[E]	11.1[E]	4.7	17.4
Women	10.5[E]	10.6[E]	10.5[E*]	5.9	15.0
31 to 50					
Men	18.8	23.8	19.2	13.1	25.3
Women	13.4	20.3	13.6	9.8	17.4
51 to 70					
Men	18.5	25.4	18.7	15.1	22.2
Women	11.6	14.5	11.7*	8.7	14.7
71 or older					
Men	25.1	33.1	25.9	21.3	30.6
Women	15.1	20.2	15.1	11.3	19.0

† point estimate outside minimum-maximum value interval
* significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
... not applicable

Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and are combined with (1-α)*percent below EAR from non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. For those not taking supplements, maximum value represents highest possible percentage below EAR. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

in the *Compendium of Tables*,[4-6] use the EAR cut-point method to calculate the percentage of the population with inadequate intake based a single distribution, thereby assuming the same average intake and variance components for supplement users and non-users. Therefore, this estimate might be used for the maximum value. In such a case, without the differences being significant, one estimate using Method 3 and two estimates using Method 4 will be outside the expected minimum-maximum value range (data not shown).

Other nutrients

Interpretation problems are not limited to vitamin C. Appendix Tables B to G show estimates for vitamin D, calcium and dietary folate equivalents (including folic acid) based on the four methods of combining intake from food/beverages and from supplements. The vitamin D (Tables B and C) and calcium (Tables D and E) data present the percentages of each age/sex group below the adequate intake (AI) level. AI is used as a cut-off, but it does not represent the percentage of the population with inadequate intake. By contrast, the EAR is used for dietary folate equivalents (Tables F and G), so it is possible to discuss inadequate folate intake. (A 2009 study[19] demonstrated that folate concentrations in some food groups actually exceed what is in the database; the calculations presented here use an adjustment factor to estimate dietary folate equivalents intake.)

For calcium, no interpretation problems arise. The results obtained with the four methods are not significantly different, and all point estimates fall within the expected minimum-maximum range (Tables B and C).

For vitamin D, there are no statistically significant differences between the four Methods (Tables D and E). None of the confidence intervals falls completely outside the expected minimum-maximum value range, but some are below the minimum for Methods 1 and 2. These interpretation problems are solved with Methods 3 or 4.

For dietary folate equivalents, Method 1 results differ from the other three (Tables F and G). With Method 1, some confidence intervals for the estimate of the prevalence of inadequacy are completely outside the expected minimum-maximum value range. With Method 2, some point estimates fall outside that interval, but, the confidence intervals overlap the minimum-maximum value range. Methods 3 and 4 do not have interpretation problems.

Recommendations, limitations and conclusion

Combining nutrient intake from food/beverages with that from supplements is challenging. Problems can arise as early as the survey interview stage if some questions about supplement use were not understood by respondents. Although a review was carried out, it is possible that some answers resulted in high but plausible values for supplement use. Those high values may account for part of the large increase in between-person variation.

A second challenge lies in the attempt to combine *daily* intake from food/beverages with *usual* intake from supplements. However, because more than 80% of people who took supplements did so daily, the effect is likely minimal. For daily supplement intake, it would be preferable to estimate within-individual variation. But the interpretation problems resulting from a large decrease in the ratio of within-individual variation over total variation will persist. Addressing these collection-related limitations will not solve the interpretation problems.

This analysis demonstrates that estimates of inadequate intake of nutrients have minimum and maximum values, outside of which values logically should not fall. Confidence intervals for estimates of inadequate total intake that fall outside these expected minimum-maximum ranges are hard to interpret, and although there may be no statistical difference, even point estimates that fall outside these limits can create interpretation issues.

Conclusion

The use of Method 1 to combine nutrient intake from food/beverages with that from supplements is not recommended, because several confidence intervals for the estimates of the prevalence of inadequacy fall outside the expected minimum-maximum value range. While the 95% confidence intervals for Methods 2, 3 and 4 overlap the minimum-maximum values, Method 2 estimates can fall outside the interval. Methods 3 and 4, which are based on the original Methods 1 and 2, are easier to interpret.

This study focused on estimating the percentage of the population whose nutrient intake was below a certain threshold. These methods can also be used to calculate the percentiles of the distribution by combining the two distributions on a prorated basis (Method 3) or by appending the datasets and using empirical percentiles (Method 4). ■

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Annexe

Table A
Prevalence of use of calcium, vitamin D and dietary folate equivalents supplements in past month, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

Age group/ Sex	Calcium	Vitamin D	Dietary folate equi-valents
		%	
1 to 3 (both sexes)	20.7	34.9	30.7
4 to 8 (both sexes)	27.7	40.9	38.7
9 to 13			
Males	16.4	24.9	24.0
Females	15.0	23.1	22.2
14 to 18			
Males	13.5	14.6	13.8
Females	14.7	16.6	15.0
19 to 30			
Men	18.3	19.1	17.6
Women	23.5	22.2	22.9
31 to 50			
Men	19.6	18.7	19.3
Women	33.4	30.6	29.2
51 to 70			
Men	28.9	27.5	26.0
Women	49.4	45.0	31.2
71 or older			
Men	27.2	28.6	25.2
Women	46.0	43.0	28.5

Source: Canadian Community Health Survey - Nutrition 2004.

Table B
Prevalence of calcium intake below adequate intake (AI) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	2.5[E]	2.9[E]	2.7[E]	1.5	3.8
4 to 8 (both sexes)	15.3	22.9	19.1	15.6	22.7
9 to 13					
Males	53.8	63.2	60.5	55.1	65.9
Females	72.5	83.6	81.3	76.5	86.1
14 to 18					
Males	45.1	51.7	49.5	43.8	55.2
Females	71.1	83.8	81.1	77.1	85.1
19 to 30					
Men	41.2	47.3	44.6	37.8	51.4
Women	55.9	69.8	60.8	54.8	66.9
31 to 50					
Men	51.5	61.5	57.8	53.0	62.6
Women	48.9	72.6	58.6	54.2	63.0
51 to 70					
Men	61.5	86.2	78.1	74.7	81.5
Women	47.7	91.8	66.8	63.8	69.8
71 or older					
Men	66.1	89.9	79.9	74.3	85.5
Women	51.6	94.7	73.3	69.4	77.2
Method 2 (shrink, add)					
1 to 3 (both sexes)	F	2.7[E]	2.1[E]	0.9	3.3
4 to 8 (both sexes)	15.9	23.8	20.0	16.0	24.0
9 to 13					
Males	53.9	63.1	61.6	56.7	66.5
Females	72.9	83.8	82.4	77.9	86.9
14 to 18					
Males	46.5	53.2	51.2	46.3	56.1
Females	71.6	84.7	82.5	78.9	86.0
19 to 30					
Men	40.6	46.7	44.2	37.0	51.4
Women	57.4	71.1	63.6	58.1	69.1
31 to 50					
Men	52.3	63.2	58.9	54.1	63.6
Women	50.1	74.0	62.1	57.8	66.4
51 to 70					
Men	61.8	86.6	79.7	76.6	82.9
Women	47.8	91.4	67.7	64.5	71.0
71 or older					
Men	66.2	90.1	81.9	77.6	86.2
Women	51.7	94.7	75.3	71.9	78.7

[E] use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
Notes: Minimum and maximum values estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

Table C
Prevalence of calcium intake below adequate intake (AI) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	2.5[E]	2.9[E]	2.6[E]	1.5	3.8
4 to 8 (both sexes)	15.3	22.9	18.7	15.2	22.2
9 to 13					
Males	53.8	63.2	60.9	55.5	66.4
Females	72.5	83.6	81.9	77.1	86.8
14 to 18					
Males	45.1	51.7	49.9	44.0	55.8
Females	71.1	83.8	81.8	77.7	85.8
19 to 30					
Men	41.2	47.3	45.0	37.7	52.2
Women	55.9	69.8	61.7	55.7	67.6
31 to 50					
Men	51.5	61.5	57.5	52.6	62.4
Women	48.9	72.6	60.0	55.5	64.4
51 to 70					
Men	61.5	86.2	79.6	76.2	83.0
Women	47.7	91.8	68.1	65.1	71.1
71 or older					
Men	66.1	89.9	81.0	75.9	86.0
Women	51.6	94.7	74.6	71.3	77.9
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	F	2.7[E]	2.1[E]	0.7	3.5
4 to 8 (both sexes)	15.9	23.8	19.5	15.2	23.9
9 to 13					
Males	53.9	63.1	61.5	56.6	66.5
Females	72.9	83.8	82.9	78.4	87.4
14 to 18					
Males	46.5	53.2	51.6	46.4	56.7
Females	71.6	84.7	82.8	79.2	86.4
19 to 30					
Men	40.6	46.7	43.8	36.0	51.6
Women	57.4	71.1	63.9	58.5	69.4
31 to 50					
Men	52.3	63.2	58.9	53.7	64.1
Women	50.1	74.0	61.9	57.8	66.1
51 to 70					
Men	61.8	86.6	80.0	76.6	83.3
Women	47.8	91.4	68.3	65.2	71.4
71 or older					
Men	66.2	90.1	81.6	77.1	86.2
Women	51.7	94.7	74.7	70.7	78.7

[E] use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

Table D
Prevalence of vitamin D intake below adequate intake (AI) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	22.8	31.9	21.4†	18.5	24.3
4 to 8 (both sexes)	20.0	39.0	20.8	18.3	23.3
9 to 13					
Males	20.2	26.5	20.7	17.1	24.4
Females	38.7	47.4	35.3†	30.8	39.7
14 to 18					
Males	21.6	24.1	21.7	18.1	25.4
Females	48.5	57.9	45.8†	41.6	50.1
19 to 30					
Men	40.1	47.4	36.4†	30.3	42.5
Women	51.7	64.8	47.0†	41.8	52.2
31 to 50					
Men	39.8	47.9	38.5†	33.7	43.3
Women	41.2	58.8	38.3†	33.8	42.7
51 to 70					
Men	60.8	80.0	63.7	59.2	68.3
Women	50.1	91.3	59.9	56.1	63.6
71 or older					
Men	69.0	96.3	80.1	75.1	85.2
Women	54.4	97.1	73.6	67.6	79.5
Method 2 (shrink, add)					
1 to 3 (both sexes)	22.5	32.2	22.2†	18.8	25.6
4 to 8 (both sexes)	20.8	40.6	23.2	20.4	26.1
9 to 13					
Males	21.4	28.0	21.8	17.3	26.3
Females	38.3	47.6	38.1†	33.1	43.1
14 to 18					
Males	22.9	25.5	22.8†	18.2	27.4
Females	48.8	58.1	50.8	45.9	55.7
19 to 30					
Men	38.7	45.9	39.0	32.9	45.1
Women	52.2	65.6	52.7	47.4	57.9
31 to 50					
Men	41.2	49.4	41.3	35.4	47.1
Women	42.5	60.3	43.0	36.7	49.3
51 to 70					
Men	60.6	79.9	62.4	56.9	67.9
Women	50.3	91.4	58.5	54.4	62.7
71 or older					
Men	69.6	96.9	80.6	76.8	84.5
Women	55.3	98.2	74.6	68.9	80.3

† point estimate outside minimum and maximum value interval

Notes: Minimum and maximum values estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

Table E
Prevalence of vitamin D intake below adequate intake (AI) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	22.8	31.9	23.1	19.5	26.6
4 to 8 (both sexes)	20.0	39.0	20.4	16.9	23.9
9 to 13					
Males	20.2	26.5	20.3	15.5	25.1
Females	38.7	47.4	39.1	33.3	45.0
14 to 18					
Males	21.6	24.1	21.9	17.4	26.3
Females	48.5	57.9	49.6	44.5	54.7
19 to 30					
Men	40.1	47.4	40.4	33.7	47.0
Women	51.7	64.8	52.6	46.6	58.5
31 to 50					
Men	39.8	47.9	40.2	33.8	46.5
Women	41.2	58.8	42.3	34.8	49.8
51 to 70					
Men	60.8	80.0	64.9	60.1	69.7
Women	50.1	91.3	57.6	53.1	62.2
71 or older					
Men	69.0	96.3	80.1	75.7	84.4
Women	54.4	97.1	75.9	72.1	79.8
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	22.5	32.2	22.9	19.4	26.4
4 to 8 (both sexes)	20.8	40.6	21.7	18.3	25.2
9 to 13					
Males	21.4	28.0	21.8	16.5	27.1
Females	38.3	47.6	38.9	33.5	44.2
14 to 18					
Males	22.9	25.5	23.2	18.3	28.1
Females	48.8	58.1	50.1	45.3	54.9
19 to 30					
Men	38.7	45.9	39.4	33.4	45.3
Women	52.2	65.6	53.0	47.6	58.4
31 to 50					
Men	41.2	49.4	42.1	35.6	48.5
Women	42.5	60.3	44.0	35.8	52.2
51 to 70					
Men	60.6	79.9	64.0	58.8	69.3
Women	50.3	91.4	58.1	53.5	62.7
71 or older					
Men	69.6	96.9	80.4	76.5	84.2
Women	55.3	98.2	77.0	73.3	80.7

Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

Table F
Prevalence of dietary folate equivalents intake below estimated average requirement (EAR) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	2.7[E]	2.7[E]	3.1[E†]	1.7	4.6
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	<3	<3	2.9[E†]	1.5	4.3
14 to 18					
Males	<3	<3	4.1[E*]	2.6	5.7
Females	11.4	13.1	14.4[†]	11.6	17.2
19 to 30					
Men	<3	<3	3.6[E*]	2.1	5.1
Women	8.7[E]	9.5[E]	15.2[*]	12.1	18.3
31 to 50					
Men	F	F	7.9[*]	6.0	9.9
Women	8.3[E]	15.1[E]	14.6	12.0	17.3
51 to 70					
Men	5.9[E]	7.2[E]	11.1[*]	8.7	13.4
Women	10.9[E]	17.8	18.4[†]	15.9	20.8
71 or older					
Men	13.1[E]	14.5[E]	15.9[†]	11.9	19.9
Women	24.4	31.5	23.8[†]	20.9	26.8
Method 2 (shrink, add)					
1 to 3 (both sexes)	F	F	2.0[E†]	0.8	3.1
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	F	F	<3	...	...
14 to 18					
Males	<3	F	F	...	...
Females	11.7	13.6	11.3[†]	7.9	14.7
19 to 30					
Men	<3	<3	<3		
Women	8.3[E]	9.0[E]	8.0[†‡]	3.5	12.4
31 to 50					
Men	F	F	F	...	...
Women	8.4[E]	15.4[E]	10.0[E]	5.9	14.0
51 to 70					
Men	6.3[E]	7.5[E]	6.5[E‡]	3.5	9.6
Women	10.8[E]	17.9	13.5[‡]	9.9	17.2
71 or older					
Men	13.8[E]	15.3[E]	11.2[E†]	6.0	16.5
Women	24.4	31.5	24.6	20.0	29.1

* confidence interval outside minimum and maximum value interval
† point estimate outside minimum and maximum value interval
‡ significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6 to 33.3%)
<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
F too unreliable to be published
... not applicable

Notes: Minimum and maximum values estimated with Method 1 using separate distributions and combined with (1-α)*percent below EAR from supplement non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

Table G
Prevalence of dietary folate equivalents intake below estimated average requirement (EAR) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	2.7[E]	2.7[E]	2.7[E]	1.1	4.3
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	<3	<3	<3	...	...
14 to 18					
Males	<3	<3	<3	...	...
Females	11.4	13.1	11.5	7.9	15.1
19 to 30					
Men	<3	<3	<3	...	...
Women	8.7[E]	9.5[E]	8.8[E†]	4.2	13.4
31 to 50					
Men	F	F	F	...	...
Women	8.3[E]	15.1[E]	8.4[E†]	4.2	12.7
51 to 70					
Men	5.9[E]	7.2[E]	5.9[E†]	2.8	9.1
Women	10.9[E]	17.8	11.2[E†]	6.8	15.7
71 or older					
Men	13.1[E]	14.5[E]	13.3[E]	7.0	19.6
Women	24.4	31.5	24.5	18.5	30.5
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	F	F	F	...	...
14 to 18					
Males	<3	F	<3	...	...
Females	11.7	13.6	11.7	8.2	15.2
19 to 30					
Men	<3	<3	<3	...	...
Women	8.3[E]	9.0[E]	8.3[E†]	3.5	13.1
31 to 50					
Men	F	F	F	...	...
Women	8.4[E]	15.4[E]	8.4[E†]	4.4	12.5
51 to 70					
Men	6.3[E]	7.5[E]	6.3[E†]	2.9	9.7
Women	10.8[E]	17.9	11.1[E†]	6.4	15.8
71 or older					
Men	13.8[E]	15.3[E]	13.9[E]	6.7	21.2
Women	24.4	31.5	24.5	19.2	29.9

† significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6 to 33.3%)
<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
F too unreliable to be published
... not applicable

Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and combined with (1-α)*percent below EAR from supplement non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.