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Within-person variance for adjusting nutrient distribution in epidemiological studies

ABSTRACT

The objective of the study was to present the within-person variance component for adjusting nutrient distribution in adults and elderly people. The data used were from a population-based survey with a representative sample (n = 511) of individuals aged 19 years and over in the municipality of São Paulo, Southeastern Brazil, conducted in 2007. The within-person variance component was obtained using the Iowa State University method. Differences in within-person variance components were observed for some nutrients according to gender. These values should be used to adjust nutrient intake distributions, because lack of adjustment may result in biased data analysis and interpretation.

DESCRIPTORS: Data Interpretation, Statistical. Nutrition Surveys. Nutrition Assessment. Within-person variance.

INTRODUCTION

Diet variability is the principal characteristic of food intake among individuals and populations. Even if individuals have a stable dietary pattern, daily food intake may be characterized as a random event. Day-to-day activities, the day of the week and seasonality, among other factors, contribute towards daily dietary variability, and these may gain additional weight through sociocultural, economic and ecological factors. These fluctuations can be partially removed during data analysis, provided that the within-person variance is known.[3]

Day-to-day variability in nutrient intake can be removed using statistical methods, such that the distribution will only reflect the variation between individuals in the group. The distribution of the adjusted usual intake is more reliable and has less variance than seen in the estimated distribution for a single day of dietary intake. Among the methodologies for adjusting the distribution of nutrient intake, the one put forward by Iowa State University (ISU) seems to be the most advantageous among the methods so far published, given that it estimates the distribution of the habitual nutrient intake and the component of within-person variance of the intake, which are essential data for correcting the intake in groups for which only one day of dietary intake per individual is available.[2]

The precision of evaluations on dietary intake in population-based groups depends on good estimates of the usual nutrient intake. Short-term measurements such as 24-hour recalls or food records depict within-person variance provided that they are obtained on at least two days. It thus becomes advisable to gather data on several days of dietary intake, although this is an expensive and laborious procedure. For this reason, in studies using a single day of dietary intake, it is recommended that external variance should be used to adjust the habitual nutrient intake.[4]

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Within-person variance data for adjusting nutrient distribution are available for the United States population. Thus, the aim of this study was to present the within-person variance component for a Brazilian population, for nutrient distribution adjustment among adults and elderly people.

METHODS

This study used data on 511 individuals of both sexes aged 19 years and over, in the city of São Paulo, Southeastern Brazil, in 2007. The data originated from a population-based cross-sectional study named the "São Paulo Health Survey", which was conducted in 2003 (ISA-2003). Details of the sampling were described previously.[1]

A household dietary survey using 24-hour recalls (24HR) and the automated multiple pass method (AMPM)[5] was carried out. The AMPM consisted of a five-stage guided interview to improve the precision of the information obtained from the 24HR. The stages consisted of: quick list of foods, forgotten food list, time and occasion, detail cycle and final review probe. The interviewers received prior training, with the use of a standard form for applying the 24HR and an explanatory manual for filling it in. To calculate the within-person variability of intake, the individuals gave responses for another three 24HR by telephone, with intervals of approximately two months between the recalls. The second, third and fourth 24HR were obtained from 101, 85 and 45 individuals, respectively. The data gathering at the households and by telephone was carried out such that all days of the week and months of the year were included, distributed randomly among the individuals in the sample. Before entering the data into specific software, the quality of the information gathered was checked and standardized quantification of the foods and drinks was performed. The data from the 24HR were converted into energy and nutrients by means of the Nutrition Data System for Research (NDSR) software, 2007 version (Nutrition Coordinating Center, University of Minnesota, Minneapolis, USA), for which the main database is the table produced by the United States Department of Agriculture. The nutritive values of Brazilian foods that were not included in the NDSR software were inserted in accordance with Brazilian information.

The values for between-person variance (estimates for variance of the usual intake) and within-person variance (estimates for variance of the measurement error) and the kurtosis of the distribution of the measurement error (fourth moment of within-person error) of each nutrient was obtained from the estimates of the distribution of the usual nutrient intake, by means of the method put forward by ISU,[2] using the Software for Intake Distribution Estimation (PC-SIDE version 1.0, 2003; Department of Statistics, Iowa State University, Ames, Iowa, USA). A model was proposed for each nutrient, with inclusion of weighting variables (primary sampling unit, stratum and sample weight). The jackknife method was chosen as the replication technique for estimating the standard error for moments and percentages in complex samples. The standardized parameters of the ISU method, within PC-SIDE, were used for the estimates of usual nutrient intake distributions. The data were stratified according to sex.

From the estimates of between-person and within-person variance obtained through PC-SIDE, it was possible to calculate the within-person variance component given by the ratio of within-person variance in relation to total variance (sum of within-person and between-person variance). The result was the component of the variance that was attributable to the within-person effect, i.e. the percentage corresponding to each type of variance in relation to the total.

The project was approved by the Research Ethics Committee of the School of Public Health, University of São Paulo (CAAE procedural no. 0003.0.207.000-08).

RESULTS

The sample was composed mainly of women (60.0%; 95%CI: 54.0;65.7); the main age range was from 30 to 50 years (41.6%; 95%CI: 35.8;47.6); and the main schooling level for the head of the family was between eight and eleven years (35.6%; 95%CI: 29.8;41.9).

The components of the variance were estimated from data that had previously been normalized, and the ratios corresponded to the proportion of within-person variance in relation to the between-person variance in nutrient intake. For example, 78% of the total variability in the daily intake of vitamin A among men could be attributed to within-person variance and 22% to between-person variance.

There were differences in the values of the within-person variance in nutrients according to sex. For 12 nutrients, the variability was greater among men, with differences of 0.01 to 0.18 in relation to the values among women. Another 22 nutrients presented greater variability among women than among men, with differences of 0.01 to 0.45 (Table). These results show the importance of using gender-specific within-person variance data.

For example, using the within-person variance component for adjustments, the prevalence of inadequate phosphorus levels in men aged 19 years and over was 16.8% (95% CI: 11.3;22.4) without adjustment and 4.9% (95% CI: 1.0;8.8) with adjustment.

Table. Ratio of the total variability attributable to the within-person effect and fourth moment of within-person error, according to sex. São Paulo, SP, 2007.

Nutrient	Males		Females	
	Within-person variance component	Fourth moment	Within-person variance component	Fourth moment
Vitamin A (mcg)[a]	0.76	4.96	0.68	3.90
Vitamin C (mg)	0.85	2.56	0.88	3.01
Vitamin E (mg)[b]	0.72	2.85	0.98	3.08
Thiamin (mg)	0.93	2.69	0.79	3.99
Riboflavin (mg)	0.75	2.49	0.74	2.81
Niacin (mg)[c]	0.87	3.36	0.94	3.19
Vitamin B6 (mg)	0.72	3.09	0.94	3.64
Folate (mcg)[d]	0.71	4.20	0.64	3.47
Vitamin B12 (mcg)	0.77	2.71	1.00	2.86
Copper (mg)	0.75	3.60	0.92	3.03
Iron (mg)	1.00	2.19	0.98	2.96
Magnesium (mg)	0.67	2.80	0.95	4.05
Phosphorus (mg)	0.80	2.83	0.82	3.07
Selenium (mcg)	0.96	2.97	1.00	3.05
Zinc (mg)	0.73	2.41	1.00	2.79
Vitamin D (mcg)	1.00	2.17	0.86	4.09
Vitamin K (mcg)	1.00	2.21	1.00	3.36
Pantothenic acid (mg)	0.93	2.48	0.85	3.40
Calcium (mg)	0.72	2.62	0.67	3.21
Manganese (mg)	0.81	2.78	0.84	3.21
Potassium (mg)	0.72	2.36	0.86	3.79
Sodium (mg)	0.77	2.43	0.88	3.17
Carbohydrate (g)	0.49	2.80	0.77	3.37
Protein (g)	0.91	2.94	1.00	3.07
Total fat (g)	0.86	2.37	1.00	2.79
Saturated fat (g)	0.88	2.58	1.00	2.43
Monounsaturated fat (g)	0.99	2.77	1.00	2.92
Polyunsaturated fat (g)	1.00	2.47	1.00	2.72
Cholesterol (mg)	0.77	2.65	1.00	2.81
Total fiber (g)	0.90	3.24	0.72	3.85
Soluble fiber (g)	0.89	2.96	0.85	3.38
Insoluble fiber (g)	0.87	2.99	0.74	3.98
Retinol (mcg)	0.93	2.65	0.79	2.87
Linoleic acid (g)	0.87	2.73	1.00	2.87
Linolenic acid (g)	1.00	3.28	1.00	2.46
Trans fat (g)	0.55	3.03	1.00	3.47
Energy (kcal)	0.53	2.39	0.81	3.37

[a] Equivalent to the activity of retinol, taking into consideration new conversion factors for carotenoids; [b] total α-tocopherol; [c] niacin equivalent, corresponding to the sum of preformed niacin and the quantity converted from tryptophan; [d] dietary folate equivalent, corresponding to the sum of dietary folate and synthetic folic acid and taking into account the greater bioavailability of the latter..

DISCUSSION

This work breaks new ground in that until now, there have not been any published papers on the variability of nutrient intake among the Brazilian population using the ISU methodology. The values for the within-person variance component in this study came from a population-based health survey in the municipality of São Paulo. This makes it possible to use this variance as a correction factor for the distribution of nutrient intake in epidemiological studies for evaluating dietary intake based on only one day of intake. In addition to the values for the within-person variance component, the values for the fourth moment of measurement error are presented. This item is needed as a parameter for adjusting the distribution of the nutrient intake.

In some cases, it was not possible to calculate the within-person variance component (values of 1.0), since the estimate for between-person variance was close to zero due to great dispersion of the within-person variance in intake of these nutrients. This was probably due to the small number of individuals in the third and fourth repetitions of the 24HR. Greater numbers of repetitions of the 24HR could have resolved this question, considering that values of 1.0 for the within-person variance component are ineffective for correcting the distribution of the nutrient intake.

The values of the within-person variance component for each nutrient were compared with the American data from the National Health and Nutrition Examination Survey of 2001 to 2002.[a] The values from the present study differed from those of the American study, by percentages ranging from 0 to 89% for men and 0% to 85% for women. All the values were greater than the American values, except for carbohydrates and zinc among males and folate among females. These results suggest that there are limitations to the use of the American data for correcting the dietary intake data of other populations and reinforce the importance of estimates of within-person variance in Brazil. Jahns et al[4] observed differences in the values for within-person variance in nutrient intake between Russians and Americans, but concluded that nutrient intake data should be adjusted using external variability when it was not possible to gather several days of dietary intake data. It is difficult to compare estimates of variance between different populations, and one alternative for this would be to use external variance and comparison between the prevalences of inadequacy thus obtained.

One of the limitations to the present study was the small number of individuals with three or four repetitions of the dietary measurement. This could have been one of the reasons for the large dispersion of the intake of some nutrients and consequent impossibility of estimating the within-person variance component for these nutrients. In addition, stratification according to demographic characteristics such as age group and sex created subgroups with small numbers of individuals with repetitions of the dietary measurement, thus impeding calculation of the within-person variance component.

We conclude that the results from the present study can and should be used in similar samples for adjusting nutrient intake distributions, since lack of adjustment may result in biased data analysis and interpretation.

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