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Measuring the intakes of foods and nutrients of marginal populations in north-west Mexico

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Abstract

Objective: To describe methodological issues regarding the measurement of food intake of marginal populations in the north-west of Mexico.

Methods: Dietary data from three sources were analysed. The Sonora State Food Basket Study (505 individuals from all ages, both sexes, high, medium and low income, and from urban and rural settings), 144 individuals from rural Indian communities, and 152 low-income urban women. Methods of dietary data collection were single 24-hour recalls for the first two studies, and four non-consecutive 24-hour recalls as well as a food-frequency questionnaire (FFQ) for low-income urban women.

Results: The food patterns in the three studies showed similar core foods; however, food diversity resulted in 19, 13 and 57 different foods reported by 90% of the population in the state, Indian communities and urban women, respectively. Mean intakes of selected food components in the sample of urban women vs. a representative sample of the population of the state were similar, although smaller variation in consumption was observed in urban women with repeated 24-hour recalls. Inter-individual variation in intake of food components was similar in the state and urban women samples, but the Indian communities showed lower coefficients of variation (CVs). Use of four 24-hour recalls decreased the inter-individual variation in food component intakes of low-income urban women, especially for vitamin intakes. The FFQ did not show an additional decrease in inter-individual variation for macronutrients, but reduced even more the CVs for vitamins. Intra-individual variation was higher than inter-individual variation for urban women's intakes when estimated by repeated 24-hour recalls. This effect was reversed when estimated by duplicate food frequencies. Ratios of intra-individual to inter-individual variation in food intake were lower for Mexican when compared with US women. These results should be considered, especially for association analysis of low-income women's diets and health outcomes.

Keywords
Diet
Marginal population
Dietary methodology

As in many of the studies before the 1990s, food intake in the population of north-west Mexico has traditionally been measured using a single 24-hour recall. The main reasons for this are the limited resources for community nutritional diagnostics to allow for repeated measures of the diet of individuals, as well as the logistics of the fieldwork. Since the purpose of the dietary diagnostics was mainly the description of food patterns or the determination of mean intakes, the error of estimation of the variance and the usefulness of individual intakes in studies of association were of little concern.

In the last decade, however, concern about the prevalence of chronic diseases[1,2] and the importance of diet–disease relationships have aroused researchers' awareness of the importance of error measurement and the problems of representativeness when a single 24-hour recall is the method of choice.

Development and validation of methods like the food-frequency questionnaire (FFQ) have been made at national and regional levels[3,4]; however, culturally adapted questionnaires are rare. As a consequence, single and low-cost interviews like the 24-hour recall must remain in use.

What we need, as Beaton and others[5,6] have discussed, is knowledge of the magnitude of error associated with the measurement of food intake using the available methods, in order to correct our intended association analysis.

The aim of this study is to describe methodological issues regarding measurement of the food intake of marginal populations in the north-west of Mexico. In this context, we describe the inter-individual and intra-individual variation in the estimation of food intake in the population of north-west Mexico, as well as the pattern of food intake by season.

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Methods

We used the information available from food intake studies in the population of the state of Sonora, located in the north-west of Mexico. Several authors[7,8] and national studies, using economic activities and health indicators, have defined this part of the country as a region with low levels of poverty (as compared with the southern region of the country), as well as low levels of stunting[9]. High mortality and morbidity rates in adults are related to chronic diseases such as cardiovascular problems and type 2 diabetes[1,7].

This study analysed dietary information from three studies. The Sonora State Food Basket Study[10] (late 1980s) included 505 individuals from all ages, both sexes, high, medium and low income, and from urban and rural settings. We also used dietary data from 152 low-income urban women from a study of dietary risk factors of women in the north-west of Mexico[4]. Finally we included dietary data from rural Indian communities[11] collected as part of a study on the aetiology of type 2 diabetes.

The dietary data collection method used in the three studies was the 24-hour recall. Single 24-hour recalls were used in the state food basket study and the Indian community study. Regarding the study on dietary risk factors of women, the data collection involved four non-consecutive 24-hour recalls distributed along the four seasons of the year, as well as an FFQ designed and validated for that group of women.

For 24-hour data collection, food models and pictures were used, as well as home measures of containers. Analysis of dietary components relied upon data in a food dictionary compiled at Centro de Investigación en Alimentación y Desarrollo[12] (CIAD) from several food composition tables, such as those of the US Department of Agriculture[13], the National Nutrition Institute in Mexico[14], and the food composition tables developed at CIAD for regional foods.

The analysis included descriptive statistics (mean, standard deviation (SD), coefficient of variation (CV)) and analysis of variance, and was performed using SPSS 7.0 software.

Results and discussion

The data on food patterns from the Sonora State Food Basket Study reveal that the food intake of the majority of the Sonoran population seems to be quite simple, when compared with the food intake of those populations in developed countries. In fact, 50% of the population have a food pattern composed mainly of beans, corn or wheat tortilla, eggs, meat (mostly chicken, sausages, bologna and small amounts of beef), milk, sugar, tomatoes and potatoes. It is noteworthy that fruits and vegetables are consumed infrequently and in small quantities.

The rural Indian community is one of the lowest-income populations in the state of Sonora. The food pattern of 90% of 144 adult Indians reveals a very simple pattern of consumption. Thirteen foods were consumed by 90% of the sample and they are mainly the staple foods common to the Sonora population, including beans, corn and wheat tortilla, eggs, milk, coffee, sugar and potatoes.

The food patterns for the whole population of Sonora and the rural Indian communities were based on the frequency of consumption of foods using a single 24-hour recall.

Even though the same core foods were present in the diets of urban women from the study on dietary risk factors, the food pattern showed a wider variety (57 foods consumed for 90% of the sample), probably because intake estimation was based on four 24-hour recalls spread across the four seasons of the year.

Table 1 compares intakes of selected nutrients between women in the Sonora State Food Basket Study and urban women in the dietary risk factors study. Similar intakes of total energy and percentage of energy provided by macronutrients were found. However, the SD decreased for the study on urban women when multiple 24-hour

Table 1 Nutrients in the diets of women in the Sonora State Food Basket Study and urban women in the dietary risk factors study. Values are given as mean ± standard deviation

Nutrient	Food basket women (n=141) (1980s)	Urban women (1990s)
Total energy (kcal)	1856 ± 922	1940 ± 521
Fat energy (%)	35 ± 9	36 ± 6
Saturated fat energy (%)	11 ± 4	11 ± 2
Carbohydrate energy (%)	51 ± 10	51 ± 7
Cholesterol (mg)	365 ± 308	329 ± 202
Fibre (g)	35 ± 22	30 ± 13
Vitamin A (μg RE)	639 ± 1209	1059 ± 1527
Vitamin C (mg)	71 ± 100	81 ± 56

RE – retinol equivalents.

Table 2 Between-subject coefficients of variation in adult diets (single 24-hour recall)

Nutrient	Sonora State Food Basket Study Urban	Sonora State Food Basket Study Rural	Urban women from dietary risk factors study	Rural (Indian)
Energy	49.7	48.8	38.1	23.0
Protein	55.2	62.8	42.4	25.6
Carbohydrate	48.2	50.6	43.4	22.4
Total fat	62.3	60.3	48.3	32.8
Cholesterol	81.8	89.3	87.7	101.2
Fibre	63.4	60.4	58.7	30.2
Vitamin A	187.8	81.4	205.8	152.7
Vitamin C	149.1	112.8	112.5	144.8
Iron	67.7	71.9	44.8	25.0

Table 3 Intra-individual and inter-individual coefficients of variation for intakes of urban adult women ($n = 50$)

	Between-subject variation			Within-subject variation	
Nutrient	One 24-hour recall	Four 24-hour recalls	FFQ	Four 24-hour recalls	FFQ
Total energy	38.1	30.8	34.8	36.3	26.3
Protein	42.4	33.4	36.0	40.1	22.9
Carbohydrate	43.4	32.2	30.8	38.5	24.9
Total fat	48.3	37.5	45.2	48.3	39.6
Cholesterol	87.7	63.3	70.2	78.4	41.0
Fibre	58.4	42.9	19.8	56.2	42.3
Vitamin A	205.8	143.8	77.0	212.4	69.5
Vitamin C	112.5	69.1	46.9	102.7	75.9
Iron	44.8	36.9	35.9	49.6	37.5

FFQ – food-frequency questionnaire.

recalls were used. Consumption of micronutrients, especially vitamins A and C, showed high relative variation in both cases.

Comparing the inter-individual CVs for some selected nutrients between adult women from the three studies (Table 2), similar values were observed for macronutrients in urban and rural women from the Sonora State Food Basket Study and in urban women from the dietary risk factors study (with the first recall). The inter-individual CVs of the Indian communities, however, were substantially lower, due to the simpler food pattern.

Between-person CVs for cholesterol and particularly vitamins A and C are the largest among nutrients of the three studies. Animal foods are consumed in these low-income populations, although in small quantities and with low frequency. Fruit and vegetable intakes are low, and culturally and seasonally determined.

Analysing the inter-individual CVs of 50 randomly selected women from the total of 152 in the dietary risk factors study (Table 3), reduced CVs for selected nutrients were observed when comparing the estimation using a single 24-hour recall with the estimation by four 24-hour recalls, especially for vitamins. Using the estimates for the same nutrients by a semi-quantitative FFQ, the between-subject CVs were not lower for macronutrients; however, they were lower for fibre and vitamins A and C.

In multiple 24-hour recalls, intra-individual CVs were higher than inter-individual CVs for all nutrients. But for dual administration of the semi-quantitative FFQ the effect was reversed for most nutrients; the exceptions were dietary fibre, vitamin C and iron.

Using the information on intra-individual and inter-individual variations in selected nutrient intakes from the four 24-hour recalls, ratios of intra-individual CV to inter-individual CV were calculated. Table 4 shows a comparison of the ratios calculated for urban women from the dietary risk factors study with those reported for American women in the Nurses' Health Study[15]. Intra-individual to inter-individual CV ratios were lower for Mexican women than for US women. One can expect these results, because the diversity of Mexican diets is far lower than that for a developed country like the United States. The magnitude of the ratios, however, indicates that even in a less developed country there is intra-individual variability greater than the inter-individual variability that needs to be considered, especially for association analysis.

The data on intra-individual and inter-individual CV variations were used to deattenuate the correlation coefficients between the estimation of diet by four 24-hour recalls and the semi-quantitative FFQ in 50

Table 4 Ratio of intra-individual to inter-individual variance for some dietary components in the diets of urban women

Nutrient	Urban women, Sonora, Mexico	NHS*
Total energy	1.4	1.9
Protein	1.5	3.9
Carbohydrate	1.5	1.2
Total fat	1.7	2.8
Cholesterol	1.6	6.8
Fibre	1.8	–
Vitamin A	2.1	11.7
Vitamin C	2.3	2.0
Iron	1.8	3.1

* Nurses' Health Study, from Willett[15].

Table 5 Correlation coefficients between intake estimates of selected food components by four 24-hour recalls and a semi-quantitative food-frequency questionnaire (50 urban women from the dietary risk factors study)

Food component	Correlation coefficient	Corrected by intra-/inter-subject variation
Energy	0.63	0.73
Protein	0.52	0.61
Carbohydrate	0.46	0.54
Total fat	0.63	0.75
Cholesterol	0.53	0.63
Fibre	0.48	0.58
Vitamin A	0.08	0.10
Vitamin C	0.22	0.28
Iron	0.60	0.73

Table 6 Urban women's intakes of nutrients, by season*. Values are given as mean ± standard deviation

Nutrient	Spring	Summer	Autumn	Winter
Energy	1954 ± 912^{a}	1564 ± 784^{c}	1598 ± 713^{d}	2160 ± 1159^{a}
Protein	73 ± 35^{a}	53 ± 30^{c}	55 ± 32^{d}	75 ± 45^{a}
Carbohydrate	234 ± 112^{a}	210 ± 102^{c}	208 ± 94^{d}	270 ± 45^{b}
Fat	83 ± 44^{a}	59 ± 38^{c}	63 ± 33^{d}	90 ± 56^{a}
Cholesterol	384 ± 343^{a}	247 ± 246^{c}	211 ± 201^{d}	410 ± 416^{a}
Vitamin A	1759 ± 3688^{a}	690 ± 1014^{c}	707 ± 1132^{d}	1370 ± 3480^{b}
Vitamin C	93 ± 79^{ab}	$75 \pm 91a^{c}$	77 ± 98^{a}	86 ± 88^{a}
Iron	17 ± 10^{a}	12 ± 7^{c}	12 ± 8^{d}	17 ± 10^{a}

* Different superscripts by row indicate significantly different mean intakes.

women from the dietary risk factors study (Table 5). These results show how association analysis can be improved by correcting for the day-to-day intake variation among low-income women.

Finally, in the dietary risk factors study, the comparison of nutrient intakes between seasons (Table 6) shows that the differences in intake are mainly between winter and spring compared with summer and autumn ($P < 0.05$). Carbohydrate consumption, however, is higher during winter, and vitamins A and C show high variability as a consequence of different intakes by season. This last result is due to the greater availability of fruits and vegetables during spring and winter seasons. This availability coincides with the lower cost of these foods during the harvest seasons for fruit and vegetables in the region. This seasonality in consumption of fruit and vegetables should be taken into account in study design, especially if there is a focus on micronutrient consumption.

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