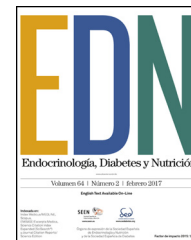




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ORIGINAL ARTICLE

3 Self-administered structured food record 4 for measuring individual energy and nutrient intake 5 in large cohorts: Design and validation

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KEYWORDS

17 Closed-ended food
18 record;
19 Nutritional
20 assessment;
21 Validation;
22 Self-administered
23 food record
24

Abstract

18 *Introduction:* Several instruments developed to assess dietary intake of groups or populations
19 have strengths and weaknesses that affect their specific application. No self-administered,
20 closed-ended dietary survey was previously used in Argentina to assess current food and nutrient
21 intake on a daily basis.

22 *Objective:* To design and validate a self-administered, structured food record (NutriQuid, NQ)
23 representative of the adult Argentine population's food consumption pattern to measure indi-
24 vidual energy and nutrient intake.

25 *Materials and methods:* Records were loaded onto a database using software that checks a
26 regional nutrition information system (SARA program), automatically quantifying energy and
27 nutrient intake. NQ validation included two phases: (1) NQ construct validity comparing records
28 kept simultaneously by *healthy volunteers* (45–75 years) and a nutritionist who provided meals
29 (*reference*), and (2) verification of whether NQ reflected target population consumption (calo-
30 ries and nutrients), week consumption differences, respondent acceptability, and ease of data
31 entry/analysis. Data analysis included descriptive statistics, repeated measures ANOVA, intra-
32 class correlation coefficient, nonparametric regression, and cross-classification into quintiles.

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Results: The first validation (study group vs. reference) showed an underestimation (10%) of carbohydrate, fat, and energy intake. *Second validation:* 109 volunteers (91% response) completed the NQ for seven consecutive days. Record completion took about 9 min/day, and data entry 3–6 min. Mean calorie intake was 2240 ± 119 kcal/day (42% carbohydrates, 17% protein, and 41% fat). Intake significantly increased in the weekend.

Conclusion: NQ is a simple and efficient tool to assess dietary intake in large samples.

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PALABRAS CLAVE

Registro estructurado de alimentos; Evaluación nutricional; Validación; Registro de alimentos autoadministrado

Registro alimentario estructurado y autoadministrado para estimar la ingesta individual de energía y nutrientes en grandes cohortes: diseño y validación

Resumen

Introducción: Diferentes instrumentos para evaluar la ingesta alimentaria grupal o poblacional tienen fortalezas y debilidades que afectan a su aplicación. No existe experiencia nacional con un registro dietético auto-administrado cerrado para evaluar la ingesta actual de alimentos y nutrientes diaria de alimentos.

Objetivo: Diseñar y validar un registro de alimentos estructurado, auto-administrado (NutriQuid [NQ]), representativo del patrón de consumo alimentario de la población argentina adulta para medir la ingesta individual de energía y nutrientes.

Materiales y métodos: Desarrollamos un *software* para incorporar registros en una base de datos y verificar información nutricional (programa SARA), cuantificando automáticamente la ingesta de energía y nutrientes. La validación de NQ incluyó 2 fases: 1) comparación simultánea de registros del NQ completado por *voluntarios sanos* (45-75 años) y de una nutricionista que preparó las comidas ofrecidas (*referencia*), y 2) verificación si el NQ reflejó el consumo diferencial de población objetivo (calorías y nutrientes) durante la semana, aceptabilidad por los encuestados y facilidad de ingreso/análisis de datos. Análisis estadístico: incluyó estadística descriptiva, ANOVA de medidas repetidas, coeficiente de correlación intraclase, regresión no paramétrica y clasificación cruzada en quintiles.

Resultados: La *primera validación* (*voluntarios vs. referencia*): mostró una subestimación del 10% de la ingesta de carbohidratos, grasas y energía. *Segunda validación:* 109 voluntarios (91% de respuesta) completaron el NQ durante 7 días consecutivos. Completar los registros requirió 9 min/día y la carga de datos 3-6 min. La ingesta calórica promedio fue de 2.240 ± 119 kcal/día (42% carbohidratos, 17% proteína y 41% grasa) y aumentó significativamente durante el fin de semana.

Conclusión: El NQ es una herramienta simple y eficiente para evaluar la ingesta alimentaria en grandes grupos.

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Introduction

Lifestyle modification is the major component of interventions for prevention of chronic diseases such as Type 2 diabetes (T2D), where positive effects on development have been shown.¹⁻³ Thus, these changes are considered the primary therapeutic intervention for T2D prevention and treatment.^{4,5}

Currently, the effects of implementation of a diabetes prevention program based on lifestyle changes (including dietary intake) are being evaluated in the province of Buenos Aires, Argentina.⁶ Therefore, we need a tool to assess country-specific nutrient and food intake of study participants at the beginning and throughout follow-up.

Measurement of dietary intake is complex and challenging, particularly at group or population level. Appropriate

selection of measurement method depends on the objectives of surveillance and the type of information required.⁷ It also covers prerequisites such as peculiarities of the target population, retrospective/prospective modality, human and financial resources, and data processing availability.⁸

Different versions of food frequency questionnaires, 24-h dietary recalls, dietary records, dietary history, brief dietary assessment instruments and combinations thereof are methods commonly used. All have strengths and weaknesses affecting their specific application.^{8,9}

For nutritional evaluation of large populations, the survey requires certain conditions to assess the effects of lifestyle change interventions accurately, namely: (1) reflect local or culture-specific eating habits, (2) allow quantitative estimation of food, total energy and specific nutrient intake, and

(3) facilitate the record-keeping process, minimizing data load and use of human and economic resources.

Food frequency questionnaires (FFQs) are predominantly used in epidemiological studies with a relevant period of retrospective assessment. However, its use to estimate quantitative parameters is considered inappropriate because estimation nutrient intake is only approximate.⁸

The 24-hour dietary recall (24 h-DR) allows quantitative results, but it also requires trained interviewers and several days of interviews to determine habitual intake involving a high load of record keeping and data coding, and processing.⁸

The open-ended (unstructured) food record (also known as food diary) provides quantitative results of food and nutrient intake. Data for a defined period of time are recorded, usually three to seven consecutive days.^{8,9} Its strength is that provides quantitative information, but record-keeping and data processing load is high. It also requires well informed and motivated respondents to register/estimate total foods and beverages consumed precisely (e.g., fat-content, form of preparation). The number of complete records and validity of information decrease as the record continues beyond 4 days, partly due to registration fatigue.^{8,10} Additionally, recorded foods must be interpreted by a nutritionist before entry into a database for calculation of nutrient and energy intake.¹¹ This latter aspect excludes its use in projects involving large cohorts.

Closed-ended forms of dietary assessment methods facilitate data capture and eliminate coding by using lists of foods or food groups (checklist forms), thus becoming useful for assessments in large cohorts. However, these tools are not suited to our need to minimize record keeping and data processing. Therefore, these prerequisites permit only self-administered tools. Of the existing, validated tools for assessing food intake in Argentina^{12,13} and the Southern Cone of Latin America,^{14,15} only one is self-administered¹⁶; however, all these measures are FFQs or 24 h-DR.

So far no self-administered closed-ended dietary record has been used in Argentina to assess current food and nutrient intake by recording food intake on a daily basis, concurrently with food consumption. Therefore, we attempted to validate a new country-specific, self-administered structured food diary questionnaire, developed for use in Argentina. This questionnaire might facilitate recording of daily food intake, simplify data entry/processing and optimize time, human and economic resources and even evaluate nutrient intake changes in primary health intervention studies.

Material and methods

A structured list-based record of daily food intake was developed by an interdisciplinary team (nutritionists, physicians, computer scientists and statisticians) from the Primary Prevention Program of Diabetes of the Province of Buenos Aires (PPDBA). Usual food consumption pattern of the Argentinian population was obtained from several national documents,^{16–19} to prepare a list of 59 items selected and grouped according to food groups and times of day. Three additional questions were included to estimate sodium intake (Fig. 1). The complete

version (2 pages) and instructions may be downloaded from <http://www.ppdba.cenexa.org/nutriquid>.

The NutriQuid (NQ) record consists of four vertical columns: the first left-hand column lists the selected foods; in the second column, respondents circle their choices by type of preparation or food origin (e.g. sea or freshwater fish). The third column defines the portion size of the corresponding food: the selected portion of meat, pasta and cereals, is accompanied by a drawing. For the other items household measures such as cups and spoons are used. In the fourth column, the respondent registers the total amount of servings of each item consumed daily. Each page ends with a reminder to check for any omissions. One-page printed instructions explain how to use the NQ form (Fig. 1).

The NQ recorded information was loaded into a MySQL database²⁰ using a bespoke software developed using the Symfony 1.4 framework.²¹ The data loaded was thereafter run through the dietary analysis software package that calculates nutrient intakes based on the total amount of servings of each item consumed, consulting nutritional information from the SARA database.²² Thus, our system quantifies total consumption of energy, protein, carbohydrates, saturated, monounsaturated and polyunsaturated fatty acids, vegetable and animal fats, cholesterol, dietary fiber, sodium, calcium, potassium, various vitamins, and vegetable and fruit consumption.

When the item recorded was not in the SARA program (e.g. some products such as pizza, cakes and pies), the nutritionist team calculated calorie and nutrient content using information from the CENEXA food database²³ and Argenfoods.²⁴ Refined sugar content was calculated from manufacturers' information.

NQ validation

Validation included two phases:

First phase. Verification of NQ diet record accuracy: for this purpose, we compared NQ records completed by study participants to those simultaneously completed by the corresponding nutritionist who had defined the composition of foods and meals offered (*reference*). This activity was implemented between May and July 2014, at Interzonal Hospitals "Prof. Dr. Rossi" and Italiano of La Plata, and at the "Horacio Cestino" of Ensenada, Buenos Aires, Argentina. It included 42 individuals aged 45–69 years (20 women and 22 men) treated in those hospitals, without chronic metabolic diseases, nutritional disorders, cancer or recent surgery, and receiving standard normal diets.

On the morning of the survey, participants received the NQ and its instructions, and were asked to record all meals and drinks they received during the day at their respective hospital. Reference nutritionists simultaneously performed the same task. Although recording was anonymous, respondents wrote the last four numbers of their personal identification card on each NQ, to avoid overlapping data from different people and facilitate further analysis.

Second phase. Verification that NQ recorded data could: (1) reflect caloric and nutrient intake characteristic of our target population according to previous measurements in our region^{17–19}; (2) identify possible differences in food


Food item	Type of food (circle one)	One portion size is equivalent to	Serving per day (0, ½, 1, 2...)
Egg		1 unit	
Thick flank, top side, liver, kidney, tripe, round roll, tenderloin, ground lean beef.			
Veal scallop, breaded			
Ground beef and other meat	bone-in / boneless		
Chicken	Skinless/ with skin		
Pork or lamb			
Fresh fish	Seafish/freshwaterfish		the size of your palm (150g)
Before proceeding, please check whether you have filled in the second column options and the number of servings consumed in the fourth column.			

Figure 1 Fragment of the Argentine structured food record (NutriQuid). Short-cut of: <http://www.ppdba.cenexa.org/nutriquad>.

consumption on different days of the week (definition of minimum number of days necessary to attain this aim); (3) be easy to keep for seven days and be well-accepted by the respondent; and (4) simplify data entry and further data processing.

This phase lasted from August to October 2014, incorporating adult volunteers aged 45–75 years living in the same geographical areas as those participating in the PPDBA.

Sample size was determined by seeking a 5% differences in total energy content (this difference considered 110 kcal with an expected standard deviation of 200 kcal) and assuming a 5% alpha error and a 20% beta error resulting in 106 individuals (two-tailed). We increased this number to 120, considering possible exclusion of incomplete questionnaires and dropouts.

Participants (80 women and 40 men aged 45–75) received the NQ, and were asked to record seven consecutive days of complete food and drinks consumption. The day material was given to participants varied so that the first day of recording included all seven days of the week. At the end of the recording week, food records were collected by a member of the research team.

As in phase 1, records were completed anonymously, but participants wrote the last four digits of their identification card on the NQ to avoid overlapping data from different participants and to facilitate further analysis.

Ethics statement

This study was conducted according to Helsinki Declaration guidelines, and all procedures involving human subjects were approved by the Ethics Committee of the National University of La Plata, Argentina.

Statistical analyses

First phase: we used descriptive statistical techniques to estimate total energy consumption, carbohydrates, protein, fat and micronutrients recorded in the NQ. Subsequently, the percentage difference between values recorded by volunteers and reference nutritionist for each variable was

calculated and tested for significance (for paired data). Pearson correlation coefficients and cross-classification by quintiles of intake were also determined.

Second phase (7 consecutive days individual records), ANOVA for repeated measures was used to assess differences between individual daily records; also the intra-class correlation coefficient (ICC) from a two-way mixed ANOVA model as a measure of test-retest reliability of each NQ component. ICC assessed reproducibility of daily measurements of the same person for each NQ component (total energy and different nutrients) throughout the study week. SPSS 17.0 software and CSS/Statistica (v6, Statsoft Corp) were used for descriptive statistics and for testing internal test-retest reliability. Quantitative variables were expressed as mean ± standard deviation. Values of $p \leq 0.05$ (two-tailed) were considered statistically significant.

Results

First validation phase

Comparison between NQ of participants and those of the reference nutritionist showed no significant differences in mean protein intake (108 g/day reference vs. 105 g/day). A slight but significant underestimation of about 10% was observed for energy (Δ -7%), carbohydrates (Δ -7%) and total fat (Δ -14%). The third was due to a marked difference in vegetable fat affecting polyunsaturated fatty acids as well (Table 1). No significant differences were observed for other parameters except sodium ($p = 0.035$).

Correlation coefficients of energy-unadjusted values for energy and macronutrients (carbohydrates, protein, total fat) recorded by participants and reference varied from 0.38 for total fat to 0.70 for carbohydrates. After energy adjustment, they ranged from 0.39 to 0.54 (Table 1).

Cross-classification by quintiles of energy, carbohydrate, protein, and total fat intakes (g/day and %E) of study group participants and their reference are shown in Table 2. Overall, 78% of participants in the lowest NQ quintile were in the lowest one or two reference quintiles, and 83% of those in the highest NQ quintile were in the highest one or two

Table 1 Comparison of structured food record (NutriQuid) as completed by nutritionist vs. participants.

Nutrient/food	Intake data (NQ recorded)			Reference vs. participants, % diff.	Pearson correlation coefficient	
	Reference	Participant	p-Value		Crude	E-adjusted
Energy (E) [kcal/d]	2338 ± 292	2153 ± 429	0.005	-7.4 ± 18.0	0.42	-
Carbohydrate [g/d]	263 ± 35	245 ± 59	0.009	-7.2 ± 15.9	0.70	0.39
Carbohydrate [%E]	45.2 ± 5.4	46.0 ± 8.9	0.557	2.3 ± 18.7	0.39	-
Protein [g/d]	108 ± 19	105 ± 37	0.512	-2.9 ± 27.3	0.48	0.41
Protein [%E]	18.5 ± 1.7	19.5 ± 4.8	0.153	5.3 ± 22.8	0.41	-
Fat [g/d]	95 ± 22	79 ± 28	0.001	-14.6 ± 29.8	0.38	0.54
Fat [%E]	36.3 ± 5.7	33.0 ± 9.2	0.009	-9.0 ± 22.5	0.53	-
Vegetable fat [g/d]	46.7 ± 13.6	28.4 ± 19.5	0.001	-36.7 ± 43.9	0.21	0.33
Vegetable fat [%E]	17.9 ± 4.4	11.9 ± 7.7	0.001	-32.2 ± 43.7	0.33	-
Animal fat [g/d]	48.9 ± 16.0	51.7 ± 25.4	0.352	3.6 ± 1.8	0.64	0.69
Animal fat [%E]	18.7 ± 5.4	21.4 ± 9.1	0.013	14.3 ± 35.7	0.69	-
SFA [g/d]	25.4 ± 6.1	26.3 ± 11.4	0.598	4.4 ± 42.0	0.48	0.54
MUFA [g/d]	30.6 ± 8.1	29.5 ± 11.8	0.576	-0.6 ± 42.9	0.27	0.31
PUFA [g/d]	32.0 ± 10.2	17.9 ± 11.6	0.001	-40.7 ± 36.1	0.32	0.35
Cholesterol [mg/d]	346 ± 114	330 ± 164	0.483	-0.7 ± 45.5	0.46	0.41
Dietary fiber [g/d]	18.2 ± 4.1	17.9 ± 5.2	0.670	-0.8 ± 24.1	0.61	-
Sodium [mg/d]	3578 ± 1229	2907 ± 1752	0.035	-3.6 ± 83.6	0.14	-
Potassium [mg/d]	3368 ± 782	3279 ± 851	0.472	-0.2 ± 24.7	0.53	-
Calcium [mg/d]	805 ± 187	906 ± 399	0.074	14.7 ± 53.9	0.44	-
Ascorbic acid [mg/d]	152 ± 45	159 ± 75	0.491	5.5 ± 43.5	0.54	-
Thiamin [mg/d]	1.64 ± 0.53	1.90 ± 1.10	0.090	16.7 ± 48.3	0.48	-
Niacin [mg/d]	27.1 ± 5.6	25.5 ± 10.5	0.215	-6.7 ± 26.8	0.60	-
Folic acid [µg/d]	351 ± 286	350 ± 268	0.948	11.2 ± 49.1	0.87	-
Cobalamin [µg/d]	6.3 ± 1.9	6.5 ± 2.2	0.653	6.9 ± 37.8	0.37	-
Retinol [µg/d]	367 ± 129	372 ± 210	0.882	4.7 ± 60.1	0.39	-
Vegetable and fruit [portions/d]	3.1 ± 1.0	3.1 ± 1.3	0.789	5.7 ± 44.5	0.54	-

Values represent means ± SD. N=42 cases for all parameters. Means, mean differences and Pearson correlation coefficients related to intakes of energy and nutrients and two food groups (vegetable and fruit) based on data derived from Argentine food records NutriQuid (NQ) completed by untrained participants vs. those completed by nutritionists (reference).

Table 2 Cross-classification by quintiles of non-energy adjusted intakes for the structured food record (NutriQuid) obtained from records completed by study group participants vs. nutrition experts (reference).

Nutrient	Lowest quintile study group on NutriQuid (%)			Highest quintile study group on NutriQuid (%)		
	Lowest quintile reference	Lowest two quintiles reference	Highest quintile reference	Highest quintile reference	Highest two quintiles reference	Lowest quintile reference
Energy	33	89	0	56	56	11
Carbohydrate	67	100	0	78	100	0
Carbohydrate [%E]	33	78	22	56	78	0
Protein	56	78	11	56	78	0
Protein [%E]	44	78	11	44	89	0
Fat	44	56	11	44	77	0
Fat [%E]	56	67	0	67	100	0

reference quintiles. On average, less than 10% were misclassified into extreme quintiles.

The NQ recorded data demonstrated that the one completed by the study group generated results comparable to

those completed by the *reference*, with an underestimation in macronutrients of about 10%. Total fat difference recorded was affected by an underestimation of vegetable fat intake.

Second phase

Ninety-one percent of the 120 invited participants returned their completed questionnaires, thus gathering 763 records of daily food intake over seven consecutive days (Table 3).

The time required to complete the survey was about 9 min per day (7–14 min) and 3–6 min to enter each NQ registry into the database depending on the operator. Thereafter, the software automatically converted the loaded data into values of energy and nutrient intake (see “Materials and methods” section).

Regarding reproducibility, daily average caloric intake per week was 2240 ± 119 kcal/day. Of total daily energy consumed, protein accounted for 17%, carbohydrate for 42% and fat for 41%. Refined sugars accounted for 27% and animal fats 58% of total carbohydrates and fat, respectively (Table 3).

Energy consumption increased on Saturdays and Sundays, with a high correlation between the two weekend days (0.99) (Fig. 2).

Comparing variation in daily energy intake and in various nutrients throughout the week, we identified (Table 3):

- Significant differences in total energy, carbohydrates, saturated fatty acids, refined sugars, and vegetable fat but not in the remaining nutrients. These variations resulted from higher consumption over the weekend.
- Higher consumption over the weekend induced significant differences in total energy, carbohydrates, saturated fatty acids, refined sugars, and vegetable fat but not in the remaining nutrients.
- ICC values for each dietary component ranged from 0.27 to 0.64 for animal fats and carbohydrates, respectively.

Discussion

We developed a self-administered-closed-ended record of daily food intake for adults in Argentina to assess individual nutrient intake in large cohort intervention studies. For economic and infrastructure considerations, we used a paper-based version rather than a computer-based tool used by others.²⁵

We did not compare our NQ (phase 1) with other assessment methods, such as a FFQ or 24h-DR, because their specific problems/limitations would have led to a methodological biases aggregation impeding clear data interpretation. Instead, we chose an intra-methodological approach in a controlled setting: comparison of untrained respondents to a nutritionist reference (true value). In fact, this test represents a great challenge for the method because it compares data provided by a nutritionist science professional who prepared the meals with the data provided by untrained volunteers in the field of nutrition. The small difference in the data provided by the reference nutritionist and the volunteer, indicates the easy comprehension of the NutriQuid protocol.

The NQ food record showed moderate to good validity for energy, nutrient, vegetable and fruit consumption, except vegetable fat intake ($p < 0.001$, $r = 0.214$). We found under-reporting of energy and nutrient intake, common in dietary assessment methods, specifically in fat intake.^{26–29} Our food records data analysis showed that a quarter of participants

Table 3 Daily consumption of energy and nutrients.

Variables	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	ICC (95% CI ICC)
Energy (kcal) [*]	2109 ± 1209	2171 ± 1076	2245 ± 1177	2104 ± 901	2284 ± 1037	2399 ± 1102	2374 ± 1293	0.629 (0.555–0.703)
Protein (g)	95 ± 52	96 ± 49	99 ± 51	91 ± 40	98 ± 43	103 ± 47	100 ± 50	0.516 (0.436–0.601)
Carbohydrates (g) ^{**}	221 ± 139	227 ± 111	231 ± 132	220 ± 101	230 ± 116	253 ± 124	253 ± 144	0.638 (0.565–0.711)
Fiber (g)	17 ± 12	18 ± 11	18 ± 12	17 ± 10	17 ± 10	18 ± 13	21 ± 18	0.651 (0.579–0.722)
Na (mg)	2825 ± 2462	2747 ± 1906	2759 ± 1917	2708 ± 1709	2806 ± 1701	3018 ± 1921	2902 ± 2130	0.478 (0.396–0.565)
K (mg) ^{***}	3033 ± 1864	2998 ± 17	3068 ± 2002	2883 ± 1489	3007 ± 1829	3048 ± 1772	3083 ± 2091	0.591 (0.514–0.669)
SFA (g) ^{****}	29 ± 21	28 ± 17	31 ± 20	28 ± 18	32 ± 19	34 ± 20	35 ± 24	0.396 (0.315–0.486)
MUFA (g)	33 ± 21	34 ± 20	36 ± 21	33 ± 19	36 ± 21	36 ± 20	39 ± 24	0.441 (0.360–0.531)
PUFA (g)	23 ± 18	25 ± 21	24 ± 17	24 ± 16	25 ± 19	25 ± 20	27 ± 24	0.415 (0.334–0.505)
Refined sugar (g) ^{****}	59 ± 48	59 ± 43	63 ± 45	58 ± 41	65 ± 49	72 ± 52	69 ± 52	0.523 (0.443–0.608)
Vegetable fat (g)	39 ± 38	38 ± 31	40 ± 37	38 ± 28	42 ± 36	43 ± 37	43 ± 43	0.377 (0.298–0.468)
Animal fat (g)	51 ± 35	56 ± 39	58 ± 35	53 ± 37	59 ± 36	59 ± 38	63 ± 42	0.279 (0.205–0.367)

Values represent means ± SD.

^{*} $p < 0.001$. ^ΔSignificant difference for Saturday vs. Monday; Saturday vs. Thursday.

^{**} $p < 0.001$. ^ΔSignificant difference for Saturday and Sunday vs. Monday; Saturday and Sunday vs. Thursday.

^{***} $p < 0.015$. ^ΔSignificant difference for Sunday vs. Monday and Tuesday.

^{****} $p < 0.007$. ^ΔSignificant difference for Saturday vs. Monday, Tuesday and Thursday; ICC: intraclass correlation coefficient (95% CI for ICC).

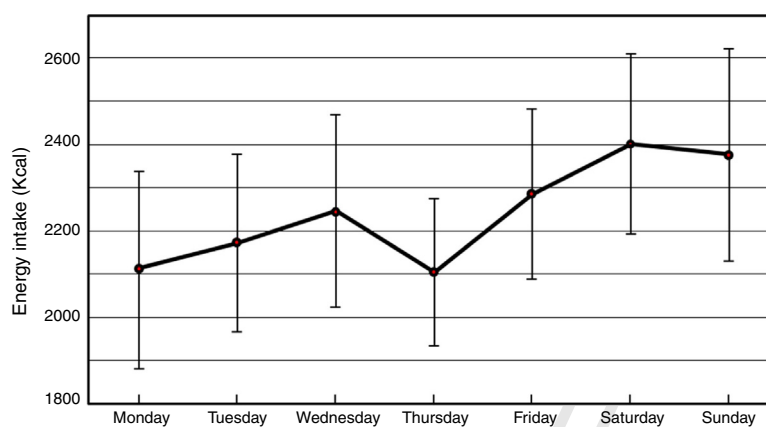


Figure 2 Daily energy consumption. Each value represents the mean \pm SD.

358 forgot/neglected to record oil used for salads and other
359 dishes. This contributed greatly to the mean difference
360 in total fat, polyunsaturated fatty acid and energy intake
361 between participants and *reference* records. Consequently,
362 to improve NQ efficiency, we will modify the instruction
363 leaflet introducing an easy household guide to help partic-
364 ipants to estimate portion size consumed and stressing the
365 importance of recording oil used in meal preparation.

366 Calculation of sodium intake ($p=0.035$, $r=0.144$) was
367 influenced by additional information submitted by respon-
368 dents at the end of the food record, but its integration
369 was perhaps difficult due to the data collection format. The
370 underestimation of salt, vegetable oil (source of PUFA) and
371 grated cheese (source of calcium) by the participants, could
372 be ascribed to the fact that their content in the tested meals
373 was known and thus appropriately recorded by the reference
374 nutritionist while this knowledge was completely ignored by
375 the participants. Other authors also reported difficulties in
376 estimating intake of certain foods, in particular salt, oil, and
377 added fat.^{26–28} Therefore, we need to change the layout and
378 wording of the salt section; for this purpose we will add, in
379 the guide of homemade food measurements, a paragraph
380 emphasizing the importance of careful estimation of salt
381 consumption. We will further add a drawing with different
382 serving sizes using a teaspoon and its fractions.

383 Our NQ validity indicators are comparable to
384 those reported by other local authors using different
385 methodology.^{13,15} In fact, a validation study of FFQ vs.
386 24 h-DR conducted in urban Rosario, Argentina, in a compa-
387 rable age-group, reported similar r -values for energy and
388 fat intake and lower levels for protein and carbohydrate
389 intake.¹³ A survey in southern Latin America (Argentina,
390 Chile, and Uruguay) using a FFQ in a 21–74-year age-group
391 found comparable results.¹⁵

392 Comparison with other validation studies may be limited
393 by their different methodological approaches. Recent stud-
394 ies compared two methods (new against an established
395 method), but recording periods differed (winter and spring).
396 Impact of seasonal differences in food availability has been
397 identified in a recent meta-analysis.²⁹ The advantages of
398 our intra-methodological approach stem from the use of
399 coincident record periods and comparison of data from the
400 target group applying the new tool vs. estimated values from
401 the reference experts (as opposed to another self-reported

402 measure). This approach was only possible in a closed setting
403 (using hospital in-patients).

404 Acceptability of the NQ by respondents was good, as
405 demonstrated by the 91% response observed in the second
406 validation phase, confirming that it offers easy record-
407 keeping. Self-administered questionnaires are economically
408 advantageous compared to other methods.³⁰ It also saves
409 time spent on interviews, thereby decreasing implementa-
410 tion time and cost, important elements for massive data
411 collection. Also, the time needed to fill in the NQ (aver-
412 age 9 min) and to upload records to the database (average
413 3–6 min) was relatively short.

414 The software developed to evaluate nutrient intake from
415 this survey by consultation with different databases enabled
416 their immediate full identification (Table 3) and reflected
417 the caloric and macronutrient intake characteristics of our
418 target population (Argentinian adults, 45–75 years old).^{17–19}

419 NQ sensitivity allowed to detection of small changes in
420 energy and nutrient consumption, e.g., detection of small
421 changes in daily intake between weekdays and weekends.
422 The weekly NQ assessment also demonstrated highly accept-
423 able ICC values for total energy, carbohydrates, refined
424 sugars, protein, fiber, sodium, and potassium, but lower for
425 vegetable and animal fat.

426 The test–retest examination also showed lower con-
427 sistency (ICC) for fat components. Considering the high
428 correlation between weekdays and between weekend days,
429 three or four days (including one weekend day) instead of
430 seven-day records would reduce record keeping and data
431 processing, a conclusion supported by reports of registration
432 fatigue.^{8,10}

433 Despite these advantages, the NQ has some limitations:
434 designed and validated in an adult population (45–75 years),
435 it was intended for application in the PPDBA, targeting this
436 age-group (http://www.ppdba.cenexa.org/el_programa).
437 Hence, it should be validated for other age-groups. How-
438 ever, this limitation would be a strength when the NQ is
439 used for similar purposes. It should also be noted that the
440 selection of foods included in the survey was based on nor-
441 mative consumption of foods in Argentina^{17,19}; therefore,
442 adaptation to local conditions is needed for use in regions
443 with different food habits. The comparatively low number
444 of food items in the NQ seemed appropriate for our region
445 and also decreased respondent burden.

In conclusion, the NQ is an easy-to-use, low-cost tool enabling reasonably accurate assessment of dietary intake in medium to large adult populations in Argentina. Further research is needed to demonstrate its benefits and applicability in different age groups and pathological conditions.

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Conflict of interest

The authors declare that they have no conflict of interest.

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