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ORIGINAL

New pre-coded food record form validation

Víctor Manuel Rodríguez[a,b,*], **Ana Elbusto-Cabello**[a], **Mireia Alberdi-Albeniz**[a], **Amaia De la Presa-Donado**[a], **Francisco Gómez-Pérez de Mendiola**[c], **Maria Puy Portillo-Baquedano**[a,b], **Itziar Churruca-Ortega**[a,b]

[a] Nutrition and Obesity Group. Department of Pharmacy and Food Science, University of the Basque Country (UPV/EHU), Vitoria, Spain.

[b] CIBER de Fisiopatología de la Obesidad y Nutrición (CIBEROBN), Spain.

[c] Vitoria-Gasteiz City Council, Spain.

[*] Corresponding author:
E-mail: bittor.rodriguez@ehu.es (V. M. Rodríguez)

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New pre-coded food record form validation

KEYWORDS

Pre-coded food record;

Diet Records;

Instrument development;

Validation studies; Validity;

Reproducibility;

Reliability;

Dietary assessment;

Nutrition assessment.

ABSTRACT

Introduction: For some research fields, simple and accurate food intake quantification tools are needed. The aim of the present work was to design a new self-administered and pre-coded food intake record form and assess its reliability and validity when quantifying the food intake of adult population, in terms of food or food-groups portions.

Material and Methods: First of all, a new food-record form was designed, which included food usually consumed and which sought to be easy-to-use, short, and intuitive. The validation process consisted in analyzing both the reliability and validity of the tool's design in a representative population sample (n=330; age: 19-77). Reliability was checked by comparing (Spearman's CC, ICC) food intake (mean value of portions) between two series of five-day food records in a one-month period. Validity was checked by comparing the food intake mean value of two records to results obtained from a *gold standard* (24-hour recall).

Results: 73.7% of the food from the record presented correlations higher than 0.5 for reliability (ICCs from 0.38 to 0.94) and 97.4% showed higher values than 0.7 and 68.4% than 0.8 for validity (ICCs from 0.28 to 0.97).

Conclusions: The solid correlation coefficients and ICCs obtained indicate that this is a reliable tool for the quantification of food intake in adults in terms of food or food group portions.

Validación de un nuevo registro alimentario precodificado

PALABRAS CLAVE

Registro de alimentos pre-codificado;

Registro dietético;

Desarrollo de instrumentos;

Estudios de validación;

Reproducibilidad; Fiabilidad;

Evaluación dietética;

Evaluación nutricional.

RESUMEN

Introducción: Para algunos campos de investigación se precisan herramientas de cuantificación de la ingesta alimentaria sencillas y precisas. El objetivo del presente trabajo fue diseñar un nuevo registro de ingesta de alimentos auto administrado y pre-codificado así como evaluar su fiabilidad y validez para cuantificar la ingesta de alimentos de la población adulta, en términos de porciones bien de alimentos o bien de grupos de alimentos.

Material y Métodos: Se diseñó el nuevo registro que incluía alimentos consumidos habitualmente y que debía ser fácil de usar, breve e intuitivo. El proceso de validación consistió en analizar tanto la fiabilidad y la validez de la herramienta en una muestra representativa de la población (n=330; edad 19-77 años). La fiabilidad se comprobó mediante la comparación (CC de Spearman, CCI) de la ingesta (media de raciones estándar) de alimentos entre dos series de registros de cinco días en un período de un mes. La validez se comprobó mediante la comparación de la ingesta de alimentos el valor medio de dos registros con los resultados obtenidos a partir de un *gold standard* (recordatorio de 24 horas).

Resultados: El 73,7% de los alimentos del registro presentó correlaciones superiores a 0,5 para la fiabilidad (CCI de 0,38 a 0,94) y el 97,4% presentó valores superiores a 0,7 y el 68,4% superiores a 0,8 para la validez (CCI de 0,28 a 0,97).

Conclusiones: Los sólidos coeficientes de correlación e ICC obtenidos indican que el nuevo registro es una herramienta fiable para la cuantificación de la ingesta de alimentos en adultos en términos de raciones de alimentos o grupos de alimentos.

INTRODUCTION

Food intake quantification tools are a matter of interest because they permit the knowledge of both food consumption patterns and changes in eating habits. The information obtained from these tools is useful to determine: dietary deviations with regard to recommendations, the relationship between dietary patterns and the prevalence of certain pathologies, as well as to assess the impact of nutritional interventions. Food intake assessment methods have to be adapted to the objectives of the studies, the sensitivity of the information to be collected and available resources. Methodological development of such tools is rather recent due to the fact that it is a complex process[1,2].

Of the tools available for the evaluation of community and family food consumption the most noteworthy are food-balance, total diet studies, food records, recalls, inventories and counting[3,4,5]. With regard to individual tools, dietary history (DH), food records (FR), 24-hour recall (24 h) and food frequency questionnaires (FFQ) are the most notable ones.

Although all have been validated and are widely used tools, they present disadvantages such as the need for either qualified staff (DH, 24 h) or for considerable commitment on the part of survey respondents in order to reach better accuracy (FR, FFQ)[2,4,6,7,8,9].

Currently the use of biomarkers is being studied because of its relative accuracy. However, it must be pointed out that dietary stimuli-induced assorted physiological responses depend on individuals, and, moreover, their quantification method is invasive[10,11].

Therefore, each method must consider accuracy because of food intake variability and the common misevaluation caused by the limitations of tools. Thus, all food-intake quantification tools have to be validated. For this purpose both reproducibility or reliability (the quality of being predictable, the ability of a tool to obtain similar results after being used repeatedly or at different moments) and validity (having premises or conclusions so that the tool measures what it has to, after comparing it to a precise reference method, gold standard, or an external validity criterion) have to be checked[12,13,14].

The aim of the present work was to design a new self-administered and pre-coded form to record daily food intake and to validate it by analyzing its reliability and validity for food intake quantification in the adult population, in terms of daily food or food-group portions.

MATERIAL AND METHODS

Food record design

Two requirements were taken into account when designing the food intake quantification tool: a) simplicity (the need for ease in the use of the record) and b) precision of the information obtained. Therefore, the tool was designed to be a short and intuitive self-administered food record. More precisely, it is a daily food consumption record containing the most usual foodstuffs according to the Nutritional Assessment of the Spanish Diet[15] that includes the most common and nutritionally interesting foodstuffs. Then, in order to make the tool easier to complete, they were organized into 9 groups. These are presented, and thus pre-coded, by a picture and a color (Figure 1): 1) cereals and derivatives; 2) vegetables and fruit; 3) dairy products; 4) fish and shellfish; 5) meat and eggs; 6) legumes and nuts; 7) beverages; 8) oils and fats; 9) sugary products. At the same time, each food group contains food subgroups or individual foods (35 in all). In some cases differential nutrition features have been highlighted. For example, cereals and derivatives are divided into whole grain or refined; dairy products, fish and meat are arranged depending on their fat content (whole, semi skimmed and skimmed or high-, medium- and low-fat) and finally raw and cooked vegetables are differentiated.

For each food there is a small box which represents a food portion. In some cases the box is divided into two or four parts for half or quarter of a portion respectively. Finally, the tool includes a box to write down the intake of foods not included in the record, such as pizza, paella, etc., as well as the amount consumed.

To fill in the record the box (or part of the box) of each food portion (or part of portion) consumed has to be crossed out. In order to make it easier, domestic food portion sizes (pieces, cups, plates, etc.) for the mostly frequently consumed food portions have been detailed (on the back of the record form, information not shown). For example, the domestic portion size of one portion of breakfast cereals is one cup, so the form advises that "you have to cross out one box (one portion) when you eat a cup (domestic portion size)". The domestic food portion sizes were standardized by a nutritionist-dietitian team according to common household weights and defined by Spanish Society of Community Nutrition (SENC)[16], the food portion sizes described in the Epic Picture Book[17] and those defined by Carbajal and Sanchez-Muniz[18].

Figure 1. Pre-coded foor record form.

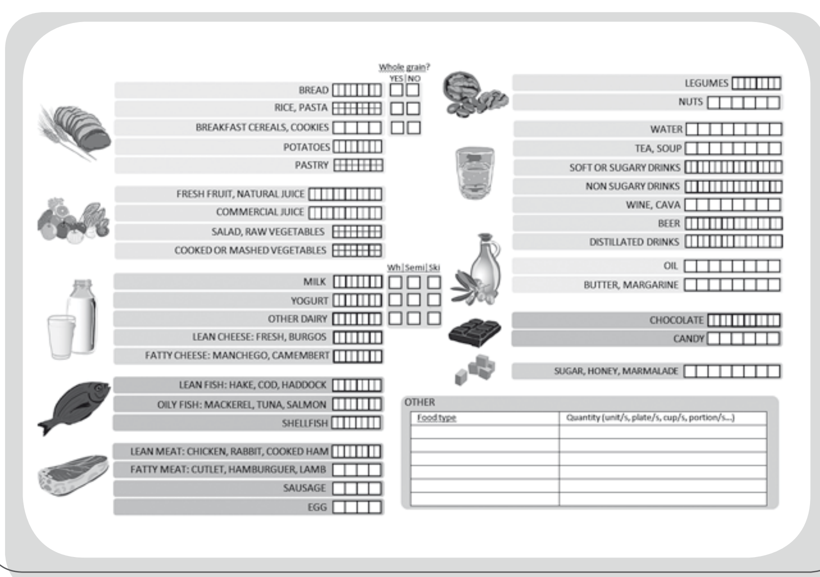
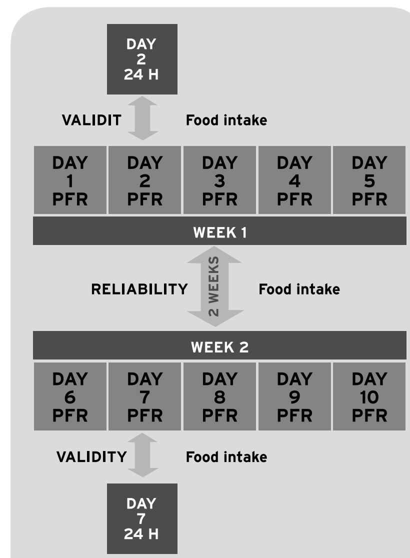


Figure 2. Design of the study.



PFR: Pre-coded food record
24 h: 24-hour recall

Subjects

In order to carry out the study in a sample representative of general population, for universes bigger than 100.000 individuals, 95% confidence and 5% margin of error the needed sample was estimated in 384 individuals. 497 volunteers between 19 and 77 years (45 ± years old) from Vitoria-Gasteiz city took part in the study. They were recruited from townspeople who participated in activities organized by the city council, Pharmacy Faculty of University of the Basque Country (UPV/EHU), and finally students, employees and workers of the city council. 330 individuals finished the study (66% participation rate, 5.4% sample error for a 95% confidence), of which 188 (57%) were women and 142 (43%) men. 41.8% of the participants were 20-40 years old (35% men and 65% women), 30.3% 40-60 years old (40% men and 60% women) and 27.9% older than 60 years (58% men and 42% women).

Design of the study

The validation process consisted in analyzing both the validity and the reliability of the estimated food intakes obtained by using the new food record in a representative population sample. The study design is detailed in Figure 2.

To test reliability, volunteers completed ten of the new food records, divided into two non-consecutive series of five-days (week 1 and week 2), in one month period. Food intake of each week was calculated (portion means per day for each participant), presupposing that there was no intervention which could affect to eating habits between weeks. The objective was to analyze the correlation of food intake data between both series, in terms of food and food group's portions/day.

For the validity study, food intake data of the second day of each five-days series recorded with the new record form was compared with those obtained from a 24 h (gold standard) of the same days. Information obtained from the 24 h was converted to the same units (defined measure of portions) used in the food record. Again, food intake (two days mean values for each participant) obtained from the record designed was compared to that obtained from the 24 h, in terms of food and food group's portions/day.

Two previously trained nutritionist-dietitians informed and trained the volunteers, carried out the 24 h, collected the complimented records and analyzed data. The training consisted in a 40 minutes session in which volunteers were informed of how to complete the record form and how to use the help information about domestic food portion sizes. They were instructed to complete food records daily and that point was monitored by phone calls. Epic-Soft Picture Book for estimation of Food Portion Sizes[17] was used, with the authorization of the authors, to help participants to get used to the size and weight of portions described in the record studied, and to confirm the food intake quantities of the 24 h.

Statistical Analysis

Data were analyzed using the SPSS 18 software package (IBM, New York, USA). After checking that no data continued the normality hypothesis (Kolmogorov-Smirnov), Spearman`s *rho* correlation coefficient and ICC were used to analyze the relation between data (mean values). Significance was set at $p<0.05$ for bilateral contrasts.

RESULTS

Reliability

To assure record reliability in terms of food consumed (Table 1), Spearman`s *rho* correlation coefficient for food intake of each participant´s daily intake (mean value of portions of each food and food group) between the two five-days series (week 1) and (week 2) was calculated. 26.3% of foods presented correlations lower than 0.5, while 73.7% exceeded that value. Among them, 39.5% presented correlations higher than 0.6 and 23.7% higher than 0.7. With regard to food and food subgroups, the highest correlations (>0.7) belonged to bread, breakfast cereals-cookies, fruits and natural juice, milk, infusions-broths-soups, wineraw-cava/ sparkling wine, beer, sugar-honey-marmalade. The lowest ones (<0.4) belonged to lean fish, shellfish, fatty meat and sugary soft-drinks. Most ICC values (88.6%) were higher than 0.6, 68.6% higher than 0.7 being the lowest values those for lean fish, oilyfish, shellfish and fatty meat (0.58%, 0.57%, 0.38% and 0.44% respectively). Table 2 depicts the Spearman's correlation coefficients for the intake of those food groups included in the record. It can be observed that correlation coefficients are above 0.5 for all the food groups; 66.6% presented correlations higher than 0.6 and 44.4% higher than 0.7 and ICCs varied from 0.63 to 0.92, showing from moderate to high reliability.

Validity

Correlations between individual food intake data (mean) of the 330 volunteers taken from the self-administered record designed and consumption recorded by 24 h are described in Table 3. Spearman's correlation coefficient values were high (>0.6): 97.4% higher than 0.7 and 68.4% higher than 0.8. From the total 35 food items, 31 presented ICCs higher than 0.8, 3 from 0.5 to 0.7 and the lowest 0.28 (distilled drinks, liqueurs). Moreover, in food group consumption (Table 4) correlations were also higher than 0.7 in all cases and ICCs were all high (from 0.84 to 0.94).

DISCUSSION

In the present study a food record form was selected because it is not retrospective and thus does not present errors related to memory difficulties[19]. The criterion for designing the record has been usefulness: it is simple and intuitive, as users can register the amount of food consumed by crossing out the box relating to each food portion (or part of portion). Willett[2] explained that studies that compare different methods of quantifying food intake reveal that adding more items, far from increasing the information obtained, can decrease it substantially. Thus, the tools for intake quantification have to be short and to define its objectives clearly[20]. Accordingly, in order to achieve usefulness and accuracy, food lists of food intake quantification procedures are clear, concise and systematically and well organized[6,21].

Tabla 1. Correlation and ICC of food portions (mean values) consumed during Week 1 and Week 2 .

Food	Week 1 portions/day	Week 2 portions/day	Spearman CC	ICC
Bread	1.80	1.75	0.810 (**)	0.874
Rice, pasta	0.26	0.27	0.443 (**)	0.602
Breakfast cereals, cookies	0.61	0.60	0.788 (**)	0.869
Potatoes	0.22	0.25	0.455 (**)	0.643
Pastry	0.30	0.26	0.580 (**)	0.752
Fresh fruit, natural juice	1.73	1.68	0.780 (**)	0.878
Commercial juice	0.11	0.11	0.541 (**)	0.881
Salad, raw vegetables	0.58	0.57	0.618 (**)	0.779
Cooked or mashed vegetables	0.48	0.47	0.467 (**)	0.634
Milk	1.26	1.20	0.727 (**)	0.871
Yogurt	0.40	0.41	0.628 (**)	0,751
Other dairy products	0.08	0.08	0.451 (**)	0.712
Lean cheese	0.11	0.11	0.504 (**)	0.681
Fatty cheese	0.16	0.15	0.527 (**)	0.719
Lean fish	0.24	0.20	0.371 (*)	0.582
Oilyfish	0.31	0.32	0.412 (**)	0.568
Fish (total)	0.55	0.52	0.539 (**)	0.665
Shellfish	0.05	0.05	0.293 (*)	0.379
Lean meat	0.49	0.47	0.432 (**)	0.652
Fatty meat	0.27	0.26	0.336 (*)	0.440
Meat (total)	0.76	0.73	0.455 (**)	0.613
Sausage	0.38	0.34	0.541 (**)	0.718
Egg	0.39	0.40	0.555 (**)	0.741
Legume	0.27	0.27	0.483 (**)	0.675
Nuts	0.24	0.25	0.673 (**)	0.805
Water	3.72	3.61	0.861 (**)	0.911
Infusion, broth, soup	0.45	0.46	0.721 (**)	0.888
Sugary beverages	0.11	0.10	0.389 (*)	0.651
Sugar free beverages	0.05	0.05	0.418 (**)	0.784
Beverages (total)	0.16	0.15	0.486 (**)	0.775
Wine, cava (sparkling wine)	0.58	0.55	0.808 (**)	0.941
Beer	0.24	0.26	0.707 (**)	0.816
Distilled drinks, liqueurs	0.05	0.04	0.523 (**)	0.729
Oil	1.78	1.71	0.693 (**)	0.709
Butter, margarine	0.14	0.12	0.681 (**)	0.869
Chocolate	0.24	0.25	0.602 (**)	0.763
Candy	0.08	0.07	0.511 (**)	0.865
Sugar, honey, marmalade	1.12	1.04	0.829 (**)	0.902

**p<0.01 *p<0.05

Tabla 2. Correlation and ICC of food group portions (mean values) consumed during Week 1 and Week 2.

Food group	Week 1 portions/day	Week 2 portions/day	Spearman CC	ICC
Cereals	2.92	2.94	0.792 (**)	0.849
Vegetables	1.11	1.07	0.672 (**)	0.813
Vegetables and fruit	2.80	2.36	0.562 (**)	0.634
Dairy	2.01	1.96	0.688 (**)	0.825
Fish and shellfish	0.61	0.58	0.564 (**)	0.688
Meat and meat products	1.14	1.07	0.593 (**)	0.777
Sugary products	1.55	1.46	0.823 (**)	0.898
Alcoholic drinks	0.87	0.85	0.815 (**)	0.925
Fat and oils	1.92	1.83	0.716 (**)	0.769

**$p<0.01$

Tabla 3. Correlation and ICC of food portions (mean values) consumed during two days (the second day of each week) recorded by the pre-coded form and 24 h.

Food	Pre-coded food record portions/day	24 h portions/day	Spearman CC	ICC
Bread	1.88	1.89	0.848 (**)	0.904
Rice, pasta	0.28	0.27	0.790 (**)	0.905
Breakfast cereals,cookies	0.60	0.60	0.933 (**)	0.970
Potatoes	0.22	0.24	0.825 (**)	0.928
Pastry	0.28	0.28	0.863 (**)	0.930
Fresh fruit, natural juice	1.76	1.75	0.897 (**)	0.953
Commercial juice	0.13	0.13	0.903 (**)	0.972
Salad, raw vegetables	0.62	0.59	0.819 (**)	0.843
Cooked or mashed vegetables	0.52	0.52	0.810 (**)	0.868
Milk	1.32	1.30	0.897 (**)	0.951
Yogurt	0.40	0.37	0.862 (**)	0.900
Other dairy products	0.09	0.08	0.813 (**)	0.901
Lean cheese	0.12	0.10	0.841 (**)	0.940
Fatty cheese	0.17	0.15	0.782 (**)	0.906
Lean fish	0.19	0.17	0.777 (**)	0.901
Oilyfish	0.37	0.36	0.750 (**)	0.875
Fish (total)	0.56	0.53	0.788 (**)	0.875
Shellfish	0.06	0.06	0.794 (**)	0.619
Lean meat	0.56	0.57	0.790 (**)	0.829
Fatty meat	0.25	0.24	0.810 (**)	0.915
Meat (total)	0.81	0.82	0.764 (**)	0.844
Sausage	0.35	0.39	0.799 (**)	0.825
Egg	0.39	0.39	0.797 (**)	0.878
Legume	0.29	0.27	0.837 (**)	0.932
Nuts	0.26	0.38	0.821 (**)	0.517
Water	3.71	3.58	0.888 (**)	0.936
Infusion,broth, soup	0.47	0.42	0.878 (**)	0.943
Sugary beverages	0.09	0.08	0.823 (**)	0.850
Sugar free beverages	0.05	0.06	0.811 (**)	0.856
Beverages (total)	0.14	0.14	0.840 (**)	0.884
Wine, cava (sparkling wine)	0.61	0.55	0.906 (**)	0.960
Beer	0.20	0.20	0.898 (**)	0.940
Distilled drinks, liqueurs	0.03	0.08	0.652 (**)	0.285
Oil	1.83	1.80	0.824 (**)	0.870
Butter, margarine	0.14	0.13	0.928 (**)	0.962
Chocolate	0.26	0.27	0.882 (**)	0.877
Candy	0.10	0.13	0.723 (**)	0.702
Sugar, honey, marmalade	1.20	1.18	0.910 (**)	0.945

**$p<0.01$

Tabla 4. Correlation and ICC of food group portions (mean values) consumed during two days (the second day of each week) recorded by the pre-coded form and 24 h.

Food Group	Pre-coded food record portions/day	24 h portions/day	Spearman CC	ICC
Cereals	2.96	2.98	0.857 (**)	0.899
Vegetables	1.14	1.10	0.830 (**)	0.872
Vegetables and fruit	2.90	2.86	0.887 (**)	0.931
Dairy	2.09	2.01	0.877 (**)	0.930
Fish and shellfish	0.63	0.60	0.773 (**)	0.837
Meat and meat products	1.15	1.22	0.775 (**)	0.851
Sugary products	1.64	1.67	0.899 (**)	0.942
Alcoholic drinks	0.83	0.84	0.875 (**)	0.939
Fat and oils	1.96	1.93	0.839 (**)	0.895

**$p<0.01$

Food records are usually validated by comparing results from consecutive days by using biomarkers, weight based records, 24 h or combinations of these[22,23]. However, all methods present disadvantages for the validation of sensitive and reliable tools[14]. Taking into account that the accuracy of the food record form developed in the present study is lower than that of the usual records (because it is a short pre-coded record), we decided to analyze both its reliability over time as well as its validity, by comparing the record with a reference method or gold standard[14]. When seasonality is a bias risk it is necessary to confirm reliability over long periods. Nevertheless, the record of the present study corresponds to the food intake of a day, and thus, the variability from one day to other is logical and inherently high. As it is possible to validate food records comparing the intake of correlative record sequences[22], and that too long a study could lead to lack of interest in participants, reliability was evaluated by comparing food intake mean values between two five-days food record sequences separated into two weeks[20]. To assess validity, 24 h was selected as reference method, because it is useful for food record validation, it provides reasonable accuracy without affecting volunteers' intake and it is cheaper and easier to use than the weighed food record[7,14,20,23].

Food record reliability was between 0.29 and 0.86 (mean=0.57) in terms of food or food subgroups (ICCs from 0.38 to 0.94, mean=0.75), and between 0.56 and 0.82 (mean=0.68) for food groups (ICCs from 0.63 to 92, mean=0.80). Reproducibility results are similar to those obtained by other authors in food quantification tool validity studies, in which they observed data between 0.40 and 0.70[20,24,25,26,27]. Among 35 food or food subgroups only 4 obtained weak correlations, (lower than 0.4). Because in the reliability study we compare self-reported food intake of two five-days series separated by two weeks, it can be assumed that correlation and concordance between food intake data (in terms of portions of certain type off food consumed each day) of two different weeks can be, at most, similar, but the normal dietary variation produces some logical moderate CCs.

With regard to the pre-coded record validity *vs.* 24 h, the correlations observed varied from 0.65 to 0.93 (mean=0.83) in terms of food and food subgroups, with ICCs higher than 0.8 for 31 food items and the lowest (0.28) for distilled drinks and liqueurs, probably because when participants have to self-report alcohol they forget it while in the 24 h, being led by a professional, it appears. Regarding those food items with lower CC in the reliability study (lean fish, shellfish, fatty meat and sugary soft-drinks), they all presented Spearman's CC above 0.77 and, except for shellfish, ICCs higher than 0.85. So, we can assume that correlation is low in some items of reliability study because of the normal variation of the diet but that the food record form measures quite good daily food intake. In a similar way to the reliability study, correlations were higher for food groups than for individual food or food subgroups, from 0.77 to 0.89 (mean=0.84) while ICCs ranged from 0.84 to 0.94. These results are sound when compared to those from other pre-coded record validity studies. Chinnock (2006) validated a food record for adults which contained 17 food groups by using as reference method a weighed food record for 7 days and thus obtaining correlations from 0.22 to 0.93 (mean=0.67)[19]. Moreover, the reproducibility in the record validated in the mentioned study was lower than that obtained in the present study, probably because it was a more complex record (it was divided into mealtimes and it included information and photos of portions) and because of the gold standard (weighed food record). Lillegard *et al.*

(2007) validated a pre-coded food diary, which included 277 foodstuffs, to measure energy intake and some nutrient intake in children, where 0.43 and 0.49 mean correlations were obtained[28]. In this case correlation results are lower, the reason could be that 1) the objective of the diary –energy consumed and nutrient quantification– and the transformations required produce greater quantification errors; and that 2) the child population showed less interest, as proposed by authors. Earlier studies, which focused on record validation compared to weighed food records, such as those carried out by Bingham *et al*. (1994) and Becker *et al.* (1998), have demonstrated similar correlation results, with 0.53 and 0.69 correlation coefficients[23,29].

CONCLUSIONS

The solid correlation coefficients and ICCs which were obtained in the reliability and validity studies of the new pre-coded food record designed to assess food intake indicate that this is a reliable tool for the quantification of food intake in terms of food and food group portions of adults living in Spain. The simplicity of the record (information volume and clarity), its intuitive character and the feature of its being self-administered makes it useful as an easy but reliable tool for the description of food group intake.

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COMPETING INTERESTS

The authors have declared no conflict of interest.

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