Nutrición Hospitalaria

Validación de un atlas fotográfico de porciones de alimentos diseñado como una herramienta para estimar visualmente las cantidades de alimentos en Ecuador

Validation of a photographic atlas of food portions designed as a tool to visually estimate food amounts in ecuador

10.20960/nh.2147

OR 2147

Validation of a photographic atlas of food portions designed as a tool to visually estimate food amounts in Ecuador

Validación de un atlas fotográfico de porciones de alimentos diseñado como una herramienta para estimar visualmente las cantidades de alimentos en Ecuador

María Pilar Villena-Esponera[1,2], Rafael Moreno-Rojas[1], Sonia Mateos-Marcos[2], Marco-Vinicio Salazar-Donoso[2] and Guillermo Molina-Recio[3]

[1]Department of Food Science and Technology. Universidad de Córdoba. Agrifood Campus of Excellence International CeiA3. Córdoba, Spain. [2]Department of Food Safety and Quality. Pontificia Universidad Católica del Ecuador Sede Esmeraldas (PUCESE). Esmeraldas, Ecuador. [3]Department of Nursing, School of Medicine and Nursing. Universidad de Córdoba. Córdoba, Spain. NURSE group. ADENYD

Received: 14/06/2018
Accepted: 11/07/2018
Correspondence: María Pilar Villena Esponera. Department of Food Science and Technology. Universidad de Córdoba. Agrifood Campus of Excellence International CeiA3. Campus Rabanales, ed. Darwin – Anexo. 14014 Córdoba, Spain
e-mail: pilar.villena@hotmail.com
DOI: 10.20960/nh.2147

ABSTRACT

Introduction: the use of real images of food portions constitutes a useful and effective tool to help measure the amount of food consumed.

Objective: to validate content and visual perception of the images of a photographic atlas of food portions designed for Ecuador.

Methods: first, eight experts assessed the content in an atlas of food portions, using the Delphi technique. Then, 56 adults (aged 18-59) gave an assessment

of their visual perception of about 35 portions of nine selected products. The concordance in the estimation using the atlas *versus* an estimation without the atlas was evaluated through the intra-class correlation coefficient (ICC), the Bland-Altman graphical method, and a hypothesis contrast. The differences between the real amounts and the estimation were assessed using the Wilcoxon test ($p < 0.05$). For each of the food items, the percentage of participants who chose the correct photograph, the one directly above or below was calculated.

Results: the assessment carried out by experts showed that this instrument is relevant and appropriate. ICC values of between 0.576 and 0.956 were obtained using the atlas, as well as significant differences between the real amounts and the estimation without the atlas ($p < 0.001$). There was a sufficient correlation between the actual image and its perception for all food items except mayonnaise. The correct photograph was chosen in 66% of 500 estimations.

Conclusions: the photographic atlas of food portions for Ecuador is an appropriate tool for helping to estimate the amount of food consumed by adults.

Key words: Photographs. Food. Delphi technique. Visual perception. Ecuador.

RESUMEN

Introducción: utilizar imágenes reales de porciones de alimentos es útil y efectivo para estimar la cantidad de alimentos consumidos.

Objetivo: validar el contenido y la percepción visual de las imágenes de un atlas fotográfico de porciones de alimentos diseñado para Ecuador.

Métodos: primero, ocho expertos evaluaron el contenido de un atlas de porciones de alimentos utilizando la técnica Delphi. Luego, 56 adultos (18-59 años) participaron en la evaluación de la percepción visual de 35 porciones de nueve productos seleccionados. La concordancia en la estimación utilizando el atlas respecto a una estimación sin el atlas se evaluó a través del coeficiente de correlación intraclase (CCI), el método gráfico de Bland-Altman y el contraste de hipótesis. Las diferencias entre las cantidades reales y las estimadas se evaluaron mediante la prueba de Wilcoxon ($p < 0,05$). Para cada

alimento, se calculó el porcentaje de participantes que eligieron la fotografía correcta, la adyacente superior o la inferior.

Resultados: la evaluación realizada por expertos mostró que esta herramienta es relevante y apropiada. Se obtuvieron valores de CCI entre 0,576 y 0,956 utilizando el atlas, así como diferencias significativas entre las cantidades reales y la estimación sin el atlas ($p < 0,001$). Hubo una adecuada concordancia entre la percepción de la imagen realizada y la imagen real para todos los alimentos, excepto para la mayonesa. La fotografía correcta fue elegida en el 66% de las 500 estimaciones realizadas.

Conclusiones: el atlas fotográfico de porciones de alimentos para Ecuador es una herramienta apropiada para ayudar en la estimación de la cantidad de alimento consumido.

Palabras clave: Fotografías de alimentos. Validación. Tamaño de porción. Ecuador.

INTRODUCTION

One major limitation when carrying out food surveys is how to measure the size of the portions of the food consumed, mainly because its estimation depends on the respondent's short term memory (1) and the interviewer's experience. The errors that are made lead to a bias in the evaluation of nutrient intake (2), and it is therefore necessary to design tools that achieve greater accuracy in measuring each person's food consumption (2,3).

A number of different visual methods are used to help reduce the error in the estimation of food consumption, for example: the use of household measures, common objects such as dice, tennis balls, desk of cards, etc., to relate their size to the portions consumed (3-5). However, the most common errors in using these methods occur when estimating high-volume but low-weight portions of foods (6).

The use of real images of food portions constitutes a useful and highly effective tool to help measure the amount of food consumed (7-14). It also has the advantage of being easily adaptable to local conditions, because it is cheap, easily photocopied and portable (15) and is widely considered as being the tool which most accurately represents the actual food consumed compared to other methods (7). Although, in Ecuador, some manuals and photographic atlases of

typical dishes, portions (16) or recipes that can help to measure the amount of food consumed do exist, no visual tool for measuring food consumption has yet been correctly validated and published.

The aim of this study was to check the validity of the content and perception of the images from a photographic atlas of food portions in Ecuador, which was designed as a tool to help adults estimate the weight of their food portions.

METHODS

Design of the photographic atlas

The selection of foods and prepared dishes was based on information obtained through R24h from several research projects (17-19) and the National Health and Nutrition Survey of Ecuador (20). The 68 food items selected were divided into different groups: dairy products, eggs, meat and meat products, fish and seafood, legumes, cereals and tubers, vegetables, fruit, cakes and desserts, oils, fats and sugar, drinks and, finally, a series of traditional Ecuadorian dishes, based on the results of the study by Sánchez-Llaguno et al. (17).

Unfortunately, at the time of designing this photographic food atlas, there were no local or regional data available for measuring the 5th and 95th percentile of the portion size consumed in the country for different foods, which might have helped us to produce a series of images based on these data with fixed increases in the portion sizes. In addition, for many foods, the proportional increase of the portion size of the servings made it impossible to show the actual size of the food consumed, and so an expert committee in Ecuadorian cuisine was called in to establish a range of typical portion sizes for a variety of individuals.

For each food item, the portion was weighed before being photographed, using a Laica Compact Ks1015 electronic scale with 1 g/0.05 oz. precision, and three to four photographs were taken showing a standard portion, as well as larger or smaller amounts, thus making it possible to measure intermediate portions between the images presented in the photographic atlas.

For the technical side of the photography, we used the recommendations set out for the picture books the PANCAKE (21) and PANEU (22) project, which has been used to compile the photographic atlases used in the ENALIA (23,24)

surveys, which were validated by the European Food Safety Authority (EFSA) as part of the EU Menu project.

The technical specifications were as follows:

1. Scale and size: all photographs were taken on a scale of 1:1, with a 4-5MB photo size and dimensions of 120 x 80 cm.
2. Camera angle: the photographs were taken at an angle of 35-52 degrees. Glasses were photographed at an angle of approximately 14 degrees.
3. The tableware used was white and of the size normally used in the study area:
    - Flat, white plates. External diameter: 25 cm; internal diameter: 15.5 cm.
    - Deep, white dish. External diameter: 19 cm; height: 5 cm.
    - Glass: Glass. Upper diameter: 7.5 cm; lower diameter: 4 cm. Length: 11.5 cm.
    - Wide-topped glass: Glass. Upper diameter: 8 cm; lower diameter: 5 cm. Length: 7 cm.
    - Cutlery: stainless steel. Length of fork: 18 cm; length of knife: 20 cm. Tablespoon: length, diameter: 6 cm; width, diameter: 4 cm. Teaspoon: length, diameter: 4.5 cm; width, diameter: 3 cm. Coffee spoon: length, diameter: 3 cm; width, diameter: 2.5 cm.

The photographic atlas was submitted to a validation process before proceeding to its publication, as detailed in figure 1 and below.

Validation of the photographic atlas

Study 1: evaluation by experts

Following the criteria of Hernández et al. (8), who designed a photographic food atlas for Venezuela, a qualitative validation process was carried out by a committee of recognized experts in the field of nutrition. The process of choosing the eight expert judges was based on the following inclusion criteria: a) an outstanding academic or professional career in their specific area (food, nutrition, education); b) proven interest in the health and nutrition fields; c) experience in decision-making; and d) participation in actions, policies and/or programmes linked to food and nutrition issues.

So as not to place limits on the experts' judgment when evaluating the proposed items, the qualitative Delphi technique was used to establish a dynamic process of change, feedback and decision making (25). This technique involves using a series of anonymous rounds to consult the committee of experts on different themes, with the aim of achieving a consensus, while allowing the participants maximum autonomy.

Using an evaluation format consisting of dichotomous responses and open questions for each item, they were asked to evaluate the appropriacy, relevance, design and structure, number of photographs, sequence of information, format and number of food items in the photographic atlas (first round). Next, the research team checked the contributions offered by the judges and incorporated them into the photographic atlas. The edited document was then sent out again for a second round of evaluations, together with a questionnaire evaluating the same issues as before, but using a selection of four answers and an open question for them to give their general assessment of the survey. Thanks to the broad consensus reached in this second round, it was not deemed necessary to carry out further rounds of evaluation.

Study 2: validation of food photographs

In January 2017, 61 adults (aged 18-58 years), belonging to the Pontifical Catholic University of Ecuador, were invited to participate as volunteers in the study. It was decided that the inclusion criterion for participation in the study would be for them to be students, teachers, or university service personnel who were 18 years of age or older and could read and write.

To carry out the analysis of perception, based on the comparison between a portion of pre-weighed food and its estimated one using the photographic food atlas (26), nine different food items were selected (peas, cereals, *chaulafán* [fried rice], carbonated soft drinks, lentils, mayonnaise, fish, cottage cheese and noodles) represented by the four different portion sizes included in the photographic atlas (except for *chaulafán*, represented by three images). In total, 35 portions were selected and prepared for the analysis.

The prepared dishes were identified with a code formed by a letter to identify each dish and another letter to define the portion (L, R, X, V), making sure that

the code did not provide any clues to the size of the portion presented. Each participant was randomly presented with one portion of each of the different foods (nine dishes per person). None of the participants had consumed the food previously.

The estimation of the amount of food present in the dish was made by two means: a) selecting the image of reference in the photographic atlas; and b) an estimation backed up by a nutritionist, who supplied the participants with household reference measures (10).

The study design was approved by the University of Córdoba (Spain) and all the participants were required to sign an informed consent form.

Statistical analysis

The first step in assessing the concordance in the estimation of the amount of food using the photographic atlas *versus* an estimation without it was to employ the intra-class correlation coefficient, with values > 0.40 considered to be acceptable and those > 0.75, as excellent (27), and with the Bland-Altman graphical method for all the food portions analysed (28). This graph includes a horizontal line to mark the mean difference, and two other lines known as limits of agreement, at a distance of ± 1.96 DE; the lower the range between these two limits, the better the agreement. A hypothesis contrast test between the real means and the means obtained by using the atlas or not, using Student's t-test, was also performed.

The results of the estimates made using the photographic atlas and the real measurements were then compared. As proposed by Nelson et al. (26), the percentage of the differences between the estimation using the atlas and the real quantity was calculated using the following formula:

% Differences = [(estimated-real) / real] x 100

A negative difference indicates underestimation, while a positive difference indicates overestimation of that particular portion. To test whether using the atlas significantly overestimated or underestimated portion sizes, the Wilcoxon non-parametric test was used to compare the estimated weights with the actual weights.

Finally, for each of the foods, the percentage of participants who chose the correct photograph (C), the one just above (O) or the one just below (U), was

determined when comparing the foods in the photographs of the atlas, calculating the level of agreement between both measurements using the Kappa index (29). To work out the differences in estimation per sex, training and BMI, the Chi-square test was used. The statistical calculations were carried out using SPSS version 15.0 (SPSS Inc., Chicago, United States) and Epidat version 4.1 (Consellería de Sanidad, Xunta de Galicia, Spain). In all the statistical tests, the significance level used was $p < 0.05$.

RESULTS

Evaluation by experts

In the first evaluation round, the eight experts evaluated all the aspects defined positively. However, they made a series of suggestions and observations that were checked out by the research team and included in the photographic atlas: including changes in the photographs taken for the series of beverages, inclusion of 12 series of photographs (reaching a total of 80 food items) and inclusion of the nutritional value for each food ration. In the second evaluation round, the seven experts who took part considered all the issues analyzed to be either suitable or extremely suitable. After obtaining this unanimous agreement on all the aspects evaluated by the experts participating in this round and its positive general assessment, the survey was not evaluated further, and the content of this Ecuadorian photographic food atlas was considered to be validated.

Validation of food photographs

After reviewing the survey, five participants were ruled out for presenting incomplete or incorrect information in their assessments. Four food ration evaluations were also rejected due to a duplicated selection of images. Finally, 500 food rations were evaluated by 56 participants, 67% of whom were female, with a mean age of 27 ± 8.7 years. The participants were classified according to their BMI as 41% normal, 41% overweight and 18% obese, and their level of education was 4% primary school, 36% secondary school, 35% university students and 25% graduate or postgraduate students.

The intra-class correlation coefficient (Table I) produced excellent concordance values between the real and estimated portions using the photographic atlas

for all foods (> 0.75), except for fish and mayonnaise, which had adequate concordance values (> 0.40). The values obtained from this same index to evaluate the concordance between the real portion and the estimate without the atlas show values of below 0.75 (data not shown), indicating little or no agreement, for lentils (0.276), mayonnaise (0.026) and noodles (0.388). The highest ICC value in the estimation without the atlas was obtained for *chaulafán* (0.713).

The actual food quantities (mean and SD) are shown, together with the quantities estimated with photographs, in table I. The amounts of three foods (ranging from 1.4% for pea to 6.5% for *chaulafán*) were overestimated, while another six were underestimated (ranging from 0.7% for mayonnaise to 36.5% for cereals).

Figure 2 shows that for the sum of all food portions estimated by each participant, the average difference between the weights of the estimated portion sizes is -20.53 g using the atlas and -201.25 g if done without the atlas, with significant differences between the estimate without the atlas and the amount of actual food present on the plate ($p < 0.001$). The 95% agreement limits range from -255.20 to 214.13 using the photographic atlas, whereas without the atlas they range from -1,410.37 to 1,007.87.

For each of the portions of the foods selected in the validation of the photographic atlas, the percentages of correctly estimated, overestimated and underestimated ones were analysed (Table II). The assessment perception of the images corresponding to the smaller portion (portion A) were correct (80-100%) for peas, cereals, *chaulafán,* carbonated soft drinks, fish, cottage cheese and noodles. The worst performance was for mayonnaise, with a 6% correctly estimated and an overestimation of 88% for the size of this portion, followed by lentils, with a 50% correctly estimated and an overestimation of 43% of the portions of this size.

In the evaluation of the middle portion (portion B), cereals, *chaulafán* and mayonnaise obtained a correctly estimated over 70%. Cottage cheese obtained the worst performance (18% correctly estimated). In the case of cottage cheese, the deviation was produced exclusively for the biggest portion (76%). In the evaluation of portion C, carbonated soft drinks, *chaulafán* and mayonnaise obtained a correct estimation of either excellent or good. Portion C

of the fish was not successfully chosen by any evaluator, who chose the next portion (portion B) or portion A (54%, data not shown) on 46% of the occasions. As for cereals and lentils, the smaller portion of food was chosen.

Finally, when evaluating the largest portions represented (portion D), high correct estimations for peas, carbonated soft drinks, lentils, fish and cottage cheese were obtained. However, cereals and noodles produced a high level of deviation towards the smaller food portions.

Taking all the serving sizes for each of the foods selected for validation into account, those with a high percentage of hits were *chaulafán* (n = 53, 89%), carbonated soft drinks (n = 56, 86%) and peas (n = 56, 79%). Mayonnaise (n = 56, 39%) was the food with the lowest hit rate. The agreement between the image as perceived by the evaluators and the corresponding real image, measured by Cohen's kappa coefficient, was excellent for *chaulafán* and carbonated soft drinks ($p < 0.001$); good for peas ($p < 0.001$); moderate for cereals, fish, cottage cheese and noodles ($p < 0.001$); and poor or weak for lentils and mayonnaise ($p < 0.001$). There was no statistically significant link between the correct estimation of portion sizes and sex, nutritional status (BMI) and level of studies ($p > 0.05$).

Photographic atlas

Once the recommendations had been included and the relevant modifications made, the Photographic Atlas and Tables of Food Composition of Ecuador was published with 80 items of food, represented by 3-4 servings, which generated a total of 298 colour photographs of the different sizes of food portions with information on their composition.

Figure 3 shows an example of the photographs included in the atlas. As can be seen, the food is included with a number of portions in order of size, their net weight in grams and, in some cases, a reference to other possible foods to use their image and estimate their weight.

DISCUSSION

As far as we know, this is the first study made to develop and validate a visual tool to estimate food portions in Ecuador, with the purpose of reducing the error generated when estimating the portions consumed by participants in

nutritional studies. With this tool, in addition to measuring the portions of the 80 foods represented, it is possible to choose a portion size between the different images or use one of the images to represent another product of similar proportions and appearance.

As a first step, as commented by Hernández et al. (8), it was considered to be important to obtain an assessment by experts in the field of nutrition. The observations indicated by the different judges were included, and this helped to improve the quantity and quality of the images presented in the photographic atlas. In addition, on the recommendation of the experts, the photographic atlas includes the nutritional composition for each food portion, using Nutriplate 2.0 software (30) developed by the University of Córdoba (Spain) for its calculation.

A validation process was then performed by the instrument, which, as shown by Nelson et al. (10), allows us to evaluate cognitive processes such as perception, conceptualization and memory. In this study, perception (the ability to link a real amount of food to that shown in a photograph) was evaluated, but conceptualization and memory could not be assessed because when the estimates were made, no time had elapsed between seeing the food and using the photographic atlas. This approach is, in fact, less realistic than evaluation in a 24-hour recall situation; nevertheless, it has the advantage of allowing a larger number of estimates of food portions to be made in a one-day session (31) and permits us to understand, correct and prevent the causes of error in estimating portion size when used in clinical and educational contexts, where the aim is to help subjects identify portions of a certain size in relation to a clinical objective (26).

For the validation, nine food items and the 3-4 portions represented in the photographic atlas were selected. Although the number of food portion items validated in this study is not representative of all the foods included in the atlas, we feel that we have chosen those foods which are most commonly consumed or most difficult to estimate (31). In addition, since it was a study in which the participants did not consume the food, it should be noted that it was important not to include an excessive number of food items so as not to tire the participants (26).

The results show that the use of the photographic atlas of food items estimates the amount of food presented more reliably than estimations without it. However, in our study, two of the nine food items analysed produced errors, which suggest problems for their estimation: cereals and fish. For cereals, the mean difference between the size of the serving and the estimated portion sizes was high (-36.5%). This difference is due to an underestimation of the portion, in particular the middle portion (C), where the users underestimated the portion in 75% of the estimates made. This error could be ascribed to the fact that the reduced angle in the photograph did not make the depth of the portion very clear. Nelson et al. (10) comment that evaluating the amount of cereals on a plate would be more successful if the participants had a better idea of the width of the part of the plate not covered by the cereal by reducing the camera angle when the photographs are taken.

In the case of fish, we feel that the errors produced were due to the difference in shape and size of the portion on the plate compared to that shown in the photographs. The images from the photographic atlas showed portions of fish, whereas the plate contained a whole fish fillet. This problem, where the number of food units presented differs from what is shown in the photographs, has already been commented on by other authors (32).

The other foods showed mean differences of -6.2% to +6.5%, and these ranges are similar to those found by other authors. Huybregts et al. (15) reported that the mean differences between the actual size of the serving and the estimated portion size were between -8.4% for couscous and + 6.3% for liquid sauces, while Turconi et al. (13) found mean differences of between -2.7% for bread and +15.9% for vegetables. The range was wider in the study by Robson et al. (33) with differences of between +37.6% (muesli) and -23.3% (crispy rice) and in Venter et al. (5), who found +54.0% for bread and -35.3% for tomato sauce and onions.

The fact that some food items seem to be more difficult to estimate accurately than others is a common finding (31,33). Results from previous studies based on perception found that the estimation varied widely between foods (10,33-37). In the study by Keyzer et al. (38), in which the three cognitive processes of perception, memory and conceptualization were evaluated, errors were found

with some food items (e.g., beverages, margarine and bread) while, at the group level, the estimation of food quantities was acceptable.

The different directions and variations in the error associated with different food items highlighted the importance of measuring the extent to which they agreed and not just the mean differences. The proportion of portions estimated correctly was 66%, which was close to the results of previous studies: Ovaskainen 50% (37), Amougou 77% (39), Souza 68% (40), Venter 68% (5), Trolle 50% (23), Lucas 49% (3) and López 60.9% (2). Like other authors (32,37,41), the smallest portion produced the best mean values for correct estimation (80%). It is logical for the smaller portions to obtain higher values of overestimation due to the large amount of images available for selecting a larger portion. However, only in the case of carbonated soft drinks and mayonnaise did we observe the trend found by other authors, where the sizes of the small portions are overestimated and those of the large portions are underestimated (10,11). Other studies showed that the food items served in sauce, without a clearly defined shape, were more difficult to estimate (5,12,15,31). This situation was reflected in our study in the case of mayonnaise, which registered a low percentage for accuracy in estimating the portion (only 39% of estimates were correct).

Some authors suggest that the ability to evaluate the amount of food on a plate can be influenced by certain characteristics of the participants such as age, sex, body mass index or level of studies (10,29,42). However, as in our study, other authors did not find any differences in the evaluation of the portion according to these variables (5,7,13,33,43). Nevertheless, although the subjects chosen represent a fair sample of the adult population as regards literacy (1,10,31,35), we feel it would be better to replicate this study in a population with a low level of education, below adult age or older adults.

After the (qualitative and quantitative) analysis, we can conclude that the Photographic Atlas and Tables of Food Composition of Ecuador (44) developed in this study is a useful and effective tool that allows us to make a more accurate estimation of the amount of food in a portion.

ACKNOWLEDGMENTS

The authors are grateful to the experts of nutrition who participated in the study for their contributions. In addition, we thank the teachers, students and the university service personnel of the Pontificial Catholic University of Ecuador in Esmeraldas (PUCESE) for their participation in the validation study.

FUNDING

This study was supported by the Universidad de Córdoba (UCO) and the Pontificia Universidad Católica del Ecuador Sede Esmeraldas (PUCESE).

REFERENCES

1. Lazarte CE, Encinas ME, Alegre C, Granfeldt Y. Validation of digital photographs, as a tool in 24-h recall, for the improvement of dietary assessment among rural populations in developing countries. Nutr J 2012;11:61. DOI: 10.1186/1475-2891-11-61
2. López BL, Longo NE, Carballido PM, Di Carlo P. Validación del uso de modelos fotográficos para cuantificar el tamaño de las porciones de alimentos. Rev Chil Nutr 2006;33:480-7.
3. Cypel YS, Guenther PM, Petot GJ. Validity of portion-size measurement aids: a review. J Am Diet Assoc 2006;97:289-92.
4. Byrd-Bredbenner C, Schwartz J. The effect of practical portion size measurement aids on the accuracy of portion size estimates made by young adults. J Hum Nutr Diet 2004;17:351-7.
5. Venter CS, MacIntyre UE, Vorster HH. The development and testing of a food portion photograph book for use in an African population. J Hum Nutr Diet 2000;13:205-18.
6. Ferrari MA. Estimación de la ingesta por recordatorio de 24 horas. Diaeta 2013;31:20-5.
7. Navarro A, Cristaldo PE, Díaz MP, Eynard AR. Atlas fotográfico de alimentos para cuantificar el consumo de alimentos y nutrientes en estudios nutricionales epidemiológicos en Córdoba, Argentina. Rev Fac Cienc Méd (Córdoba) 2000;57:67-74.
8. Hernández P, Bernal J, Morón M, Velazco Y, Oráa E, Mata C. Desarrollo de un atlas fotográfico de porciones de alimentos venezolanos. Rev Esp Nutr Hum Diet 2015;19:68-76.

9. Anderson AS, Barton K, Craigie A, Freeman J, Gregor A, Stead M, et al. Exploration of adult food portion size tools. NHS Health Scotland 2008. Accessed on March 2017. Available from: http://www.healthscotland.com/documents/2548.aspx
10. Nelson M, Atkinson M, Darbyshire S. Food photography I: the perception of food portion size from photographs. Br J Nutr 1994;72:649-63.
11. Nelson M, Atkinson M, Darbyshire S. Food photography II: use of food photographs for estimating portion size and the nutrient content of meals. Br J Nutr 1996;76:31-49.
12. Korkalo L, Erkkola M, Fidalgo L, Nevalainen J, Mutanem M. Food photographs in portion size estimation among adolescent Mozambican girls. Public Health Nutr 2013;16:1558-64.
13. Turconi G, Guarcello M, Berzolari FG, Carolei A, Bazzano R, Roggi C. An evaluation of a colour food photography atlas as a tool for quantifying food portion size in epidemiological dietary surveys. Eur J Clin Nutr 1995;59:923-31.
14. Subar AF, Crafts J, Zimmerman TP, Wilson M, Mittl B, Islam NG, et al. Assessment of the accuracy of portion size reports using computer-based food photographs aids in the development of an automated self-administered 24-hour recall. J Am Diet Assoc 2010;110:55-64.
15. Huybregts L, Roberfroid D, Lachat C, Van Camp J, Kolsteren P. Validity of photographs for food portion estimation in a rural West African setting. Public Health Nutr 2008;11:581-7.
16. Ministerio de Inclusión Económica y Social. Atlas fotográfico, porciones y alimentos. MIES – Programa Aliméntate Ecuador; 2010.
17. Sánchez-Llaguno SN, Neira-Mosquera JA, Pérez-Rodríguez F, Moreno-Rojas R. Preliminary nutritional assessment of the Ecuadorian diet based on a 24-h food recall survey in Ecuador. Nutr Hosp 2013;28:1646-56.
18. Neira-Mosquera JA, Pérez-Rodríguez F, Sánchez-Llaguno SN, Moreno-Rojas R. Study on the mortality in Ecuador related to dietary factors. Nutr Hosp 2013;28:1732-40.
19. Freire WB, Silva-Jaramillo KM, Ramírez-Luzuriaga MJ, Belmont P, Waters WF. The double burden of undernutrition and excess body weight in Ecuador. Am J Clin Nutr 2014;100(Suppl.) S1636-43.

20. INEC. Encuesta Nacional de Salud y Nutrición - ENSANUT. Ministerio de Salud Pública de Ecuador; 2012. Accessed on October 2016. Available from: http://www.salud.gob.ec/encuesta-nacional-de-salud-y-nutricion-ensanut/
21. Trolle E, Vandevijvere S, Ruprich J, Ege M, Dofková M, De Boer E, et al. Validation of a food quantification picture book targeting children of 0-10 years of age for Pan-European and national dietary surveys. Br J Nutr 2013;110:2298-308.
22. Ambrus Á, Horváth ZS, Farkas ZS, Cseh J, Petrova S, Dimitrov P, et al. Pilot study in the view of a Pan-European dietary survey - Adolescents, adults and elderly. EFSA J 2013;10(11):EN-508,104. DOI: 10.2903/sp.efsa.2013.EN-508
23. AECOSAN. Atlas fotográfico ENALIA. 2013. Accessed on March 2017. Available from: http://www.aecosan.msssi.gob.es/AECOSAN/docs/documentos/seguridad_alimentaria/gestion_riesgos/atlas_enalia.pdf
24. AECOSAN. Atlas fotográfico ENALIA 2. 2014. Accessed on March 2017. Available from: http://www.aecosan.msssi.gob.es/AECOSAN/docs/documentos/seguridad_alimentaria/gestion_riesgos/atlas_fotografico_enalia_2.pdf
25. Landeta J. El método Delphi. Una técnica de previsión para la incertidumbre. Barcelona: Ariel; 1999.
26. Nelson M, Haraldsdóttir J. Food photographs: practical guidelines I. Design and analysis of studies to validate portion size estimates. Public Health Nutr 1998;1:219-30.
27. Willett W. Nutritional epidemiology. 2nd ed. New York: Oxford University Press; 1998.
28. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986;307-10.
29. Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. Phys Ther 2005;85:257-68.
30. Moreno Rojas R, Pérez-Rodríguez F, Cámara Martos F. Nutriplato 2.0 web para valoración de recetas y platos de libre uso. In: XVI Jornadas Nacionales de Nutrición Práctica. Madrid; 2012. Accessed on April 2015. Available from: http://europeana.eu/portal/record/2022701/oai_helvia_uco_es_10396_7845.html

31. Tueni M, Mounayar A, Birlouez-Aragon I. Development and evaluation of a photographic atlas as a tool for dietary assessment studies in Middle East cultures. Public Health Nutr 2012;15:1023-8.
32. Lucas F, Niravong M, Villeminot S, Kaaks R, Clavel-Chapelon F. Estimation of food portion size using photographs: validity, strengths, weaknesses and recommendations. J Human Nutr Diet 1995;8:65-74.
33. Robson PJ, Livingstone MBE. An evaluation of food photographs as a tool for quantifying food and nutrient intakes. Public Health Nutr 2000;3:183-92.
34. Bonifacj C, Gerber M, Scali J, Daures JP. Comparison of dietary assessment methods in a southern French population: use of weighed records, estimated-diet records and a food-frequency questionnaire. Eur J Clin Nutr 1997;51:217-31.
35. Lillegaard ITL, Øverby NC, Andersen LF. Can children and adolescents use photographs of food to estimate portion sizes? Eur J Clin Nutr 2005;59:611-7.
36. Weber JL, Cunningham-Sabo L, Skipper B, Lytle L, Stevens J, Gittelsohn J, et al. Portion-size estimation training in second- and third-grade American Indian children. Am J Clin Nutr 1999;69(Suppl.) S782-7.
37. Ovaskainen ML, Paturi M, Reinivuo H, Hannila M-L, Sinkko H, Lehtisalo J, et al. Accuracy in the estimation of food servings against the portions in food photographs. Eur J Clin Nutr 2008;62:674-81.
38. De Keyzer W, Huybrechts I, De Maeyer M, Ocké M, Slimani N, Van't Veer P, et al. Food photographs in nutritional surveillance: errors in portion size estimation using drawings of bread and photographs of margarine and beverages consumption. Br J Nutr 2011;105:1073-83.
39. Amougou N, Cohen E, Mbala ML, Grosdidier B, Bernard JY, Saïd-Mohamed R, et al. Development and validation of two food portions photograph books to assess dietary intake among adults and children in Central Africa. Br J Nutr 2016;115:895-902.
40. Souza RGM, Campos MIVAM, Cordeiro MM, Monegro ET, Peixoto MRG. Validation of food's photographs for estimating the consumption food. Rev Nutr (Campinas) 2016;29:415-24.
41. Vereecken CA, Covents M, Matthys C, Matthys C, Maes L. Young adolescents' nutrition assessment on computer (YANA-C). Eur J Clin Nutr 2005;59:658-67.

42. Almiron-Roig E, Solis-Trapala I, Dodd J, Jebb SA. Estimating food portions. Influence of unit number, meal type and energy density. Appetite 2013;71:95-103.
43. Harris-Fry H, Paudel P, Karn M, Mishra N, Thakur J, Paudel V, et al. Development and validation of a photographic food atlas for portion size assessment in the southern plains of Nepal. Public Health Nutr 2016;19:2495-507.
44. Villena Esponera MP, Moreno Rojas R, Mateos Marcos S, Molina Recio G. Atlas fotográfico y tablas de composición de alimentos del Ecuador. 1st ed. Córdoba: UCOPress; 2017.

Table I. Comparisons between mean actual and estimated portion sizes, mean percentage difference and intra-class correlation coefficients (ICC), using the photographic atlas (56 Ecuadorian adults, January 2017)

Food	*n*	*ICC (95% IC)*	*Actual portion size (g)*		*Estimated portion size (g)*		*Difference * (%)*
			Mean	SD	Mean	SD	
Pea	56	0.935 (0.889-0.962)	84.5	7.0	85.6	7.0	+1.4
Cereals	56	0.880 (0.795-0.930)	45.8	5.0	29.1	4.0	-36.5†
Chaulafán (fried rice)	53	0.956 (0.923-0.974)	227.9	22.0	242.6	24.1	+6.5
Carbonated soft drinks	56	0.955 (0.923-0.974)	120.9	8.3	119.6	8.3	-1.0
Lentils	55	0.891 (0.813-0.937)	85.2	5.0	81.1	5.6	-4.8
Mayonnaise	56	0.576 (0.277-0.752)	12.0	0.8	11.9	0.5	-0.7
Fish	56	0.678 (0.450-0.811)	100.2	6.1	88.1	6.5	-12.0†
Fresh cheese	56	0.912 (0.850-0.949)	126.9	10.2	134.0	10.0	+5.6
Noodle	56	0.955 (0.924-0.974)	141.4	11.0	132.7	10.9	-6.2

*% Difference: [(estimated – actual)/actual] x 100. Difference between actual amounts and amounts estimated assessed by a signed rank test. Difference is significant at †$p < 0.05$.

Table II. Percentage of participants estimating the correct (C), overestimated (O) and underestimated (U) portion size using the photograph atlas with kappa agreement statistics (56 Ecuadorian adults, January 2017)

Food	*Portion A*			*Portion B*				*Portion C*				*Portion D*			*Total*				*kappa* *
	n	C	O	n	C	O	U	n	C	O	U	n	O	U	n	C	O	U	
Pea	14	100	0	18	67	33	0	13	62	8	23	11	91	9	56	79	13	7	0.71
Cereals	11	100	0	14	79	0	21	16	25	0	75	15	40	53	56	57	0	41	0.43
***Chaulafán* (fried rice)**	30	97	3	14	71	21	7	9	89	11	0	-	-	-	53	89	9	2	0.81
Carbonated soft drinks	17	94	6	14	64	7	21	14	100	0	0	11	82	18	56	86	4	9	0.81
Lentils	14	50	43	18	44	17	39	10	30	20	50	13	92	0	55	55	20	22	0.38
Mayonnaise	17	6	88	14	71	21	7	11	73	9	9	14	21	29	56	39	34	11	0.20
Fish	11	82	18	14	43	50	7	13	0	0	46	18	94	0	56	57	16	13	0.43
Fresh cheese	11	100	0	17	18	76	0	15	73	0	20	13	92	0	56	66	23	5	0.51
Noodle	10	100	0	13	69	0	31	15	67	33	0	18	44	50	56	66	9	23	0.55

*Agreement levels: poor, k ≤ 0; slight, 0.01 ≤ k ≤ 0.20; modest, 0.21 ≤ k ≤ 0.40; moderate, 0.41 ≤ k ≤ 0.60; substantial, 0.61 ≤ k ≤ 0.80; almost perfect, 0.81 ≤ k ≤ 1.0.

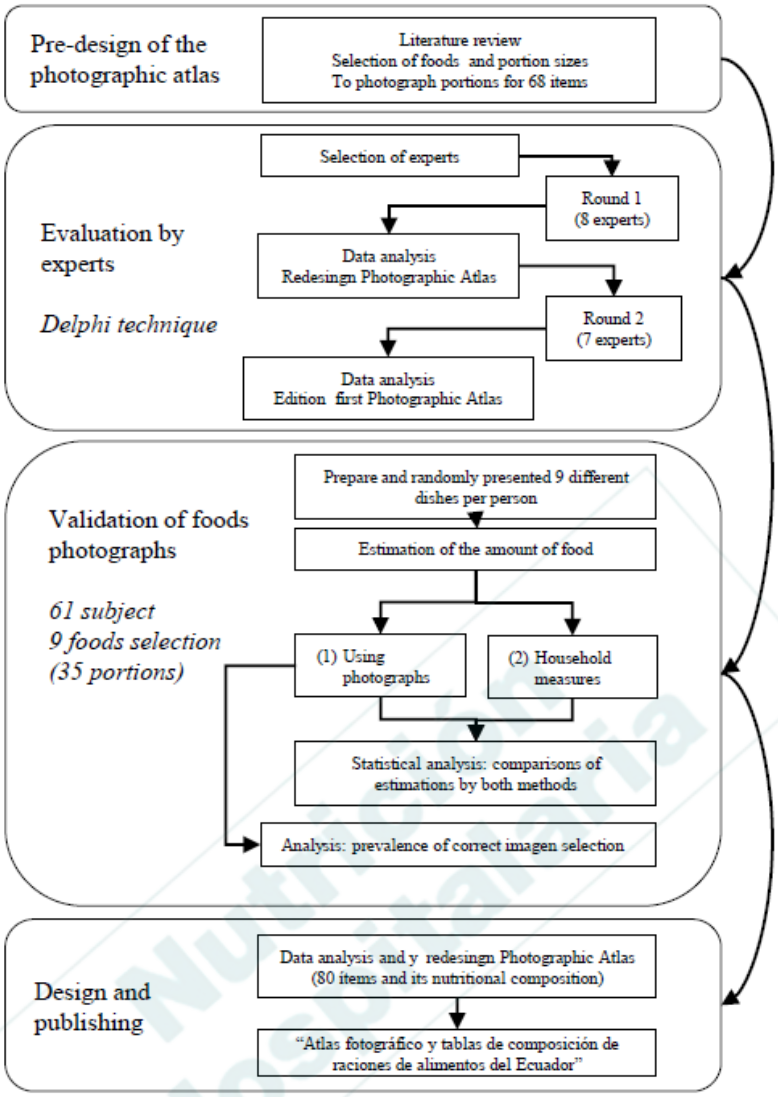

Fig. 1. Design of the validation study: validation of the content by experts and validation of food photographs.

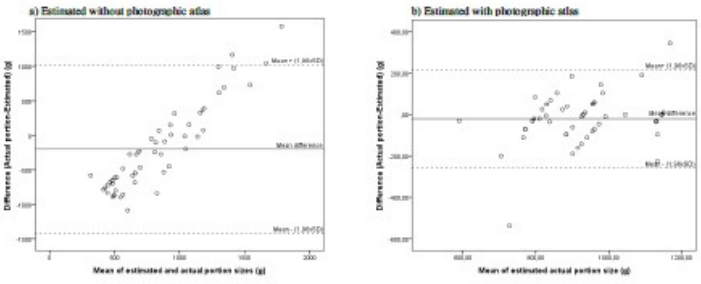

Fig. 2. Bland-Altman plots showing the mean difference () and 95% limits of agreement (– – –) between the sum of all portions estimated and the actual portions sizes for (a) estimated with the photographic atlas and (b) estimated without the photographic atlas.

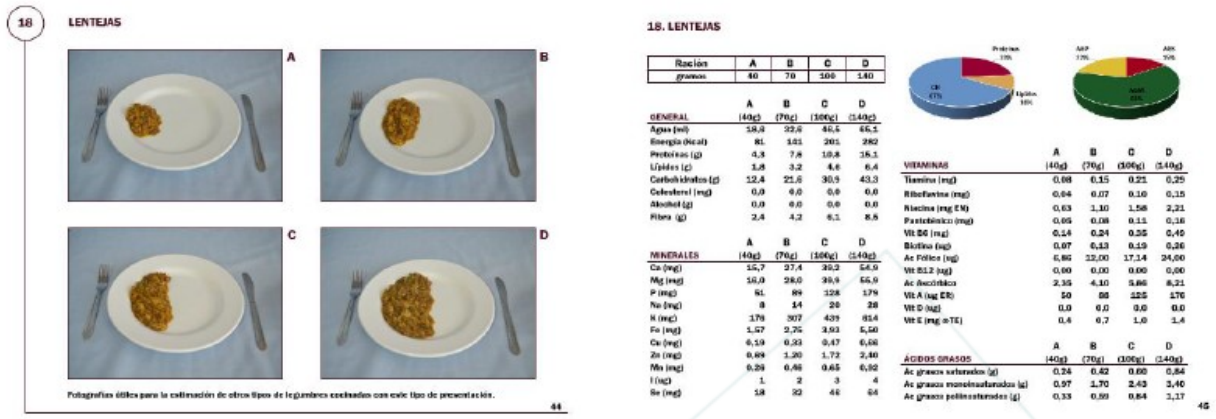

Fig. 3. Examples of portion size images included in the Photographic Atlas and Food Composition Tables of Ecuador.