

# Evaluation of photographs supporting an FFQ developed for adolescents

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## Abstract

**Objective:** To evaluate the validity of food photographs used to support the reporting of food intake with an FFQ designed for adolescents from Rio de Janeiro, Brazil.

**Design:** A set of ninety-five food photographs was elaborated. The photographs' evaluation process included the acknowledgement of foods and portions in the pictures. In the identification of foods (ninety-five photographs) and typical portions (twelve photographs), the adolescents were requested to answer a structured questionnaire related to the food photographs. The identification of the portion size of amorphous foods (forty-three photographs) was performed using three different portion sizes of actual preparations. The proportions (and 95% confidence intervals) of adolescents who correctly identified foods and portion size in each photograph were estimated.

**Setting:** A public school in Niterói, Rio de Janeiro State, Brazil.

**Subjects:** Sixty-two adolescents between 11·0 and 18·9 years old, randomly selected.

**Results:** At least 90% of adolescents correctly identified the food in ninety-two photographs and the food in the three remaining photographs was recognized by 80–89% of the adolescents. At least 98% of the adolescents correctly identified eleven typical or natural portions in the food photographs. For amorphous foods, at least 70% of teenagers correctly identified the portion size in the photograph of thirty-one foods; for the other photographs, the portion size was correctly recognized by 50–69% of the adolescents for eight foods and by less than 50% of adolescents for four foods.

**Conclusions:** The analysed photographs are appropriate visual aids to the reporting of food consumption by adolescents.

**Keywords**  
Dietary assessment  
Adolescent  
Food images  
Food portion  
FFQ

The FFQ is a dietary intake assessment tool frequently used in epidemiological studies, as it enables categorization of individuals according to their food or energy and nutrient intake levels and estimation of the association between dietary factors and disease occurrence. Nevertheless this method shows limitations that can compromise its validity, such as the low level of accuracy in the estimation of portion size consumed<sup>(1)</sup>. Several alternatives have been applied to overcome this limitation of the FFQ, such as the use of food models and images to help individuals to report the amounts of food consumed<sup>(2–5)</sup>.

Food photographs are a low-cost option and they can be easily reproduced, transported and adapted to different working conditions<sup>(6)</sup>. The validity of photographs used in food intake assessment has been assessed among adolescents with acceptable results<sup>(7–11)</sup>.

In Brazil, food images have been used with the purpose of improving portion size estimates in food surveys<sup>(12–14)</sup>

and a study investigating the ability of adults to estimate food portions in photographs by comparing them with real foods obtained satisfactory results<sup>(15)</sup>. Nevertheless, there are no studies carried out with Brazilian adolescents that assess the validity of food images used to support dietary intake assessment. The present study aimed to evaluate food photographs supporting an FFQ designed for adolescents living in the metropolitan area of Rio de Janeiro, Brazil.

## Methods

### Study design and population

The study design included the identification of foods and portion sizes in a set of food photographs elaborated to support an FFQ designed for adolescents of Rio de Janeiro, Brazil. First, in order to acknowledge the foods depicted in

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ninety-five photographs and the natural portions in twelve food photographs, the adolescents were requested to answer a structured questionnaire associated with the pictures. Additionally, to evaluate the ability to identify the portion size displayed in photographs of forty-three amorphous foods, three different portion sizes of actual foods and dishes were prepared that corresponded with the photographs and shown to the adolescents. Then, the participants were asked to point out among the actual food portions which one was depicted in the photograph. Adolescents' weight and height were measured. Data were collected between 2008 and 2009. Interviewers were nutritionists and nutrition undergraduate students who were specifically trained for this purpose.

Considering a recommendation of including at least twenty-five individuals of each sex in studies designed to validate food images<sup>(16)</sup> and anticipating a non-response rate of 40%, a sex- and age-balanced sample of seventy-two adolescents was randomly selected among students of a public school in the city of Niterói, Rio de Janeiro State, Brazil. To select the participants, a list of all students between 11 and 18 years old categorized according to gender and age was elaborated. From this list, thirty-six boys and thirty-six girls were drawn randomly, being thirty-six between 11 and 14 years of age and thirty-six between 15 and 18 years of age.

The present study was approved by the Research Ethics Committee from the Institute de Medicina Social, Universidade do Estado do Rio de Janeiro, in 2005. Participation in the research was dependent on the Informed Consent Form being signed by the responsible adult or individual aged 18 years or older.

### **FFQ design**

A detailed description of the FFQ design is published elsewhere<sup>(17)</sup>. Briefly, the FFQ was designed according to data obtained from the 3 d food records of 430 adolescents aged between 12 and 18 years who were students in public schools in the city of Niterói, Rio de Janeiro State, Brazil. A total of 308 food items were mentioned in the records analysed, of which 250 were mentioned at least fifteen times and included in the FFQ, comprising an initial list of ninety items. Some of these items were composed by the assembling of similar foods; for instance, fried, roasted or stewed beef were combined in the item 'beef'. Additionally, the methodology proposed by Block *et al.*<sup>(18)</sup> was applied to corroborate the consistency of the food list established for the FFQ. To achieve this, the percentage contribution of each food to the intake of energy, macronutrients, cholesterol, vitamins A and C, Fe and Ca was estimated. It was observed that 95% of the energy and nutrient intake was provided by the foods already included in the FFQ. Five food items mentioned less than fifteen times in the records remained in the FFQ – canned fish, beer, wine, distilled beverages and low-calorie sodas – because it was believed that they can discriminate food intake or point out trends

in food habits. The food portion sizes that were most frequently reported in the records were considered to determine the reference portion size for items such as rice, beans, meats and vegetables. 'Natural' or 'typical portions' were used for items like oranges and tangerines, bananas, French bread, eggs, hot dogs, crackers and cookies<sup>(17)</sup>.

The reproducibility and validity of the FFQ were assessed before photographs were included. Reliability was acceptable and relative validity was moderate to estimate the intakes of foods, energy and nutrients of adolescents in the metropolitan area of Rio de Janeiro<sup>(2,19)</sup>. These analyses indicated that the food list should be reviewed; so four items were excluded – processed soups, ketchup sauce, other processed sauces and heavy cream – and nine foods were included – grated cheese, *açaí*, *guaraná* syrup beverage, potato salad, soup, sweet potato, beef stroganoff, meat stew with vegetables, and toasts. At the end, ninety-three items comprised the FFQ list.

### **Food photograph design**

All food items included in the FFQ developed for adolescents from the metropolitan area of Rio de Janeiro were photographed. The food photographs were developed by the Laboratório Design e Comunicação, Escola de Belas Artes, Universidade Federal do Rio de Janeiro (Design and Communication Lab, School of Fine Arts, Federal University of Rio de Janeiro). Nutritionists were responsible for the acquisition, preparation and portioning of the items photographed. The following issues were observed in the photographs' design: neutral background, lighting giving a soft contrast, focal point accuracy, perspective correction and a reference scale. The camera used was a digital Canon EOS Rebel XT with EFS 18–55 mm lens (Lake Success, NY, USA) mounted on a tripod. Foods and beverages were always photographed from the same angle and distance, using a light grey background and adopting a dinner fork and knife as reference, according to the recommendations by Nelson and Haraldsdóttir<sup>(20)</sup>.

### **Identification of foods and typical or natural portions in photographs**

Students were exposed to ninety-five photographs of foods listed in the FFQ, so that their ability to identify the foods shown in the images could be assessed. Photographs were associated with a questionnaire including objective questions. For each photograph there was a multiple-choice question with three options naming similar foods and the students were asked to indicate the alternative that correctly described the item displayed in the image (see example in Fig. 1). For items with natural or typical portions (crackers, for instance), students were also asked to describe the amounts shown in the photographs.

### **Identification of portion size in photographs**

Sets of three different actual portions were shown alongside photographs of forty-three amorphous foods to



Mark with an (X) the name of the food that appears in the photograph:

- ( ) Lettuce  
 ( ) Watercress  
 ( ) Cabbage

**Fig. 1** Example of a question applied in the evaluation of food photographs designed to support an FFQ elaborated for adolescents



**Fig. 2** Example of the display used to evaluate the recognition of portions in food photographs designed to support an FFQ elaborated for adolescents

evaluate the ability of students to identify the portion sizes in these photographs. The actual portions were displayed on the same plates and with the same silverware used in the photographs, on tables covered with fabric of the same colour used in the background of photographs. The portions were labelled as A, B and C and in each set, only one portion was the same size as that shown in the photograph; also, the different portion sizes were randomly arranged, so there was no pattern in the correct answers. In addition, each set was visualized separately (Fig. 2). Using a specific form, participants were asked to identify which actual portion was identical to the portion size displayed in the corresponding picture.

#### **Weight status assessment**

Weight status was evaluated based on BMI (BMI = weight/height<sup>2</sup>). Weight was measured with a digital scale

with 150 kg capacity and 100 g variation (Plenna Sport, São Paulo, SP, Brazil). Height was measured in duplicate using a portable stadiometer with 0.1 cm variation (Alturaexata, Belo Horizonte, MG, Brazil), admitting a maximum variation of 0.5 cm between both measures and using the mean between two measurements. Adolescents remained barefoot, wore light clothing and were in orthostatic position<sup>(21)</sup>. Weight status was classified according to the BMI-for-age-and-sex percentile, following the criteria recommended by the WHO<sup>(22)</sup>.

#### **Statistical analysis**

The proportion (and 95% confidence interval) of correct identification of food and portion size in each photograph was calculated. The differences in the correct identification of foods and portion sizes in photographs were estimated according to sex, age group (11–14 years; 15–18 years) and weight status (overweight; not overweight).

#### **Results**

Of the seventy-two adolescents selected, fifty-eight (81%) participated in the identification of foods and natural or typical portions in the photographs and sixty-two (86%) participated in identification of the portion sizes of amorphous foods in the photographs.

The adolescents who participated in the identification of foods and natural or typical portions in the photographs (*n* 58) had a mean age of 14.5 (SD 1.6) years; 48% were aged 11–14 years, 48% were boys and 21% were overweight.

All fifty-eight adolescents correctly identified sixty-seven (71%) of the ninety-five foods in the photographs. For the other photographs, between 90% and 99% of the adolescents correctly identified twenty-five foods, and between 80% and 89% of the adolescents accurately identified three foods (broccoli, chicken and powdered nutritional supplement; Table 1). There were no statistically significant differences in the identification of foods in the photographs according to sex and weight status (data not shown). However, there was a statistically significant difference between age groups, as the proportion of adolescents who correctly identified all foods was higher in adolescents aged 15–18 years compared with those aged 11–14 years (22% *v.* 9%;  $\chi^2$  test: *P* = 0.02).

Of the twelve photographs showing foods in typical or natural portions, ten (lettuce, cookies, filled cookies, crackers, salty snacks, wafer, chicken nuggets, bun, cheese rolls, and toast) were accurately identified by all fifty-eight adolescents (95% CI 94, 100%, for all estimates). The portion of strawberries was correctly identified by 98% (95% CI 91, 100%) of the adolescents and the apple size (medium) was identified by 81% of them (95% CI 69, 90%). There were no statistically significant differences in the identification of the number of natural or typical portions in the food

**Table 1** Proportion (and 95% confidence interval) of accurate recognition of foods in food photographs by adolescents (*n* 58), Niterói, Rio de Janeiro State, Brazil, 2008–2009

Food	Accurate recognition (%)	95% CI	
		Lower	Upper
Cassava	98	91	100
Cake with filling	98	91	100
Liver	98	91	100
Jelly	98	91	100
Bologna	98	91	100
Nuggets	98	91	100
Cheese rolls	98	91	100
Cabbage	98	91	100
Potato salad	98	91	100
Soup	98	91	100
Pumpkin	97	88	100
Watercress	97	88	100
Cake	97	88	100
Stroganoff	97	88	100
Yoghurt	97	88	100
Milk	97	88	100
Porridge	97	88	100
Ham	97	88	100
Corn flakes	97	88	100
Toast	97	88	100
Cauliflower	95	86	99
Fish	95	86	99
Chocolate powder	93	83	98
Beef stew with vegetables	93	83	98
Chicken breast	91	81	97
Broccoli	90	79	96
Nutritional supplement	86	75	94
Chicken	81	69	90

photographs according to sex, weight status and age group (data not shown).

The adolescents who participated in the identification of portion size of amorphous foods (*n* 62) had a mean age of 14.4 (SD 1.9) years; 55% were aged 11–14 years, 47% were boys and 21% were overweight. At least 80% of adolescents correctly identified the portion size in twenty-one (49%) of forty-three food photographs selected for the portion recognition study. Seventeen food portion sizes in the photographs were correctly identified by between 60% and 79% of adolescents; four were accurately identified by between 40% and 59% of adolescents; and the portion size of tomatoes was correctly identified by 29% of adolescents (Table 2). There were no statistically significant differences in the number of portion sizes correctly identified in the photographs according to sex, weight status and age group (data not shown).

## Discussion

Brazilian adolescents in the present study satisfactorily identified foods and their portions from photographs: about 80% of these foods were correctly recognized from the photographs by all adolescents, 83% of the natural and typical portions shown in the photographs were correctly identified by all participants, and 89% of the

**Table 2** Proportion (and 95% confidence interval) of accurate recognition of portion size in photographs of amorphous foods by adolescents (*n* 62), Niterói, Rio de Janeiro State, Brazil, 2008–2009

Food	Accurate recognition (%)	95% CI	
		Lower	Upper
French fries	98	92	100
Pumpkin	96	88	100
Polenta*	95	87	99
Chicken pie	95	87	99
Gnocchi	95	87	99
Potato salad	94	85	98
Farofa†	92	83	97
Milk	92	83	97
Cassava	91	81	96
Beef	91	81	96
Rice	89	79	96
Pasta	89	79	96
Canned fish	87	76	95
Coffee	87	76	95
Cucumber	86	73	94
Corn flakes	85	74	92
Cabbage	85	74	92
Sausage	84	71	92
Papaya	84	71	92
Pork ribs	82	70	90
Stroganoff	82	70	90
Guava	80	66	89
Cake	78	65	88
Boiled potato	78	65	88
Cream of wheat	77	64	87
Beans	77	64	87
Lasagne	75	63	85
Cream cheese	75	63	85
Ground meat	74	62	84
Grated carrot	74	62	84
Fish	74	62	84
Yam	69	56	80
Watercress	68	55	79
Margarine	67	53	78
Pudding	66	53	77
Guava jam	63	50	75
Liver	61	47	74
Beef stew with vegetables	60	46	72
Chicken	52	38	65
Pineapple	47	34	61
Porridge	43	31	57
Chocolate powder	40	28	53
Tomato	29	18	43

\*Polenta is a typical Brazilian dish made of cornmeal boiled in water with salt.

†Farofa is a typical Brazilian dish made of toasted cassava flour, usually mixed with salt and spices.

amorphous food portion sizes shown in the photographs were identified by at least 60% of participants. There were no statistically significant differences in the identification of portions according to sex, age group and weight status.

Comparing the results with other studies validating food photographs is not simple due to variability in the foods analysed and differences in the methods applied. Turconi *et al.*<sup>(23)</sup> assessed the validity of food photographs in the estimation of food intake by children, adolescents and adults and also observed that there were no statistically significant differences in the identification of portion size in food photographs according to sex, age



and weight status. Lillegaard *et al.*<sup>(9)</sup> and Frobisher and Maxwell<sup>(11)</sup> also found that there were no statistically significant differences in the identification of portion size in food photographs according to age.

In the present study, the adolescents' ability to identify food portion size in the photographs was independent of food characteristics, as the identification of food portions in the photographs was similar for foods with natural portions and for amorphous foods. Venter *et al.*<sup>(24)</sup> developed food photographs to help adult individuals to describe the portions consumed in a cross-sectional study conducted in Africa. These authors observed that portion sizes of solid foods were more accurately estimated from photographs than those of amorphous foods such as porridge, beans, rice and pumpkin.

Vereecken *et al.*<sup>(7)</sup> conducted a study in Belgium to evaluate the precision in estimating the portion size of amorphous foods in photographs among adolescents. The convenience sample was composed of 128 adolescents, 58% male, aged between 11 and 17 years. The authors observed that, on average, 28% of the adolescents accurately recognized amorphous food portion sizes in photographs, a proportion lower than that observed in the present study (77%). However, Vereecken *et al.*<sup>(7)</sup> provided nine or more photographs for each food item, while in the present study one food photograph was compared with three different portions of real food.

Lillegaard *et al.*<sup>(9)</sup> also investigated if children and adolescents could accurately estimate food portion size based on food pictures. The authors found that, on average, 60% of sixty-three adolescents aged 9–19 years appropriately recognized the food portions in photographs. Lillegaard *et al.*<sup>(9)</sup> observed results similar to those in the present study for potato chips and rice. On the other hand, those authors observed a lower rate of precise recognition for fat spread on bread and fish than obtained in our study; while the proportion of correct identification in the images of spaghetti with tomato sauce and porridge observed by Lillegaard *et al.*<sup>(9)</sup> was higher than that found in the present analysis.

In Brazil, food photographs have been used to assist the estimation of the amount of food intake<sup>(12–14)</sup>. However, only Lopez and Botelho<sup>(15)</sup> investigated the ability of 120 adults to estimate food portion size in thirty-one photographs displaying foods in small, medium and large portions by comparing them with real foods. These authors obtained less positive results than those observed in the present study for pumpkin, French fries, ground meat, grated carrot, corn flakes, pasta, *farofa* (a typical Brazilian dish made of toasted cassava flour, usually mixed with salt and spices), beans and papaya. Results for rice and milk were similar in both studies, and the portion sizes of chicken breast, tomato and cake were more successfully identified in the study of Lopes and Botelho<sup>(15)</sup>.

The present study sought to reduce the possibility of bias when evaluating food photographs: participants

received detailed instructions about the procedures applied in data collection, which was carried out individually in a quiet environment. Also, since Lillegaard *et al.*<sup>(9)</sup> pointed out that the proportion of accurate recognition was higher for foods that had precisely the same appearance shown in the pictures, we were careful in arranging the actual portions that were compared with the photographs. To prevent differences between the appearance of real foods and those in photographs, preparations were cooked on the day of data collection and the portions were arranged in the dishes identically as they were in photographs. Additionally, plates, forks and knives were the same as used in the pictures.

The lowest frequencies of correct identification of portion size were observed for apple and tomato, probably due to the fact that these pictures, although including a fork and a knife as a size reference, did not enable an average apple or tomato to be distinguished without a large and a small apple or tomato as reference.

The studied sample size met the recommendation of Nelson and Haraldsdóttir<sup>(16)</sup> regarding the number of participants in studies on the validation of food images. Additionally, the photographs were designed according to the advice of experts in this subject<sup>(20)</sup>. Moreover, the serving sizes adopted were derived from the food intake survey conducted among adolescents from the same region, and therefore were appropriate for the target group. According to Foster *et al.*<sup>(25)</sup>, the appropriateness of foods serving sizes enables more accurate reporting of food portions consumed.

The present study is a novel one conducted in Brazilian adolescents and the photographs analysed are appropriate to assist the obtainment of data in studies on food intake applying the FFQ developed for adolescents. These tools will be useful in the assessment and monitoring of food intake of adolescents in Brazil, which is central to establish health and nutrition policies and programmes targeting adolescents, as this group is particularly vulnerable to changes in food habits.

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