Development and evaluation of a photographic atlas as a tool for dietary assessment studies in Middle East cultures

Maya Tueni1,2,*, Afife Mounayar1 and Ines Birlouez-Aragon2,3

1Department of Nutrition and Dietetics, Faculty of Science II, Lebanese University, Fanar, Lebanon: 2AgroParisTech, Paris, France: 3Spectralys Innovation Biocitech, Romainville, France

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Abstract

Objective: To assess the errors between estimates of amounts based on photographs and actual quantities of food presented to adults or eaten on the previous day.

Design: A photographic atlas was constructed by taking digital photographs of three pre-weighed portion sizes of 212 traditional Lebanese dishes. In a first approach, ten portions of real pre-weighed foods were assessed using the photographic atlas. In a second approach, the participants weighed all foods consumed at one meal and recalled the amount of food that was eaten the previous day using the photographic atlas. Differences between actual quantities and estimation were assessed using a signed rank test (P<0.05). Spearman’s correlation coefficients and bias (Bland–Altman plot) between the methods were calculated.

Setting: Lebanese university canteen and Lebanese homes.

Subjects: Forty adults (twenty males, twenty females) completed the first protocol and fifty adults (twenty-five males, twenty-five females) completed the second protocol; all were volunteers aged 21 to 62 years.

Results: Mean differences between actual and estimated portion sizes by photographs were between -13.1% and +24.5% when pre-weighed foods were presented, and between -10.4% and +3.8% when foods were consumed the day before. No significant differences were found between actual and estimated portion sizes except for three dishes (loubieh bil zeit, tabbouleh and yachnet bazella). Bland–Altman plots showed good agreement for all dishes with a negligible bias of -0.2 g between estimated and presented portions, and -6.3 g between estimated and eaten portions.

Conclusions: In the Lebanese diet, food photographs seem a reliable tool for quantification of food portion sizes.

Keywords

Food photographs

Portion sizes estimation

Dietary assessment

Lebanon

In dietary epidemiological surveys, portion sizes of commonly consumed foods are often roughly estimated due to high difficulty in remembering and evaluating them properly

Two methods have been used to quantify food portion size: (i) those in which foods are weighed directly; and (ii) those in which food quantities are recalled by tools such as household measures, food models, food replicas and food photographs. Also standard portions are used frequently.

The most accurate method for measuring food intake is weighing foods before and after eating. This method is not always the most appropriate however, because it imposes a large burden on participants, is expensive and time consuming, and does not allow assessment of past intakes.

Visual aids, such as food photographs, help circumvent many of these problems and may help improve the accuracy of food portion quantification. However, there is a crucial need to determine the error level induced by such an approach.

Some studies have evaluated the errors related to perception of foods in photographs while assessing the portion of foods presented to the participant. They speculate that assessment of portion size would not be biased by factors such as participants' unwillingness to divulge what they have eaten. Others have estimated the error arising from conceptualization of foods and memory while recalling amounts eaten by the participant. They consider that the effectiveness of portion size estimation may be reduced when memory/recall is required.

The need to assess the rapid changes in dietary habits in the Mediterranean area over recent years and the lack of data in Lebanon urged us to perform dietary surveys in this country. To fulfil this objective, a first task consisted in developing a photographic atlas to quantify portion sizes of 212 traditional Lebanese dishes, presently not available.

*Corresponding author: Email mayatueni@hotmail.com

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The present study describes the methodology used to design and validate this colour photographic atlas. Discrepancies between the food portion size deduced from the photographs and the corresponding real portion weight were assessed and main bias identified.

Specifically, we evaluated (i) the errors related to perception of foods in photographs while assessing the amounts of foods presented to participants (study 1) and (ii) the errors related to perception, conceptualization of foods and memory while recalling amounts eaten by participants on the previous day (study 2).

**Methods**

**Design of the photographic atlas**

**Choice of dishes**

The photographic atlas presents 633 colour photographs (format 7.6×4.7 cm) corresponding to 212 traditional dishes, usually consumed at home and in Lebanese restaurants, and cooked according to two main Lebanese recipe books.(18,19)

**Portion sizes**

The dishes appear according to three portion sizes presented on the same conventional plate. Each portion is associated with a letter. The general principle is to identify the consumed portion, either in one of the suggested photographs (B, D or F) or between two consecutive photographs (C or E), including below or beyond the extreme photographs (A or G; Fig. 1).

**Portion weights**

The medium portion (D) was chosen in a way to be representative of the mean portion size actually consumed by the Lebanese population, as deduced from a preliminary food consumption survey carried out between March and June 2004 on fifty Lebanese adult volunteers (twenty-five men and twenty-five women) in which portion sizes of 212 dishes were estimated by household measures (M Tueni and A Mounayar, unpublished results).

For the majority of the dishes, we added to or subtracted from the weight of the medium portion a coefficient (2SD) for the small (B) and the large (F) portions, a coefficient (SD) for the intermediate virtual portions (C and E) and a coefficient (3SD) for the extreme virtual portions (A and G):

\[ X - 3SD(A); X - 2SD(B); X - SD(C); X(D); \\
X + SD(E); X + 2SD(F); X + 3SD(G) \]

where X is the weight of the medium portion (D). The SD coefficient represented the standard deviation of the mean consumption for each food. In order to select portions neither too small nor too large, some food photographs depicting different portions, computed as described above, were shown to the fifty Lebanese adult volunteers and we asked them their opinion. For example, the mean consumption of *mdardara* was 200 (±45) g, which results in a portion B of 110 g and a portion F of 290 g. According to the volunteers' opinions, we decreased B to 100 g and increased F to 300 g. Thus, the (SD) coefficient will be 50 (Fig. 1).

**Food digital photographs**

Three different portions of each dish were weighed accurately (Tefal 3000 digital electronic scale, ±1 g precision), placed on a white dining plate contrasting with a colour background and photographed from the same angle using a digital camera (Sony-Cyber 72 Power Shot).

**Validation of the photographic atlas**

Two groups of Lebanese volunteers validated the photographic atlas. They were recruited by telephone; the phone numbers were selected randomly from the phone book. The study was approved by the Ethical Committee of the Lebanese University.

![Fig. 1 The set of pictures of *mdardara* (lentils with rice) in three portion sizes and the amounts in grams](https://www.cambridge.org/core/graphics/...012000171)
Study 1: Validation of presented portion size using food photographs

Fifty adults were invited to the Lebanese university kitchen but forty adults (twenty males, twenty females) completed the first protocol in May 2006. The non-response rate was 20%.

The ten foods selected (kafta mechwieh, kebbe bil saniyeh, koussa mehchi, loubieh bil zeit, mjaddara, riz aa djej, samboussik, warak aanab, tabbouleh, yachnet bazella) were the most consumed Lebanese dishes based on the preliminary survey described above. Participants were shown one portion size for each of the ten foods, accurately pre-weighed (Tefal 3000 digital electronic scale), and asked by an interviewer to compare the presented food with the photographs.

Study 2: Validation of previous day’s portion size using food photographs

Sixty-five adults were invited but fifty adults (twenty-five males, twenty females) completed the second protocol during one meal at home (Tefal 3000 digital electronic scale) and the next day recalled the amount of food that was eaten the previous day using the photographic atlas.

Analysis and treatment of results

The amounts of food presented or eaten and estimated by the photographs were compared. The differences were calculated and expressed as percentages of the weights of food presented or consumed. Thus, a positive value indicates an overestimate of the weight and a negative value an underestimate. Differences between estimated and actual quantities were assessed using a signed rank test. The distribution patterns of individual errors were described according to the 25th, 50th and 75th percentiles of total error variability for a given food. Spearman’s correlation coefficients were calculated in order to evaluate the extent of the linear relationship between amounts estimated by photographs and amounts presented or consumed. Agreement between the methods was evaluated according to Bland and Altman (20).

The SPSS for Windows statistical software package version 10.1 (2001; SPSS Inc., Chicago, IL, USA) and Analyse-it® statistical software for Microsoft Excel® (Analyse-it Software Ltd, Leeds, UK) were used for statistical analyses.

Results

Forty participants performed 400 estimations, twenty-two were aged 21–41 years and eighteen were aged 42–62 years (study 1). Fifty participants performed 182 estimations, twenty-six were 21–41 years old and twenty-four were 42–62 years old (study 2). In study 1 five foods were overestimated (range from +0.9% for samboussik to +24.5% for loubieh bil zeit) and five were underestimated (range from −3.6% for tabbouleh to −13.1%...
Table 2. Amounts of food eaten in one meal compared with amounts estimated 24 h later using portion size colour photographs and correlation coefficients between eaten and estimated weights (study 2), Lebanese adults aged 21–62 years, 2007

<table>
<thead>
<tr>
<th>Food category/shape</th>
<th>Amount eaten (g)</th>
<th>Amount estimated (g)</th>
<th>Percentiles of % difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Meat</td>
<td>15</td>
<td>207.1</td>
<td>105.4</td>
</tr>
<tr>
<td>Legumes</td>
<td>17</td>
<td>204.1</td>
<td>164.0</td>
</tr>
<tr>
<td>Vegetables</td>
<td>64</td>
<td>167.9</td>
<td>153.1</td>
</tr>
<tr>
<td>Sweets</td>
<td>11</td>
<td>67.1</td>
<td>49.3</td>
</tr>
<tr>
<td>Cereals and bread</td>
<td>75</td>
<td>133.3</td>
<td>132.7</td>
</tr>
<tr>
<td>Foods served in sauce or gravy</td>
<td>22</td>
<td>250.7</td>
<td>163.3</td>
</tr>
<tr>
<td>Foods served in wedges</td>
<td>41</td>
<td>60.0</td>
<td>47.9</td>
</tr>
<tr>
<td>Foods served in mounds</td>
<td>67</td>
<td>196.3</td>
<td>146.7</td>
</tr>
<tr>
<td>Foods served in pieces of different sizes</td>
<td>52</td>
<td>133.4</td>
<td>127.0</td>
</tr>
<tr>
<td>Overall</td>
<td>182</td>
<td>154.2</td>
<td>141.1</td>
</tr>
</tbody>
</table>

\( r \): Spearman's correlation coefficient.

\( *P < 0.05, **P < 0.01 \)

\( \% \text{ difference} = \frac{\text{mean amount estimated} - \text{mean amount eaten}}{\text{mean amount eaten}} \times 100 \). Difference between amounts eaten and amounts estimated assessed by a signed rank test for \( P < 0.05 \).
to the portion size they consume. In addition, a probable error could have been introduced during weighing or recording of the food portion.

Extreme differences between actual and estimated portion sizes using photographs ranged from −15.1% for the dish *kafta mechwieh* to +24.5% for the dish *loubieb bil zeit*, and from −10.4% for cereals and bread to +3.8% for meat. Except for the dishes *loubieb bil zeit, tabbouleh* and *yacbnet bazella* for which errors were found suggesting perception problems, differences were rather small and not significant, thus validating that the photographic atlas is a reliable way to estimate food portion size. Huynh et al. found that some foods appear to be more difficult to estimate accurately than others is a common finding. Robson and Livingstone found that cheese was the most difficult to quantify relatively accurately (group *kousa mehchi* 1). Haraldsdottir found suggesting perception problems, differences were rather small and not significant, thus validating that the photographic atlas is a reliable way to estimate food portion size.

The participants in our study had more difficulty in estimating portions served in sauce or gravy and in pieces of different size were more difficult to estimate between served and estimated portion sizes were between −8.4% for couscous and +6.3% for liquid sauce, while Turconi et al. found that the mean differences between estimated and actual portion weights were between −2.7% for bread and +15.9% for vegetables.

In the present study, foods served in sauce or gravy and in pieces of different size were more difficult to estimate than foods served in wedges or mounds. Similarly, the participants in the study of Nelson et al. had no difficulty in estimating wedges of quiche or mounds of boiled rice.

Other studies have shown the flat slope phenomenon; small portion sizes are overestimated and large portion sizes are underestimated. However, we could not observe this trend in our data. The consistency between portion weights and estimated portion sizes of foods presented or eaten is revealed by high mean correlation coefficients (0.88 for individual foods and 0.85 for different food categories). Haraldsdottir et al. found Pearson correlation coefficients between 0.22 and 0.54, while a mean correlation coefficient of 0.82 was obtained by Turconi et al. In the present work, the errors and bias in study 2 were larger than those in study 1. This difference in accuracy seems to illustrate that the effectiveness of this method may be slightly reduced when memory recall is required. Other studies have also noted that.

Conclusions

The colour photographic atlas developed in the present study appears to be a useful tool for portion size estimation of the most common traditional Lebanese dishes.

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