Original Article

How well do adolescents determine portion sizes of foods and beverages?

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In the present study, we examined how well adolescents (12-13 years) are able to select the correct dietary aid portion sizes after having been shown different food items. We also evaluated the effectiveness of two-dimensional life-size drawings and three-dimensional food models, used as dietary aids in this process. Fifty black children and 42 white children from Johannesburg participated in the study (N =92). Trained interviewers individually tested each child following a prescribed sequence, throughout. Each participant was shown a plate of actual food of a pre-determined weight. The participant was required to select a two-dimensional drawing, and thereafter a three-dimensional food model, which most closely resembled the real food portion. In this manner, portion size estimation was evaluated with respect to 11 different food items. Correlations between nutrients calculated from actual weight of food portions and estimates ranged from 0.842 to 0.994 (P<0.0001), indicating a significant positive linear association between the actual and estimated nutrients, using either of the dietary aids. However, findings also suggest that the drawings provided a better estimate of actual energy, fat and carbohydrates than did the food models (with respect to lying within? the limits of agreement). On the other hand, the food models were more frequently selected correctly than the drawings. Hence, both methods had advantages and disadvantages. Overall, it was found that there were no gender differences (P < 0.05) when using either the models or drawings to estimate portion size, however, there were significant ethnic differences (P < 0.05). With two exceptions, black children selected the correct aids (drawings and models), more often compared with white children. It is recommended that in dietary interviews undertaken in black children in urban areas one could use either aid; while in white adolescents the use of the food models is recommended.

Key Words: dietary survey, food portions, food models, visual aids, adolescents, black or white children, Johannesburg-Soweto, South Africa.

Introduction

Dietary surveys are often hampered by the difficulty of collecting accurate and reliable dietary information from participants.[1] When one uses a recall type of dietary method such as a 24-hour recall or a quantified food frequency, the most common difficulty is the estimation of food portion size.[2]

As early as 1982, Rutishauser[3] recommended the use of dietary aids to improve portion size recall. Indeed, in the past three decades, numerous investigators have developed and/or tested various types of dietary aids, including: photographs,[4,5] utensils and volume measures[6], three-dimensional models made of various types of materials like wax and foam;[7-9] drawings of foods, abstract and generic shapes, and household measures[10]); and commercial plastic food replicas (Nasco, Fort Atkinson, USA).

Chambers *et al*.,[11] compared four different sets of dietary aids in order to evaluate the best cognitive strategies used in reporting amounts eaten by adults. They found that the strategy most frequently used to determine portion size was visualization of the recalled item and comparison to available dietary aids. For example, regardless of whether the dietary set contained 2- or 3-dimensional (2-D, 3-D) aids, respondents looked for an aid, which best represented the size or shape of the food they ate, or the container in which it was served.[12] Similar results were found in an earlier study by Kirkcaldy-Hargreaves *et al*., in young women.[12]

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These participants were shown pre-weighed amounts of foods which they subsequently had to evaluate in terms of portion size, using four different sets of dietary aids. It was found that the lowest percentage of accuracy was obtained when food replicas (models of real foods) were used and the highest when life-size pictures (drawings) were used. These findings served as a motivation for the use of life-size 2-D drawings and 3-D food models, in the current study.

There are limitations to the use of commercial dietary aids such as food replicas, in the South African context. Commercially produced food replicas have to be imported and are hence very costly. Another difficulty is the consideration that such replicas do not represent local foods and portion sizes commonly consumed. Since South Africa has a diversity of ethnic groups and cultures and a high percentage of illiteracy (24% in rural areas),[13] it becomes particularly important to use dietary aids that are able to clearly and simply depict local and traditional foods and commonly consumed portion sizes.

The Birth to Twenty (BTT, originally Birth to Ten) study is the largest longest ongoing longitudinal birth cohort of child health and development in Africa. The children, whose lives span the transition of South Africa to democracy, were born in 1990 in the Johannesburg-Soweto area, South Africa. The goals and methods of BTT have been set out in several previous publications.[14-16] One of the research objectives of BTT is to examine dietary intake of the children at different phases of physical development. This means that the participants, who are currently 12-13-years old, will be exposed to various dietary questionnaires and interviews, including repeated 24-hour recalls and dietary frequency interviews. Therefore, an essential requirement is that portion size estimations of this group are as accurate as possible, as their nutrient intakes will be compared to various markers of development, such as growth, body composition, nutritional status and pubertal development.

The aim of the present study was two-fold, firstly, to determine how accurately urban adolescents are able to recall and identify portion sizes of commonly eaten food items using dietary aids, specifically 2-D life-size drawings and 3-D food models and possible differences between them, and secondly, to determine if there are ethnic or gender differences in portion size estimation. The outcomes of this study would direct the choice of dietary aids for the BTT study.

Materials and methods

Study population

A convenience sample of black (N =50) and white (N =42) children aged 12-13 years and living in the same geographical area of the BTT study source area, participated in the study. Children were recruited from two schools in the Johannesburg-Soweto area. One school was in a predominantly middle-income area and included white and black children; the other was in Soweto and comprised black children, predominantly from low-income areas. The choice of schools was based on the fact that the BTT study would include children from low and middle income areas.[14-16]

Participating children were requested to come to the BTT offices for lunch and day of fun. The Committee for Research on Human Subjects (Medical) of the University of the Witwatersrand approved the study and informed written consent was obtained from the parents. Children attended the testing session on a voluntary basis.

Dietary aids to be tested

2-D Life-size drawings (Fig.1) and 3-D food models (Fig. 2) were selected as prospective dietary aids to be used in the BTT study. This selection was made based on the efficacy of the 2D-drawings and the 3-D food models reported in earlier local studies in young adults, and the fact that they are economical and simple to use.[17,18] The drawings developed by Senekal[17,18] were used as 2-dimensional aids in this study. These were mainly generic, i.e. do not depict detail, but illustrate volume or size of an item; life-size line drawings showing different volume sizes viewed from above and cross-sectionally: ¼ cup, ½ cup, 1 cup, (Fig. 1). Life-size (non-generic = resembles the item) drawings of some items (gems, bananas, teaspoons, glass and bowl) were also used (Fig. 1). The 3-D food models (¼ cup; ½ cup flattish and ½ cup round; 1 cup)[18] used were made of flour and water and baked in an oven until hard from a recipe developed by Senekal (1994): (Fig. 2). These were also of a generic nature and did not resemble actual foods.

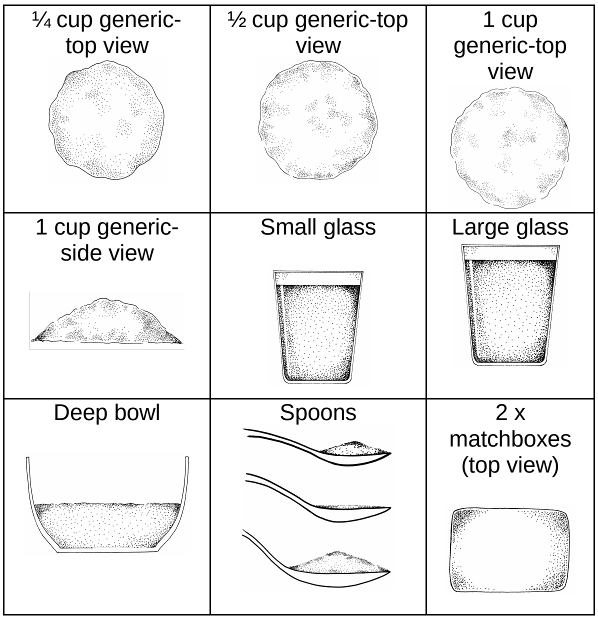

Figure 1. Examples of the 2-dimensional life-size drawings used in the study.

Figure 2. Examples of the 3-dimensional food models used in the study

Food items used in the testing procedure

Eleven food items were selected for evaluation. They differed in consistency (solids versus liquids), shape (round versus long) and texture (amorphous versus solid pieces), in order to include sufficient variety. The frequency of consumption of an item by children and adults from the white and black population groups in urban areas formed the basis of its inclusion in the test.[19] Foods were culturally appropriate and familiar to both groups. However, it was not feasible to include all the items commonly consumed by these groups.

The 11 selected food items were beef stew (amorphous with small pieces), rice (round and amorphous), potato chips (irregular form and size), gem squash (round, solid shape), margarine (thick paste consistency), mixed vegetables (amorphous, irregular shapes), tomato (wedge, solid shape), banana (large, oblong shape), cold drink (liquid), chocolate instant pudding (soft, smooth and thick texture) and peanuts (amorphous, irregular shapes).

Portion sizes of actual foods used in this study were selected according to commonly used volume metric measures, namely: ½cup, 1cup, 1½ cups, 2 cups, 1 teaspoon, 1 tablespoon, 1 serving spoon, 1 pudding bowl and 1 glass. Such measures are reported in the South African Food Quantities Manual, which is used in conjunction with the South African Food Composition Tables.[20,21] After the portion of each food item was measured in volume measures, it was weighed using a digital scale measuring to the nearest gram (Table 1).

Process of data collection

The purpose of the test was to determine whether the adolescents were able to estimate the portion size after having seen the actual food portions, and to correlate this to an appropriate sized dietary aid. We also wanted to establish which type of aid (2-D or 3-D) would provide the most accurate portion size. Whether the participants were able to remember this over a long period was of no concern, since the literature has indicated that children of this age have a good dietary recall over 24 hours.[22,23]

Four trained interviewers conducted interviews with the children. Each interview was undertaken with one participant at a time with the participant seated opposite the interviewer. The interviewer explained the purpose of the test for the participant to understand the process and purpose. The interviewer showed the subject the first plate containing a beef stew (weight established beforehand), for about 30 seconds, after which the plate was removed from sight. The participant was then shown the drawings and requested to select the one most closely resembling the actual food portion. Thereafter the 2-D drawings were removed from sight and the participant was shown the 3-D food models and again asked to select the one best resembling the actual food portion size. The interviewer then proceeded to the next food item following the same procedure with each item. Every effort was made to keep the time sequence and order of items as similar as possible for every participant in order to avoid unnecessary confounding factors or bias. The response to each food item was recorded and the same order of showing the aids was followed throughout.

Data analyses

Data analyses were undertaken using SAS.[24] Differences

Table 1. Food items tested for portion size determination in 12-13-year-old children

Food item on plate shown to children	Actual weight (g) of the food item shown	Household and metric portion size of actual food item shown	Visual aids used
Beef stew	236	1 cup (250 ml)	2-D drawings* and 3-D models†
Rice	29	½ cup (125 ml)	2-D drawings* and 3-D models†
Potato chips	112	1 cup (250 ml)	2-D drawings* and 3-D models†
Gem squash	116	½ large	2-D drawings of small, medium and large gems
Margarine	3	1 teaspoon level	2-D drawings of spoons
Mixed vegetables	80	½ cup (125 ml)	2-D drawings* and 3-D models†
Tomato	10	⅛th tomato	Demonstrated by drawing (2-D) a circle and dividing it into halves, quarters and eighths
Banana	188	1 banana	2-D life-size drawings of small, medium and large bananas
Cold drink	120	½ glass (125 ml)	Two 2-D drawings of glasses of different size and levels
Chocolate pudding	150	¾ cup (175 ml)	2-D drawings of bowls with different levels of fullness
Peanuts	21	1 handful	Empty hand shown and then asked to quantify the number of peanuts

*2-D life-size drawings are seen in Fig. 1. These include top views and cross-sections of a ¼ cup, ½ cup, 1 cup, 1½ cups and 2 cups, as well as life-size drawings of spoons, and glasses and a bowl filled to different levels. †3-D food models are made of flour and water mixed together and baked (Fig. 2). These included ¼ cup, ½ cup, 1 cup, 1½ cups and 2 cups.

between the two types of dietary aids (drawings and food models) and actual foods were tested by various methods.[5] The mean estimated weight and 95% confidence intervals for each food item were tested against the actual weight, using the signed rank test. The percentage differences were calculated according to the method described by Nelson and Haraldsdottirin, namely:[5] Percentage Error = (test measure minus reference measure)/ reference measure X 100). Significance was set at a probability of 0.05. The Wilcoxon two-sample test was used to test for differences between ethnic and gender groups.

For the remainder of the data analyses, the actual food items (*N*=11) were analysed for mean energy and nutrient intakes, using the Foodfinder™3 program. The actual mean nutrient intakes were then compared with mean intakes calculated from the size of the drawings and the models, respectively. Spearman's correlation coefficients were calculated to describe the level of agreement between two sets of measures, for all the food items to be tested. Thirdly, the extent of agreement between the actual food items and estimated portions were used to classify participants into the same and adjacent quantiles of intake.[5] Lastly, the Bland and Altman[25] method was used to describe the level of agreement between nutrients obtained by the dietary aids and those of the actual foods.

Results

Apart from one or two exceptions, black children selected the correct aids (drawings and models), more often compared with the white children (Table 2). Table 2 also shows the mean differences (in grams) between actual food items and the two dietary aids tested. These differences varied from small ones (0g–10g) for banana, pudding, cold drinks, and beef to fairly substantial ones (11-218g) for rice, potatoes, gem squash, margarine and mixed vegetables. Overall, out of a total of 552 dietary aids tested on both groups, 58% of the black and 54% of the white children estimated the portion correctly when selecting from the food models and 57% of the black and 38% of the white children estimated correctly when selecting from the drawings. Hence, the black children selected equally well from both dietary aids, while white children did less well on the drawings. There were significant differences between estimated and mean weights between the ethnic groups (black versus white) when using the 2-D drawings for the following food items: beef, potato chips, gem, margarine, and banana. This was also the case when using the food models: beef, potatoes, margarine, and peanuts. With respect to differences within each ethnic group (signed rank test), namely actual food versus a model or drawing, nearly all the differences were significant.

Table 2. Actual weight (AW) and mean estimated portion weight (EW), 95% confidence intervals and degree of accuracy for actual foods, 3-D food models and 2-D life-size drawings, tested by group (blacks, *N* = 50; whites, *N* =42)

Food item	Dietary Aid P values*	GRP	% Correct[‡]	AW (g)	EW (g)	Difference EW-AW (g)	% Difference	95% Confidence Interval	Signed Rank Test *P* value+
Beef	Drawing	B	58	236	227.7	-8.3	-3.5	205.3-250.2	*P*=0.427
	P=0.002	W	36	236	170.0	-66.0	-28.0	141.2-198.7	*P*<0.001
	Model	B	68	236	231.3	-4.7	-2.0	212.2-250.4	*P*=0.803
	P=0.046	W	52	236	200.9	-35.1	-14.9	176.8-224.9	*P*=0.010
Rice	Drawing	B	80	29	38.3	9.3	32.0	31.1-45.4	*P*=0.002
	P=0.745	W	83	29	38.0	9.0	31.0	30.6-45.3	*P*=0.015
	Model	B	58	29	44.7	15.7	54.0	37.4-52.0	*P*<0.001
	P=0.480	W	52	29	49.7	20.7	71.4	40.1-59.3	*P*<0.001
Potato	Drawing	B	32	112	147.8	35.8	32.0	130.0-165.7	*P*<0.001
	P<0.001	W	26	112	80.7	-31.3	-28.0	67.3-94.0	*P*<0.001
	Model	B	40	112	138.9	26.9	24.0	129.1-148.7	P<0.001
	P<0.001	W	55	112	89.3	-22.7	-20.2	78.1-100.6	*P*=0.001
Gems	Drawing	B	32	116	74.6	-41.4	-35.7	66.3-82.9	*P*<0.001
	P<0.001	W	7	116	56.2	-59.8	-51.6	50.2-62.1	*P*<0.001
Margarine	Drawing	B	24	3	5.3	2.3	76.0	4.9-5.6	*P*<0.001
	P<0.001	W	2	3	8.6	5.6	185.7	7.1-10.0	*P*<0.001
	Model	B	28	3	5.4	2.4	80.0	4.8-6.0	*P*<0.001
	P=0.010	W	26	3	7.7	4.7	157.1	6.3-9.2	*P*<0.001
Mixed veg.	Drawing	B	62	80	109.6	29.6	37.0	97.3-121.9	*P*<0.001
	P=0.176	W	50	80	101.0	21.0	26.2	84.4-117.5	*P*=0.002
	Model	B	60	80	113.6	33.6	42.0	101.4-125.8	*P*<0.001
	P=0.257	W	57	80	104.8	24.8	31.0	90.2-119.3	*P*=0.001
Tomato	Model	B	-	10	31.8	21.8	218.0	28.7-34.9	*P*<0.001
	P=0.017	W		10	27.0	17.0	169.7	23.2-30.7	*P*<0.001
Banana	Drawing	B	100	188	188.0	0.0	0.0	-	-
	P<0.001	W	62	188	170.1	-17.9	-9.5	162.2-178.0	*P* <0.001
Cold drink	Drawing	B	56	120	108.2	-11.8	-9.8	97.1-119.4	*P*=0.021
	P=0.319	W	83	120	110.0	-10.0	-8.3	102.9-117.1	*P*=0.016
Pudding	Drawing	B	86	150	143.0	-7.0	-4.7	138.0-148.0	*P*=0.016
	P=0.399	W	29	150	146.4	-3.6	-2.4	129.1-163.8	*P*=0.823
	Model	B	96	150	148.0	-2.0	-1.3	145.2-150.8	*P*=0.500
	P=0.093	W	83	150	153.6	3.6	2.4	147.2-159.9	*P*=0.453
Peanuts	Model	B	86	21	23.3	2.3	11.0	21.2-25.4	*P*=0.047
	P=0.013	W	55	21	30.0	9.0	42.9	23.5-36.5	*P*=0.0001

*Wilcoxon two sample test, two-sided probability – test for significant difference between actual and estimated weights of food portions by black (B) and white (W) children [†]Signed Rank Test *P* value to test significant difference between actual weight and estimated weight for each type of visual aid used [‡]Percentage participants who selected the correct portion size

Gender differences were not significant for the use of the drawings and models (not shown). Table 3 shows the level of agreement in nutrient intake by thirds of the distribution, for intakes based on portion sizes estimated using 2-D drawings versus actual food intakes and for 3-D food models versus actual intakes (as recommended). With regard to the models, the largest discrepancies were found in carbohydrate and fibre intakes, since only 38% and 42% were categorized in the same thirds, respectively. Less than 50% of participants were in the same thirds for the drawings with respect to fibre, fat, and vitamin B_{12} intake. Overall, the results were very similar using either the models or the drawings. Spearman's correlations (Table 4) between actual weight of food and estimates from either the drawings or the food models ranged from 0.855 to 0.997 (P <0.0001 for each nutrient) and 0.842 to 0.994 (P<0.0001) respectively. This indicated a significant positive linear association between the actual and estimated nutrients, using either of the two types of dietary aids. In Table 5 the results of the Bland-Altman tests[25] are presented. The level of agreement is reflected by the large percentage of participants who fall between the mean ± 2 standard deviations. In this regard more than 90% of all participants in the drawing category fell within the limits of agreement. Similar findings were found for the food models, although for energy and vitamin B_6, less than 90% were in this position. Spearman's correlation coeffi-cients reflect the level of proportional bias. Lack of pro-portional bias is shown by small correlation coefficients, which are not significant. In this case, energy (kilojoules), vitamin B_{12}, carbohydrate, and cholesterol were not signi-ficant when using the models. Energy, fat, carbohydrates and magnesium were not significant when using the drawings.

Table 3. Classification of 12-13-year-old subjects according to thirds of the distribution of the energy and nutrient content based on estimates of portion size using 3-D food models and 2-D life-size drawings vs. actual portion size of food items*

	2-D Drawings vs. actual amounts of food (*N* =92)					
Nutrient	% In same third as actual amount	% In adjacent third as actual amount	% In opposite third as actual amount	% In same third as actual amount	% In adjacent third as actual amount	% In opposite third as actual amount
Kilojoules	56.5	43.5	-	51.1	48.9	-
Protein (g)	60.9	39.1	-	50.0	50.0	-
Carbohydrates (g)	38.0	54.4	7.6	67.4	31.5	1.1
Fibre (g)	42.4	47.8	9.8	47.8	50.0	2.2
Total fat (g)	52.2	47.8	-	59.8	40.2	-
Cholesterol (mg)	60.9	39.1	-	47.8	52.2	-
Vitamin A (RE)	57.6	39.1	3.3	66.3	30.4	3.3
Vitamin C (mg)	56.5	43.5	-	58.7	40.2	1.1
Vitamin E (mg)	64.1	28.3	7.6	57.6	32.6	9.8
Vitamin D (ug)	80.4	12.0	7.6	85.9	5.4	8.7
Vitamin B_6 (mg)	53.3	46.7	-	56.5	42.4	1.1
Vitamin B_{12} (ug)	60.9	39.1	-	47.8	52.2	-
Iron (mg)	63.0	37.0	-	48.9	51.1	-

*Nutrient content of the models and drawings were being evaluated compared with nutrient intake of the actual food

Table 4. A comparison of energy and nutrient intakes of actual foods compared with portions estimated by 3-D food models and 2-D life-size drawings*

	Food models (*N*=92)				Drawings (*N*= 92)			
Nutrient	Mean (SD) Models	Mean (SD) Actual food	Spearman's correlation coefficient	*P* value	Mean (SD) Drawings	Mean (SD) Actual food	Spearman's correlation coefficient	*P* value
Kilojoules	764.6 (667.9)	731.5 (648.2)	0.881	<0.0001	733.9 (717.7)	731.5 (648.2)	0.842	<0.0001
Protein (g)	6.1 (8.6)	6.3 (8.8)	0.950	<0.0001	5.8 (8.5)	6.3 (8.8)	0.931	<0.0001
Carbohydrates (g)	15.9 (14.7)	14.6 (12.8)	0.855	<0.0001	15.2 (16.5)	14.6 (12.8)	0.844	<0.0001
Fibre (g)	1.8 (2.1)	1.6 (1.6)	0.951	<0.0001	1.8 (2.2)	1.6 (1.6)	0.944	<0.0001
Total fat (g)	9.7 (10.5)	9.5 (10.4)	0.950	<0.0001	9.4 (10.8)	9.5 (10.4)	0.929	<0.0001
Cholesterol (mg)	17.6 (34.8)	18.9 (35.4)	0.997	<0.0001	16.4 (33.7)	18.9 (35.4)	0.994	<0.0001
Vitamin A (RE)	83.2 (163.3)	60.4 (108.1)	0.953	<0.0001	80.9 (160.6)	60.4 (108.1)	0.947	<0.0001
Vitamin C (mg)	5.0 (6.3)	4.9 (5.7)	0.958	<0.0001	4.9 (6.7)	4.9 (5.7)	0.945	<0.0001
Vitamin E (mg)	1.02 (1.65)	0.66 (0.68)	0.974	<0.0001	1.05 (1.72)	0.66 (0.68)	0.964	<0.0001
Vitamin D (ug)	0.07 (0.15)	0.04 (0.06)	0.994	<0.0001	0.07 (0.16)	0.04 (0.06)	0.993	<0.0001
Vitamin B_6 (mg)	0.16 (0.19)	0.16 (0.17)	0.931	<0.0001	0.15 (0.20)	0.16 (0.17)	0.932	<0.0001
Vitamin B_{12} (ug)	0.40 (0.76)	0.43 (0.78)	0.997	<0.0001	0.37 (0.74)	0.43 (0.78)	0.994	<0.0001
Iron (mg)	0.86 (1.06)	0.84 (1.05)	0.956	<0.0001	0.81 (1.05)	0.84 (1.05)	0.943	<0.0001
Calcium (mg)	39.06 (53.3)	37.40 (52.7)	0.930	<0.0001	37.39 (53.6)	37.40 (52.7)	0.917	<0.0001
Magnesium (mg)	19.4 (17.3)	18.4 (15.5)	0.896	<0.0001	18.7 (19.2)	18.4 (15.5)	0.872	<0.0001

* Nutrient content of the models and drawings were being evaluated compared with nutrient intake of the actual food

Discussion

In recent South African dietary surveys, various dietary aids have been used to determine the recall of food portion sizes among different population groups. An example is the National Food Consumption Survey (NFCS) that used household utensils, such as spoons and cups, and abstract models made from wax and foam in their study on 1-9 year old children.[9] In the study, Transi-tion, Health and Urbanisation in South Africa (THUSA), a photograph manual was developed comprising life-size quantities of foods commonly eaten by adults.[4] Prior to the commencement of the THUSA study, the photograph manual was tested in the prospective study population. Findings indicated that 68% of the portions tested on these adults were found to be within 10% of actual weight.[4] Furthermore, the results showed there were numerous discrepancies between the estimated portion sizes of certain food items, particularly the amorphous ones. Up to now, no dietary aids have been developed and tested for use in older children or adolescents in South Africa.

Only a few studies have attempted to investigate portion size estimation by children and adolescents.[2,4,10,26,27] The results from these studies, overall, illustrate large and consistent errors with regard to reporting, whether under- or overestimated. Matheson *et al.*,[27] evaluated the accuracy of food portion estimates of 8-12 year-old African-American girl's (N = 54). The girls were asked to estimate the amount of foods (previously weighed), which they had consumed, by means of 2-dimensional dietary aids and with manipulative aids, such as clay. The interviews took place 10 minutes after the children had eaten. They found that absolute value percentage differences between actual and estimated weights were 58% for the manipulative aids and 38% for the 2-dimensional food portion visuals. In this study, we found that 58% of black children and 54% of white children scored correctly using the 3-dimensional food models and 57% of black and 38% of white children scored correctly using the 2-dimensional drawings. In the study by Matheson *et al.*,[27] Spearman's correlation coefficients between actual and estimated portions were high (except for bread) for both types of dietary aids (range = 0.56-0.79; all P<0.001). They concluded that portion size estimates are appropriate for ranking children's relative intakes, but should be used with caution when used as quantitative estimates of food or energy intakes. In this study, Spearman's correlation coefficients ranged from 0.848 to 0.998 for nutrient intakes. The high correlations were the result of the dietary aids being shown directly after the participants had viewed the actual foods. Hence, memory loss was less of an issue compared with similar studies.

A study undertaken in adults (N = 47) and children (N = 37) in Britain, examined two methods of estimating portion size, i.e food photographs and standard portion sizes.[26] They found large differences in the estimates of portion sizes regardless of the method used, or the age of the subjects. The median difference range was found to be between 52% and 100%. These differences were greater in children than in adults. They consequently recommended that standard portion sizes (for different ages) be used with children instead of expecting them to estimate portion sizes. In a recent study, by Welten *et al.*,[28] it was found that standard portion sizes largely underestimated reported portion sizes. However, it was possible to adjust portion sizes using a correction factor, which considerably improved comparability.

In the present study, certain items were more poorly assessed than others. For example, margarine, tomatoes, and gem squash resulted in the most inaccuracies. The portion size of gem squash was under-reported, while the margarine and the tomato were over-reported. All participants scored poorly on the tomato wedge that had been cut into an eighth wedge which the children found difficult to describe. Similar results were found for margarine, where participants seemed to have difficulty in distinguishing between a level and a heaped teaspoon of margarine (which was scooped into a gem squash half). However, it should be kept in mind that for these two food items the portions were so small that in fact, the differences in nutrient intakes were minor. However, large differences in nutrient intake would be incurred if

Table 5. Observations of the participants lying within limits of agreement as calculated by the Bland-Altman method* (mean difference ±2 standard deviations), for 3-D models and 2-D life-size drawings[a]

	Food models N = 92 subjects					Drawings N = 92 subjects				
Nutrient	%< -2SD	-2SD - +2SD	%> +2SD	Spearman's correlation coefficient	P value	%< -2SD	-2SD - +2SD	%> +2SD	Spearman's correlation coefficient	P value
Kilojoules	7.6	84.2	8.2	0.050	0.2440	0.2	97.1	2.7	0.053	0.2156
Protein (g)	2.0	93.5	4.5	0.170	<0.0001	2.5	91.1	6.3	0.149	0.0004
Carbohydrates	6.3	90.0	3.6	0.021	0.6190	1.1	98.0	0.9	0.033	0.423
Fiber (g)	6.2	93.1	0.7	-0.263	<0.0001	5.8	93.3	0.9	-0.254	<0.0001
Total fat (g)	3.1	91.7	5.3	0.109	0.0106	2.5	91.1	6.3	0.025	0.5526
Cholesterol (mg)	2.0	93.5	4.5	0.073	0.0878	2.4	91.3	6.3	0.173	<0.0001
Vitamin A (RE)	6.2	93.1	0.7	-0.423	<0.000	5.6	92.8	1.6	-0.371	<0.0001
Vitamin C (mg)	7.6	84.2	8.2	-0.219	<0.000	0.7	96.6	2.7	-0.158	0.0002
Vitamin E (mg)	3.3	96.7	-	-0.362	<0.000	2.5	97.5	-	-0.460	<0.0001
Vitamin D (ug)	3.9	96.1	-	-0.681	<0.000	2.8	97.2	-	-0.613	<0.0001
Vitamin B_6 (mg)	7.3	84.6	8.2	-0.165	0.0001	0.2	97.1	2.7	-0.176	<0.0001
Vitamin B_{12} (ug)	2.0	93.5	4.5	0.073	0.0878	2.4	91.3	6.3	0.173	<0.0001
Iron (mg)	2.4	93.1	4.5	-0.119	0.0050	3.1	90.6	6.3	-0.114	0.0072
Calcium (mg)	7.1	92.0	0.9	0.090	0.0351	2.7	92.6	4.7	0.094	0.0274
Magnesium (mg)	6.0	90.2	3.8	0.091	0.0316	0.2	97.1	2.7	0.057	0.1842

* Reference 29; [a]Nutrient content of the models and drawings were being evaluated compared with nutrient intake of the actual food

food items, such as liver and citrus, were included. Therefore, the outcomes in nutrient values are determined not only by the size of the item consumed, but also by the type of item. In the latter case, for example, there would be a large difference in vitamin A intake if the weight of liver were under- or over-estimated.

In conclusion, results regarding our aims suggest that the drawings provided a better estimate of actual energy, fat and carbohydrates than did the food models (with respect to lying within the limits of agreement). However, the food models were more frequently selected correctly than the drawings. Hence, both methods had advantages and disadvantages. Overall, both aids provided high correlations for *actual* versus *estimated* nutrients. There were no gender, but some ethnic differences; conesquently, we would recommend using either the drawings or the models when conducting interviews with black 12-13 year old adolescents and the models when interviewing white children.

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Original Article

How well do adolescents determine portion sizes of foods and beverages?

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青少年如何更好确定食物和饮料份量的大小？

本次研究将分析青少年（12-13 岁）如何在不同食物品种面前选择正确的饮食辅助手段以确定份量的大小。同时，我们也评价了在这一过程中作为饮食辅助手段的二维图画和三维食物模型的效果。来自于约翰内斯堡的 50 名黑人儿童和 42 名白人儿童参与了此项研究(*N* =92)。资深的考察官按指定的顺序对每名儿童单独进行了一次测试。给每名受试儿童出示一盘已知重量的食物，要求受试者选择最接近于真实食物份量的一张二维图画和一种三维食物模型。以这种方式对 11 种不同的食物份量大小进行了评估。以实际重量计算的食物组分的营养成分和以评估计算所得值间的相关系数为 0.842 至 0.994(P<0.0001)，表明通过饮食辅助手段，在实际计算和评估计算的营养成分之间有显著正相关性。然而，有结果也表明相比于食物模型，通过二维图画可对实际的食物能量、脂肪和碳水化合物进行更好的估计。另一方面，选择食物模型的正确率高于选择二维图画。因此，两种方法各有其优缺点。总的说来，在用二者进行评定食物份量大小时无显著性差异(P>0.05)，然而，二者却有本质上的差别。除了 2 名儿童以外，所有的黑人儿童选择了正确的辅助手段（图画和模型），而白人儿童在选择正确率上相对较低。建议在城市地区进行的针对黑人儿童的饮食问卷中可使用其中的一种手段，而对于白人青少年则使用食物模型手段。

关键词： 饮食调查、食物份量、食物模型、视觉辅助手段、青少年、黑人或白人儿童、约翰内斯堡-索韦托、南非。