Construction of a valid and reliable test to determine knowledge on dietary fat of higher-educated young adults

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Abstract

Objective: The construction of a questionnaire, in the format of a test, to determine knowledge on dietary fat of higher-educated young adults.

Design: The topics on dietary fat included were in accordance with those tested in other studies. Forty multiple-choice items were drafted as questions and incomplete statements following the item construction rules. The items were reviewed by nutrition and food science professionals for content- and face-related evidence (n = 4 respectively) and by students representing the study population for face-related evidence (n = 16) of validity. Twenty items were removed as the panel questioned their relevance and replaced with 17 items reviewed by them. The items now largely focused on food sources of fat. These 37 items formed the preliminary test that was administered to two groups of higher-education students expected to differ in nutrition knowledge level. The completed and scored items were statistically analysed to determine which items could be retained for the test. Items meeting the item analysis criteria formed the test. The Mann-Whitney statistic was used to determine the construct-related evidence of validity and the Kuder-Richardson (K-R) 20 formula for the reliability of the test.

Results: The 37-item preliminary test was completed by 99 and 87 students respectively forming the knowledgeable and less knowledgeable groups. Eighteen items remained after the statistical item analysis. Eight items did not meet the difficulty and discrimination index criteria respectively, nine the item-to-total correlation criteria and 13 the answer distribution criteria. The 18-item test was found to be reliable (K-R20 = 0.8997), as well as valid, since a significant difference ($p < 0.001$) in knowledge was found between the groups in the expected direction.

Conclusion: The test can be used to compare the knowledge scores of groups and of individuals as it met the reliability coefficient of 0.75 and 0.85 respectively to make such score decisions.

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Introduction

Foods not included in the basic food groups, such as confectionary and savoury snacks, feature in the diet of urban South African adults.[1,2,3] These foods are often not identified by users as major sources of dietary fat[4] and the hidden fat present negatively influences lowering fat intake.[5,6,7] Considering these aspects a study was undertaken to determine the sensory acceptability of bakery products with a reduced fat content as market availability was the factor found most indicative of prompting dietary change to reduce fat intake.[8] As part of the study the knowledge on dietary fat of the study population of young adults, represented by higher-education students, had to be determined as knowledge is a factor linked to eating behaviour.[9,10] A questionnaire with dietary fat as the knowledge domain therefore had to be obtained or constructed for this purpose and became a further aim of the study.

Literature on eating and its association with nutrition knowledge is, however, inconsistent.[9,10] A proposed reason for this is the poor knowledge assessment.[11,12] Accurate assessments of the nutrition knowledge-dietary behaviour relationship require use of valid and reliable knowledge measures,[13] but existing nutrition knowledge questionnaires generally have psychometric shortcomings because they were not subjected to rigorous validation and reliability testing.[9,11,14]

Although Parmenter and Wardle[15] indicated that a new measure should be constructed only if a suitable instrument cannot be found, they also indicated that it is common for investigators studying nutrition knowledge to design their own questionnaires so that the questions could be pertinent to the study. Axelson and Brinberg[14] emphasised that knowledge will be a good predictor of behaviour only if the measure represents aspects that correspond with the dietary behaviour under investigation. An instrument constructed and validated in one country would also not necessarily be valid for another[15] due to cultural variations in eating habits and the possibility of specific dietary recommendations.[11] The decision was therefore taken to consider the validity and reliability requirements and to construct a questionnaire in the format of a "test" as a measure to determine the knowledge on dietary fat of higher-educated young adults.

Methods

Step 1: Content selection and test item construction and review

Content selection: The topics selected were in accordance with those identified by other researchers[13,16,17,18] and included fat terminology, characteristics, functions, disease associations, dietary recommendations and food sources and choices.

Test item construction: The decision was that the test should consist of approximately 20 items. Huysamen[19] and Parmenter and Wardle[15] recommended writing twice the number of items required so that weak or inappropriate items could be discarded during the item review.[15,20] Forty items were drafted representing the topics selected on dietary fat. Items that dealt with the same topic were grouped together.[15,21] The items were constructed in the form of questions and incomplete statements.[20,21,22] Both comprehension- and application-type items, which provide the basic means of understanding,[20,21] were included. Examples of the items constructed are indicated in Table I.

The multiple-choice item format was chosen since such items are easy and less time-consuming to complete and scoring and processing are also easily,[20,23] objectively[20,22] and reliably[20] done. An item should have at least three answer choices, or distracters, to be classified a multiple-choice item.[21] Four alternatives were provided (see Table I) as nutrition textbooks and test banks consulted mostly included four and this pattern reduces guessing of an answer.[20] The choice of answers is very important as they permit control of item difficulty.[21] Alternatives such as "none of the above", "all of the above" and others were not included as options, as this is not recommended.[21,22]

Clarity, preciseness and relevance of items and avoiding double-barrelled and biased items, were a few of the rules for item construction that were applied in drafting the items.[20,21,22,23] Although not recommended for inclusion,[23] the use of negatively formulated items was considered relevant, but done sparingly.[21,22] The four such items drafted followed the rules for the construction of negative items.[20,22] The negative wording was emphasised (bold printed)

Table I : Examples of multiple-choice items constructed with four answer alternatives

Item number	Item as question or incomplete statement	Multiple-choice answer alternatives			
		a	b	c	d
2	Which of the following beverages has the **lowest energy** content per cup (250 ml)?[b]	Tomato juice (salt and pepper added)[a]	Butternut soup (no cream added)	Orange juice (no sugar added)	Skim milk (fat free)
5	Which one of the following contains the **most fat**?[b]	Peanut brittle[a]	Jelly beans	Lollipops	Marshmallows
6	Which of the following snacks has the **lowest fat** content?[b]	Beef biltong sliced	Commercial potato crisps (chips)	Peanuts	Popcorn[a]
9	Which one of the following has the **highest fat** content?[b]	Doughnut	Custard slice[a]	Koeksister	Vetkoek
10	Which one of the following has the **lowest fat** content?[b]	Croissant	Scone	Bread roll[a]	Muffin
12	Which of the following soups will have the **lowest fat** content per cup (250 ml)?[b]	Chicken and noodle soup	Chili beef soup	Mixed vegetable soup[a]	Split pea and ham soup
13	Which of the following included in the same amount as a sandwich filling will provide the **most fat**?[b]	Cheddar cheese	Streaky bacon[a]	Pork / Beef salami	Cooked / Canned ham
14	Which of the following foods has the **highest fat** content per 100 g?[b]	Fried beef burger pattie	Canned vienna sausage	Fried fish cake	Sausage roll[a]
15	Which of the following fast food choices will provide the **highest fat** content per serving of the same weight?[b]	Regular hotdog with chili	Single hamburger	Large hot chips[a]	Grilled chicken sandwich
16	If low fat ingredients and lean meat were used to prepare the following items, which one will have the **lowest fat** content per serving of the same weight?[b]	Cottage pie (mince with a mashed potato topping)	Bobotie (curry flavoured mince dish)	Meat lasagna (mince layered with macaroni and white sauce)	Spaghetti bolognaise (spaghetti with tomato flavoured mince)[a]
17	Which cooking method will add the **smallest amount of fat** to the cooked product?	Grilling[a]	Pan frying	Deep fat frying	Oven baking
18	Which of the following items would be recommended for use in coffee if someone is trying to decrease energy and fat intakes?	Cream	Coffee / Tea creamer (whitener)	Low fat (2%) milk[a]	Condensed milk
21	Which products usually contain cholesterol?	Plant products	Animal products[a]	Food products containing fat or oil	Processed food products
22	Select the cholesterol containing food item from the list:	Margarine	Baked beans	Sunflower oil	Frankfurter sausage[a]
24	Select the milk or milk product from the list that does **not** contain cholesterol:	Soya bean milk[a]	Low fat (2%) milk	Plain Bulgarian yoghurt	Feta cheese
31	Which of the following is indicated to be the "**good**" fats in the diet?	Saturated fatty acids	Unsaturated fatty acids[a]	Trans fatty acids	Hydrogenated fatty acids
32	Which of the following is **true** of cholesterol?	It is essential to the human diet	It is found in plant products	It provides energy to the body	It is manufactured in the body[a]
33	The dietary factor most associated with high blood cholesterol levels is a high intake of	cholesterol	food fat	saturated fat[a]	unsaturated fat
34	Which of the following oils should **not** be allowed in the diet used for the treatment of coronary heart disease?	Sunflower oil	Olive oil	Coconut oil[a]	Canola oil
36	The **most** appropriate margarine to protect against heart disease is one	that is labeled "unsaturated plant oil"[a]	that contains hydrogenated plant oil as the first ingredient	that is solid and sold in a brick	that is advertised as containing "no cholesterol"

[a] = Correct multiple-choice answer
[b] = Answers to nutrient content questions based on food composition data obtained from: FoodFinder™ 3. 2002. Dietary analysis software. Parow: South African Medical Research Council.

to call the respondent's attention to it[21] (see item 24 as example in Table I). The items were also reviewed in terms of independency.[20,21,22] The distribution of answers was also randomly positioned,[20,22] so that each answer alternative (a, b, c or d) was equally represented as to the correct answer.[21]

Test item review: Content-related validity[20] (or representative validity)[13] refers to how well the items represent the content domain to be measured.[20] This is obtained by careful logical analysis[20] based on the professional judgement of subject-matter experts.[21] The items were drafted by a dietitian and reviewed by two registered dietitians with research experience and involved in the field of nutrition education, and two higher-education food science lecturers. Dietitians and nutritionists have the expertise in nutritional matters to advise in this regard.[15] The items were evaluated by the panel in terms of accuracy, appropriateness or relevance, representativeness of the topics covered, suitability and mutual exclusiveness of the answers, as well as clarity[23] and format.[19,22]

Four higher-education lecturers, representing the nutrition and food science fields and familiar with the study group, together with four final-year students knowledgeable about food and nutrition and representative of the study group, evaluated the drafted items for reasonableness. This appearance of reasonableness is sometimes called face validity[21,22] and relates to the reasonableness of the test from the respondent's point of view[21] - that is, that items may be regarded as either too easy or too difficult.[19]

Face-related evidence of validity was a concern. The face-related validity evaluation panel indicated that the items covering fat terminology, characteristics, functions and dietary recommendations were too difficult and would not be considered reasonable from the respondents' point of view. To obtain support the student panel members each formed a small discussion group with three students representing the study group. Two of the participants received formal nutrition instruction at school, while the rest (n = 10) did not. These discussions confirmed that the respondents would not be competent to answer these items. As a result the items covering fat terminology and characteristics (n = 10) and most items related to the functions of fat in food, in the body (n = 4) and disease (n = 3), as well as fat dietary recommendations (n = 3) were removed. It was decided beforehand that if an item was judged by three or more panel members to be inappropriate, the item would be discarded. The panel used comments like too advanced, scientific, technical and physiological to describe these items, and also questioned their relevance.

The panel suggested that items should focus largely on food sources of fat and practical food choices and to a minor extent on diet-disease associations. The 20 items deleted were replaced with 17 items as suggested. Most of the 37 items (n = 30), now related to food sources of fat and practical food choices. These items were again evaluated by the panel.

After evaluation for content- and face-related validity as described above, through item commentary as per individual panel member followed up by group discussions, the items retained formed the preliminary test. The 37 retained items were reviewed by two education professionals for reading level, vocabulary, application of the normal rules of grammar[20] and item construction.[20,21,22,23]

Step 2: Preliminary test construction and testing

Preliminary test construction: A self-administered questionnaire was constructed based on the outcome of the first step of the development process. An introductory comment was provided to explain the purpose of the questionnaire and brief instructions for its completion indicated clearly and prominently.[21] The letters (a, b, c or d) preceding the answer alternatives[20] were circled by the respondents as their answers. The last part of the questionnaire included the respondent demographic data. Besides age and perceived body weight status, this section also included questions regarding formal nutrition education and sources of nutrition information, perceived nutrition knowledge and dieting (as the latter was identified as a predictor of knowledge).[16]

Testing: The respondents consisted of two groups of predominantly undergraduate higher-education female students. The first group consisted of approximately 100 first- and second-year education and environmental health students. It was expected that they would have a low level of knowledge in the field of nutrition. It was further expected that the second group, consisting of a further 100 first- and second-year students studying food and wellness courses that incorporated nutrition as a subject, would have a higher level of nutrition knowledge. This would ensure that one group had a greater knowledge of nutrition than the other, while other variables such as gender, age and educational level were fairly similar. Female students were selected as the target group due to their dominance among the food and wellness students. On completion, each questionnaire was reviewed for omissions. The answers were scored dichotomously.

Step 3: Statistical analysis of preliminary test items

The data was entered on a spreadsheet and consisted of the item answer alternatives selected (either a, b, c, or d), the item score (0 or 1) and the total test score of each completed questionnaire. The item analysis was done using MS Excel and Stata 8. Item analysis entails the statistical analysis of the results of a test to identify which items can be retained and which need to be revised or discarded.[22] Items that met the item analysis criteria for item difficulty, effectiveness of each answer alternative and the discrimination power[20] formed the final test.

Item difficulty index (IDI): Only those items in the easiness range 0.35 to 0.85[22] were selected. All items found to be too easy (answered correctly by more than 85% of the respondents) or which proved to be too difficult (answered correctly by less than 35%) were excluded. The IDI was used to rank the items from the easiest to the most difficult[22] in the final test.

Distribution of answers to alternatives: Items in which an answer was not chosen by at least 5% of the respondents were discarded, as that alternative could not be regarded a good distracter.[22]

Discrimination index (DI): Items for which the difference was not at least 20 percentage points between the top and the bottom 25% of the total scorers[22] or which had a DI of below 0.20[21] were discarded as they failed to discriminate between good and poor performers. Although it may be desirable to use 25%, 27% is recommended for a more refined analysis[20,21] and was used for this test.

Item-to-total correlation: Each student had a score on each item (e.g. 1 as correct or 0 as incorrect) and a score on the test as a whole. Correlation coefficients can be computed from these results.

The Pearson's correlation was used and only those items meeting a correlation of 0.20 and higher[15] were retained.

Step 4: Validity and reliability determination of final test

Those items meeting the item analysis criteria as indicated in step 3 formed the test. The two most important considerations of a well-constructed test are validity and reliability.[20]

Validity: Construct-related evidence (also known as discriminant validity)[13,14] requires that the construct presumed to be reflected in the scores actually does account for differences in test performance.[20] The use of sub-populations to determine construct validity has been applied in nutrition knowledge research.[9,11] The Mann-Whitney statistic was used to determine whether the test could discriminate between the student groups. If it did, it could be assumed that the test measured what it was supposed to measure, namely a nutrition knowledge dimension.[9]

Reliability: The Kuder-Richardson formula 20 (K-R20) was used to estimate the internal consistency of the test as it is applicable to single administration tests[20] scored dichotomously and its use advised when items vary in difficulty.[24] There are no absolute standards to serve as criteria to determine whether a given reliability coefficient is high enough. The accepted minimum varies from 0.65[24] to 0.75[25] if the decision is about scores of a group of individuals.

Results

Study sample and testing

All 186 students attending scheduled classes answered the preliminary test after being informed about the study and invited to participate. Student participation was voluntary and anonymous. Ninety-nine first- and second-year National Diploma (ND): Consumer Science: Food and Nutrition together with ND: Somatology students formed the knowledgeable group as nutrition was a subject in their programme syllabuses. Four of these students were males, while the remainder (n = 95) were females. The less knowledgeable group was presented by 87 first- and second-year ND: Education together with ND: Environmental Health students. The syllabuses of these programmes did not include nutrition as a subject. Eleven of these students were males, while the majority (n = 76) were females. The average age for both groups was 20 years.

Preliminary test item analysis

Eighteen of the 37 (49.0%) items were retained. Refer to Table II for the IDI, DI, item-to-total correlation and answer distribution analysis of the items. Eight items did not meet the IDI criteria of 0.35 to 0.85. Seven items were too difficult and one item too easy. Eight items also did not meet the DI criteria and nine items the item-to-total correlation criteria of 0.20 and higher. Thirteen items did not meet the criteria that an answer alternative had to be indicated by at least 5.0% of the respondents as the correct answer, as either one (n = 8 items) or two alternatives (n = 5 items) did not meet it.

The concern about the face-related evidence of validity caused the exclusion of items related to terminology and characteristics and most items related to functions and dietary recommendations. This led to the 37-item preliminary test being made up of 81.0% of the items related to food sources and

Table II: Item difficulty index, discrimination index, item-to-total correlation and answer distribution of test items

Item number	Item difficulty index*	Discrimination index**	Item-to-total correlation***	Distribution of answers to alternatives****			
				a	b	c	d
1	0.39	0.60	0.532	24.7%	23.1%	12.9%	39.2%
2	**0.29**	**0.07**	**0.129**	28.0%	7.5%	16.7%	47.8%
3	**0.34**	**0.17**	**0.147**	22.0%	32.8%	35.5%	9.7%
4	0.45	0.68	0.559	11.8%	19.4%	26.9%	41.9%
5	**0.88**	**0.12**	**0.139**	88.2%	**2.7%**	**1.1%**	8.1%
6	0.77	0.35	0.282	15.6%	**3.8%**	**3.8%**	76.9%
7	0.57	0.43	0.402	55.4%	8.6%	19.9%	16.1%
8	0.41	0.33	0.283	41.9%	7.5%	36.6%	14.0%
9	**0.08**	**0.08**	**0.089**	12.4%	7.0%	32.8%	47.8%
10	0.68	0.25	**0.198**	7.0%	10.2%	64.5%	18.3%
11	0.73	0.57	0.485	72.6%	7.0%	11.3%	9.1%
12	0.80	0.27	0.282	7.5%	**3.2%**	82.3%	7.0%
13	0.37	0.25	0.216	19.9%	36.6%	39.2%	**4.3%**
14	**0.25**	0.28	0.279	63.4%	**3.8%**	12.9%	19.9%
15	0.81	0.37	0.385	2.2%	5.9%	82.3%	9.7%
16	0.36	**0.09**	**0.090**	20.4%	30.6%	11.8%	37.1%
17	0.49	**0.13**	**0.059**	46.2%	**3.2%**	**4.3%**	46.2%
18	0.82	**0.12**	**0.158**	**2.2%**	11.3%	82.3%	**4.3%**
19	**0.33**	**0.07**	**0.057**	14.0%	31.2%	**1.6%**	53.2%
20	0.73	0.37	0.321	5.9%	77.4%	10.8%	5.9%
21	0.54	0.84	0.647	7.0%	53.2%	30.1%	9.7%
22	0.57	0.70	0.530	17.7%	5.4%	18.8%	58.1%
23	0.42	0.64	0.497	22.6%	**4.8%**	32.4%	39.8%
24	0.66	0.55	0.419	64.5%	19.9%	9.7%	5.9%
25	**0.33**	0.48	0.478	28.0%	33.9%	22.0%	16.1%
26	0.40	0.48	0.450	15.1%	37.6%	36.6%	10.8%
27	0.76	0.29	0.284	**2.7%**	11.3%	8.6%	77.4%
28	0.44	0.35	0.314	42.5%	23.7%	18.8%	15.1%
29	0.60	0.72	0.570	10.8%	14.5%	59.1%	15.6%
30	0.57	0.71	0.570	18.8%	57.5%	18.3%	5.4%
31	0.56	0.74	0.627	21.5%	54.8%	5.9%	17.7%
32	0.56	0.64	0.477	17.7%	13.4%	15.6%	53.2%
33	0.53	0.74	0.592	15.6%	21.5%	52.7%	10.2%
34	0.41	0.68	0.550	36.6%	10.8%	41.4%	11.3%
35	**0.12**	0.22	0.304	82.8%	**4.8%**	**2.7%**	9.7%
36	0.44	0.66	0.502	41.9%	9.1%	7.0%	41.9%
37	0.62	0.70	0.535	**3.4%**	35.5%	60.2%	**0.5%**

Values in bold print: Item did not meet specific item analysis criteria:
* Item difficulty index: 0.35 - 0.85 ** Discrimination index: ≥ 0.20 *** Item-to-total-correlation: ≥ 0.20
**** Distribution of answers to alternatives: ≥ 5.0%

choice (n = 30 items) and 19.0% to food and health-disease (n = 7 items). In the final test most of these food and health-disease-related items were retained (5 of the 7 items) as they met the item analysis criteria. The test therefore consisted of 72.0% of the items related to food sources and choice (n = 13 items) and 28.0% to food and health-disease (n = 5 items).

Validity and reliability of final test

The test, consisting of the 18 items retained, was found to be reliable. The reliability coefficient determined by the KR-20 was 0.8997. This met the accepted criterion of 0.75 where groups are compared.[25] The reasons for the high reliability may be the thorough process of item review and the IDI of most of the retained items being between 0.40 and 0.60 (14 of the 18 items), with some reaching the favourable 50.0% level[20,21] (7 of the 18 items) (see Table II). The test was also found to be valid as a significant difference ($p < 0.001$) in knowledge was found between the groups utilising the Mann-Whitney statistic ($z = -9.8059$). The median scores of the knowledgeable and less knowledgeable groups were 13 (mean = 13.38) and 7 (mean = 6.85) respectively.

The test validity was also supported by the fact that 94.0% of the knowledgeable group indicated formal lectures as their major source of nutrition information and that 87.7% of these students also indicated that they were more knowledgeable about nutrition in comparison to other young adults. In contrast, 71.0% of the less knowledgeable group indicated that they were as knowledgeable and/or less knowledgeable in comparison to other young adults. Approximately half of this group (53%) also indicated printed material, such as magazine articles, lay books, advertisements and brochures along with public lectures, radio talks and television programmes (28.0%), and family and friends (25.0%) as their major sources.

As dieting was identified as a predictor of knowledge,[16] demographic questions related to body weight status and dieting/slimming nutrition information were included to consider this influence. No major influence could be identified relating to these factors. In both the knowledgeable and less knowledgeable groups the majority of the students described themselves as being of optimal body weight (67.0% and 70.0% respectively), while some students did describe themselves as overweight (30.0% and 21.0% respectively). Nutrition information regarding dieting/slimming was indicated as important by only ten respondents in the less knowledgeable group, but seven of these respondents described themselves as being of an optimal body weight, while one (male) described himself as underweight and the other two described themselves as overweight. It must be borne in mind that all nutrition information might be important for the respondent group having nutrition as a subject and that this might explain why no student in this group indicated dieting/slimming nutrition information as important.

The 18 items were ranked in the final test according to their IDI (see Table II) from the easiest to the most difficult in the test. Item (I) one was therefore placed last and I20 first. Standard scores were calculated for future use as norms to differentiate between respondents at different levels of knowledge,[20,21] i.e. as average a score of 10 (group median score = 10; group mean score = 10.12); as above average or good a score of 13 and above (median and mean scores of knowledgeable group equalled 13 and 13.38 respectively) and below average or poor a score of 7 or below (median and mean scores of less knowledgeable group equalled 7 and 6.85 respectively).

Discussion

Item elimination during panel item review

There is currently uncertainty regarding the level of nutrition knowledge and understanding among South Africans regarding dietary fat. This was made clear in the item review as there was major face-related validity concern which led to half of the constructed items discarded by the panel. The panel's decision to discard items covering fat terminology and characteristics and most items related to fat functions and dietary recommendations are supported by the results of studies concerned with fat knowledge.

Items covering fat terminology: Parmenter and Wardle[11] also removed the understanding of terms as it was judged too scientific and not relevant. In a 1992 study reported by Buttriss[26] and representing the general United Kingdom (UK) public, a far higher percentage of the respondents claimed to have heard of cholesterol, polyunsaturated fatty acids (PUFA), saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) compared to the percentage confident to explain these terms (95% vs. 54%, 90% vs. 42%, 78% vs 28% and 31% vs 11% respectively). In a study by Auld et al[18] less than 25% of their recruited sample of American adults knew about PUFA and MUFA and adult Canadian respondents were also mostly (72%) unaware of the term omega-3 PUFA.[27] Buttriss[26] also reported on the confidence of health professionals in explaining these terms. Almost half (46%) of those interviewed early in 1992 stated that they were not confident about explaining the difference between SFA, MUFA and PUFA. The situation might even have worsened as 23% in 1993 were not confident about explaining SFA compared to 13% in early 1992. These health professionals indicated real uncertainty regarding trans fatty acids (TFA), as 71% in early 1992, 73% in late 1992 and 78% in 1993 indicated that they were not confident explaining this term. The majority (56%) of adult Canadian respondents also did not know the term.[27]

Items covering fat characteristics: Consumers were largely uninformed about the characteristics of fat, that is which kind of fat is more likely to be a liquid rather than a solid, and that hydrogenation makes a fat or oil more saturated in the 1988 Health and Diet Survey.[16] Less than 25% of the sample of Auld et al[18] and only 39% of the higher-education staff sample of Coleman and Wilson[17] knew that unsaturated fats tend to be liquid and saturated fats solid at room temperature. Auld et al[18] also found that less than 25% of their sample knew that hydrogenation increases fat saturation.

Items covering functions of fat: Regarding the functions of fat in disease, less than 25% of the sample of Auld et al[18] knew that MUFA is associated with fewer health problems than SFA. Only 27% of primary care physicians in Canada knew that omega-3 fat was the nutrient believed to help protect against thrombosis.[28] The three discarded items related to the functions of fat in disease prevention were concerned with MUFA (n = 1) and omega-3 PUFA (n = 2).

Items covering dietary fat recommendations: Despite the knowledge scores of South African higher-education students regarding diet-disease relationships and dietary recommendations being found to be of an average level [respectively 9.82 (± 4.72) out of 23 and 6.57 (± 2.16) out of 13][29] most of the items on the dietary recommendations were discarded. In the sample of urban black and white South Africans[30] 81% and 88% respectively knew that less fatty foods should be consumed. Parmenter et al[31] found

that more than 90% of the respondents in the cross-section study of the adult population of England were aware of the recommendations to decrease fat, although almost a quarter did not know the recommendation to reduce SFA. The subjects in the study of Harper and Rutishauser[4] also were aware of the need to eat less fat (83%), but only two could state the recommendations for fat intake. In the study by Auld et al[18] less than 25% of their sample knew that not more than 30% of caloric intake from fat is recommended.

Items eliminated and retained during item analysis of preliminary test

Items not meeting the answer distribution criteria: Although the panel suggested that items should focus largely on food sources and practical food choices, research studies however also suggested that people were not aware of the fat content in foods.[4,32] In a convenient sample of South African urban black women[33] over half of the sample classified high-fat foods as being low in fat. Although earlier studies in the UK[34,35] had shown that consumers are poor at categorising selected foods as high or low in fat, Mela[32] found that UK consumers can position foods with regard to fat content relatively well. The South African higher-education students participating in the study of Peltzer[29] obtained a mean score of 5.88 (±1.73) out of 10 on the food sources of fat. In the preliminary test item analysis the major loss of items occurred due to answer alternatives not being adequately selected. In general, the elimination of items occurred due to the sample being aware that chips, peanuts, cream, cheese, sausages and cold meats were high in fat and that frying was a cooking method that increased food fat content. Kelishadi et al[36] also found in their Iranian study that the respondents agreed that deep-frying is not a proper way of cooking. Where these foods were included as answers (I5, I6, I13, I14, I15, I17 and I18) the items were found not to meet the item analysis answer distribution and other criteria (see Tables I and II). Careful consideration should therefore be given to the inclusion of fat-containing food items as answers in South African knowledge test developments, as certain food items may be known to be high in fat as was determined in this study and that of Peltzer.[29]

The item related to the dietary guideline concerning fat intake (I37) also had to be discarded as the avoidance of fat and a liberal fat intake as answers were not good distracters (see answers a and d respectively in Table II) which indicated that the respondents knew that fat should not be avoided in the diet but neither is a liberal fat intake advised. In the investigation of Barratt[37] both study groups identified that less fat should be consumed (97% of the health professionals and 99% of the general public).

Items not meeting the item difficulty and discrimination indices criteria: It was further found that when dishes were used as answers these items were often too difficult or could not discriminate between the groups, possibly due to the sample not being familiar with the recipe and ingredients, i.e. main meal dishes such as cottage pie, meat lasagne etc, baked products such as croissants, scones etc, typical South African confectionary such as milk tart, jam roll etc and soups (I2, I9, I10, I12 and I16) (see Tables I and II). The study of Byrd-Bredbenner[38] indicated that the food preparation knowledge of young adults was low, yet the vast majority overestimated their knowledge. The inclusion of dishes as answers should therefore also be considered carefully in knowledge test developments as knowledge regarding the recipe ingredients may be limited and cause item elimination.

Almost 70% of the respondents in the study of Mela[32] and 84% in the study of Tate and Cade[39] believed that margarine contained less fat than butter, a belief Mela[32] presumed arose from margarine's healthier image. Parmenter et al[31] also found that over 70% of their respondents either incorrectly believed that margarine contained less fat than butter or were unsure. Reid et al[27] found that 50% of their respondents knew that margarine and butter contained the same amount of fat, while Coleman and Wilson[17] found that 39% and 53% of their sample respectively, correctly indicated that the statements that margarine contained less fat and had fewer calories than butter were false. This item (I3) had to be discarded as it was found to be too difficult and could not discriminate between the groups (see Table II).

Items retained: In the study of Harper and Rutishauser[4] only four subjects were aware that fat provided more energy per gram than carbohydrate, and only one knew that fat provided about twice the energy of carbohydrate. In the sample of urban black and white South Africans[30] less than 35% correctly indicated that fat has the most calories. This item (I4) was retained as it met the item analysis criteria (Table II). The respondents in the study of Parmenter et al[31] were also confused about which food types contained the most energy. Almost equal numbers believed it was fatty and sugary foods (33% and 35% respectively). Item one concerning the energy content of pure fat, protein-containing and starch-containing foods was retained (but had to be placed last in the test due to its IDI) (see Table II).

Four of the retained items were related to the types of fat (I26, I28, I29 and I30) and three to cholesterol (I21, I22 and I24), but were all linked to the food sources of these fat types. Less than 35% of the sample of Peltzer[30] knew that PUFA are mainly found in plant oil. Knowledge of MUFA was poor in the studies of Parmenter et al[31] and Peltzer[30] with less than 25% and 35% of the respondents respectively knowing that olive oil contained mostly this type of fat. Only 50% of the Canadian primary care physicians knew that MUFA was the major type of fat in olive oil.[28] The survey of adolescents in Rhode Island[40] indicated that many adolescents were aware of the marine sources of omega-3 PUFA, such as salmon (67%), tuna (46%) and mackerel (30%). Item 26 concerned food sources of SFA, I28 olive oil as a source of MUFA, I29 fatty fish as an omega-3 fat source and I30 food sources of TFA. A survey of primary care physicians in Canada[28] indicated that 54% knew that compared with unprocessed plant oils, hydrogenated fats contained more TFA.

Haralson et al[41] speculated that many people are possibly not as knowledgeable about the cholesterol content of foods as about the fat and SFA, because cholesterol is not visible or known as a by-product of cooking. In determining the nutritional labelling knowledge of white middle-income South African women Anderson and Coertze[42] found that only 28% knew that margarine does not contain cholesterol. In the study by Auld et al[18] less than 25% of their sample knew that plant foods do not contain cholesterol, but animal foods always do. Item 21 that pertained to the above was retained, along with two other items that are applications of I21 in that food items containing (I22) and not containing (I24) cholesterol had to be selected (see Tables I and II).

In the test most of the items relating to food and health-disease were retained (5 of the 7 items) (see I31, I32, I33, I34 and I36 in Table I) as they met the item analysis criteria (see Table II). In the

study of Parmenter et al[31] participants were asked whether they knew of any links between eating more or less of particular foods and major health problems. The highest proportion of people (81%) was aware of the relationship between a high fat intake and heart problems (with overweight/obesity being the second most popular answer). In the study by Auld et al[18] most respondents (≥ 70%) also knew that heart disease and obesity can be associated with excess fat intake and that heart disease is associated with elevated cholesterol levels. The student sample was also aware that dietary fat does not have a major association with a disease such as skeletal disorders, referring to bone and teeth (see alternative c of I35 in Table II), that is closely associated with calcium intake. According to Witwer[43] it can be assumed that the majority of mainstream consumers understand that calcium prevents osteoporosis.

Reid et al[27] found that 69% of their Canadian adult respondents and Tate and Cade[39] that 61% of their respondents agreed, mistakenly, that the amount of cholesterol consumed is the major factor that affects blood cholesterol. However, in the 1988 Health and Diet Survey[16] 56% of the respondents knew that SFA was more likely to raise blood cholesterol levels. Of the people who were aware of the fat-disease link in the study by Parmenter et al[31] over 90% also knew about the link between SFA and heart disease. This item (I33) was retained as it met the item analysis criteria and was not found to be too easy (see Table II).

Conclusions and recommendations

The final 18-item test was found to be valid since a significant difference in knowledge in the expected direction was found between the two groups of higher-educated young adults that participated, as well as reliable as the reliability coefficient determined by the internal-consistency KR-20 met the criterion of 0.75.[25] The test can therefore be used to compare the dietary fat knowledge scores of groups, but also for the scores of individuals as it met the reliability coefficient of at least 0.85 informally agreed upon by experts in educational measurement for use to make decisions about individuals.[24] The knowledge measure constructed of the items retained after the item analysis therefore yielded an instrument that can be useful to others.

Studies have found women to be more knowledgeable about dietary fat than men,[26,31,39] middle-aged more than older or young people[16,31,39] and to increase with education[16,31] and higher socio-economic status.[31,39] As this student sample was biased in favour of women having a higher education who tend to have a better knowledge, it is probable that the test may estimate the level of knowledge of females and those with higher education more favourably than that of males and those with no higher education. It may also favour older respondents who tend to have better nutrition knowledge than younger respondents.

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