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Development and test–retest reliability of a nutrition knowledge questionnaire for primary-school children

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Abstract

Objective: To evaluate a web-based nutritional knowledge questionnaire for primary-school children.

Design: Children's nutritional knowledge was assessed in five domains: healthy choices (twenty-seven items), estimated recommended portions/servings (eight items), nutrient content (five items), main food function (five items) and categorization of food items (eight items).

Setting: The questionnaires were completed in school.

Subjects: A convenience sample of 576 Belgian children (aged 7–12 years) from fourteen primary schools completed the questionnaire once, 386 completed the questionnaire twice.

Results: Healthy choices could be answered correctly by 73 % of the children, nutrients by 59 %, food categorization by 49 %, main function by 38 % and portion estimation by 36 %. Children's test–retest intra-class correlations were 0·75 for healthy choices, 0·33 for nutrients, 0·61 for food categorization, 0·44 for main function, 0·47 for portion estimation and 0·76 for the total scale. The intra-class correlation was lower in the youngest age group (grade 2: 0·51, grade 4: 0·65, grade 6: 0·66). The total score was significantly lower in the retest. The instrument was in general positively evaluated by the children.

Conclusions: The instrument is a promising, practical, inexpensive tool with acceptable test–retest reliability in fourth and sixth graders.

Keywords
Nutritional knowledge
Primary-school children
Reliability

Worldwide, many children and adolescents do not meet the recommendations for fruit, vegetable, fish, dairy or whole grains consumption and are over-consuming energy-dense, sugary and salty foods[1–4].

One of the many factors influencing dietary intake is nutritional knowledge[5]. Evidence of the association between nutritional knowledge and dietary intake has been found in several studies[6–10]. Moreover studies examining the effects of programmes designed to increase nutrition knowledge have found positive results[11,12]. However, other studies found no significant relationship[13,14]. Explanations for the inconsistent results are poor measurement of knowledge (lack of relevance, poor conceptualization, different levels of specificity of knowledge and dietary habits), different measurements of knowledge, poor measurement of dietary intake, lack of statistical power and the many factors that influence dietary behaviours of which nutritional knowledge is just one[15].

To improve children's and adolescents' food habits, local, national and international[16–21] interventions are being developed. One of these local interventions in Belgium-Flanders is an Internet intervention targeting primary-school children. The aim of the intervention will be to improve children's dietary habits by increasing children's nutritional knowledge and awareness. To evaluate the effectiveness of the intervention, changes in nutritional knowledge will be evaluated in addition to changes in dietary intake, as traditional dietary assessment instruments are not always appropriate to assess the impact of nutrition education programmes[22]. Hence, a web-based nutritional knowledge questionnaire was developed.

Limited surveys are available to assess the nutrition knowledge of primary-school children and even fewer have investigated the psychometric properties of nutritional knowledge questionnaires in this age group. Item and scale analyses are however important as they can help to improve the questionnaire. Additionally, poor reliability degrades the precision of a measurement and reduces the ability to track changes or link changes to an

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intervention. To our knowledge, only one other study has developed and evaluated a computer-based nutritional knowledge questionnaire for school-aged children[23]. Based on moderate test–retest correlations, appropriate content validity and the questionnaire's ability to measure improvement in the control group of an intervention study, the authors of that study concluded that the computer-based survey is a promising medium for assessing nutrition knowledge.

Methods

Participants and procedure

Ethical approval for the current study was obtained from the ethical board of the Ghent University Hospital.

A convenience sample of fourteen primary schools in Flanders (the northern part of Belgium) participated in the study. Children in the second, fourth and sixth grades (*n* 1029; 7–12 years of age) were invited to participate in the study. Parents of children participating in the study signed informed consent. Children completed a nutrition knowledge questionnaire and a food preferences questionnaire[24] online during school hours. To assess test–retest reliability, half of the second and fourth graders completed the nutritional knowledge questionnaire a second time, the other half completed the preference questionnaire a second time; sixth graders completed both instruments twice. The test–retest interval was one to two weeks. The children completed the programme autonomously, although a teacher and a researcher stayed with the children during the entire administration to address any problems. To assess the children's appreciation of the instrument a short evaluation tool was completed by a sub-sample at the second measurement occasion. Data collection took place in February–March 2011.

Material

The nutritional knowledge questionnaire was developed by two student dietitians and a health psychologist. In Belgium-Flanders, it is not defined which aspects of nutritional knowledge should be covered in the curricula of primary schools. Therefore the questionnaire was developed based on the literature[10,25–27] and the Flemish Food Behaviour Dietary Guidelines model ('The Active Food Triangle')[28], which is used in most schools.

Five main areas of interest were identified: (i) healthy food choices; (ii) nutrient content; (iii) main function of food items/nutrient; (iv) food group categorization; and (v) estimation of adequate portions.

Healthy food choices were assessed with three question formats. For five questions respondents were asked to rank-order a set of two to four items from the healthiest to the least healthiest. For fourteen questions respondents were asked to select the healthiest alternative from two to five multiple-choice items. Finally children were asked to select from a list of eight food items the healthy snacks. Five items asked about the nutrient content of common foods with two to three response options and another five items asked questions related to main health functions (four response options). The next set of questions (food group categorization) contained eight sets of four food images, of which the food item not belonging to the same food group as the other items had to be identified. To assess children's knowledge about adequate portions as recommended by health experts (doctors and dietitians), for eight items respondents had to select the recommended amount from four to five options. The correct responses were based on the Belgian-Flemish Food Behaviour Dietary Guidelines[29]. Items were selected to represent each of the main food groups.

A primary-school teacher, a dietitian and six student dietitians in their last year provided comments on the clarity and content of the items (content validity). A pilot test was done among children of the researchers' family and acquaintances (*n* 10) and members of a volleyball team (*n* 6) to check for clarity, resulting in a number of small modifications.

All items, except the ranking questions, were scored taking into account correction for guessing, so +1 for a correct answer and −1, −0·5, −0·33 or −0·25 for a wrong answer depending on the number of response options (respectively 2, 3, 4 or 5). The ranking questions received one point if the first item was ranked correctly and another point if the last item was ranked correctly. Finally the children could also indicate for each item that they did not know the answer, scored as zero. After the pilot test the 'don't know' option was dropped for the ranking question as this was confusing for the second graders. However, respondents could skip these questions (scored as 0) while all other questions were obligatory. A sum score was created for each domain and a sum score was computed over all domains to represent a general nutritional knowledge score; however, the healthy choices score was divided by three to have a more equal weight over the different domains.

We chose to develop the questionnaire in computer format as the use of computers can help to make questionnaires look simple and attractive[30]. Moreover, this way, many of the food items and recommended servings/portions could be visualized by food images which improves clarity and recognition[31]. Access to the online questionnaire can be obtained from the authors on request.

Children's appreciation of the tool was assessed with a short online questionnaire asking if the questionnaire was clear, interesting, nice, difficult, suitable for children, too long, if the pictures were clear and if there was enough explanation.

The questionnaires were developed in Limesurvey 1·85 (Open Source Software).

Statistical analyses

Percentages are shown, with the percentage of respondents giving the correct answer representing the difficulty index[32]. As knowledge questions should be not too easy and not too difficult, an appropriate range falls between 20% and 80% of correct responses[33]. The item discrimination index reflects an item's ability to discriminate between individuals who scored high and those who scored low on the entire test and was computed as percentage correct in the highest scoring tertile minus percentage correct in the lowest scoring tertile. The discrimination index of each item was assessed within each subscale. Discrimination indices above 20% are acceptable and above 30% good[34].

Because of the known differences in children's general and nutrition-related cognitive capacities by age[35], percentages are presented for the total sample and by grade. In addition, a new data set was created including all difficulty and discrimination indices by item and grade to investigate significant differences by grade. Repeated-measures ANOVA was used to investigate these differences.

Kappa statistics were used to assess agreement between test and retest for each item separately. For this, items were first dichotomized into correct *v.* wrong responses. Values $\kappa<0$ are considered as poor, $\kappa = 0$–$0{\cdot}20$ as slight, $\kappa = 0{\cdot}21$–$0{\cdot}40$ as fair, $\kappa = 0{\cdot}41$–$0{\cdot}60$ as moderate, $\kappa = 0{\cdot}61$–$0{\cdot}80$ as substantial and $\kappa = 0{\cdot}81$–$1{\cdot}00$ as almost perfect[36]. A low κ value might indicate that the question is not clear and/or that the respondents are guessing. The intra-class correlation (ICC)[37] was used to assess agreement on a scale level for each of the domains and for the total knowledge score. An ICC > 0·8 is usually regarded as indicating good to excellent reliability, whereas an ICC between 0·6 and 0·8 may be taken to represent substantial reliability[38]. Systematic differences (higher or lower scores on the retest) were investigated by paired-sample *t* tests.

Because of the ordinal level and skewed distribution of the appreciation items, the non-parametric Kruskal–Wallis test was used to investigate grade differences in appreciation. Data were analysed using the SPSS statistical software package version 15·0·1·1 (2007; SPSS Inc.). The significance level was set at $P< 0{\cdot}05$.

Results

Of the 1029 children approached for participation, 596 returned informed consent and 576 children (grade 2: 33%, grade 4: 34%, grade 6: 32%, boys: 44%, mean age: 9·7 (SD 1·7) years) filled in the nutritional knowledge questionnaire at the first measurement occasion (T1). Three hundred and ninety-six children completed the nutritional knowledge questionnaire a second time (T2), of whom 386 (grade 2: 25%, grade 4: 28%, grade 6: 47%, boys: 42%) could be matched with T1 measurements.

Descriptive statistics, including the difficulty and discrimination indices of the healthy choices, nutrient content, main food function and categorization of food items are summarized in Table 1; descriptive statistics of the estimation of the recommended portions/servings are described in Table 2. On average 73% of the healthy choices were correctly responded. The percentage of correct responses was, however, lower for the remaining scales (nutrients: 59%, food categorization: 49%, main function: 38%, portions: 36%).

A high difficulty index (easy items), in combination with a low discrimination index, was found for the identification of water, milk, fresh fruit salad, jam, oranges and grapes as the most healthy items; for the identification of an apple as a healthy snack; and for the identification of the three unhealthy snacks. A low difficulty index in combination with a low discrimination index was found for two items in the food group categorization, namely nuts in a series of grain products and cheese in a series of meats and meat substitutes. Finally, a low difficulty index was found for children's estimation of recommended portions of bread. The agreement on an item level of correct *v.* wrong responses on T1 *v.* T2 was fair to moderate for most items, with an average of $\kappa = 0{\cdot}39$ (SD 0·11).

Repeated-measures ANOVA indicated a significant increase of the difficulty index by grade (grade 2: 48·9 (SE 3·3), grade 4: 61·5 (SE 3·6), grade 6: 66·0 (SE 3·6); $P< 0{\cdot}001$), but no significant difference was found for the discrimination index (grade 2: 31·9 (SE 2·0), grade 4: 29·6 (SE 2·2), grade 6: 28·5 (SE 2·4); $P= 0{\cdot}466$).

A good agreement between test and retest was found for the overall knowledge scale (ICC = 0·76) and the healthy food choices subscale (ICC = 0·75), a moderate agreement was found for the subscales on food categorization, estimated recommended portions and main functions of food items (ICC = 0·44 to 0·61), but a low agreement was found for the nutrient content scale (ICC = 0·33; Table 3). In general the ICC was lowest for grade 2, with some very low values for the nutrient content, main function of food items and recommended portions scales. The mean of the healthy choices scale decreased from T1 to T2. Results of an abbreviated nutrition knowledge score (excluding the ten easy items with low discrimination index in the healthy eating score) resulted in no major changes in test–retest statistics.

In general the questionnaire was well received by the respondents (Fig. 1). No significant difference was found by grade except that second grade children found it more difficult ($P= 0{\cdot}04$) and too long ($P= 0{\cdot}001$) than fourth and sixth graders.

Discussion

In the present paper the development of a nutritional knowledge questionnaire is described. The overall

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Table 1 Overview of items in the healthy choices, nutrient, food function and food categorization scales of the children's nutritional knowledge questionnaire, difficulty and discrimination index by grade (G) and in the entire sample (Tot) for T1, and test–retest agreement (κ) between T1 and T2 for all grades: Belgian children (aged 7–12 years) from fourteen primary schools, February–March 2011

	Difficulty index				Discrimination index				κ
	G2	G4	G6	Tot	G2	G4	G6	Tot	Tot
Healthy food choices									
Rank from the healthiest to the least healthiest (presented here in the correct order; 1 point if first item is correct and 1 point if last item is correct)									
Water, tea, fruit lemonade									
% first item correct	94	90	91	92	10	14	12	6	0·35
% last item correct	83	88	88	86	27	27	25	23	0·53
Potatoes: boiled or mashed*, fried, French fries									
% first item correct	34+43*	57+22*	66+17*	52+27*	25	33	35	40	0·33
% last item correct	76	90	91	86	40	21	23	31	0·49
Brown bread, white bread, sweet roll									
% first item correct	64	88	90	81	45	35	18	43	0·49
% last item correct	71	72	78	74	29	15	18	21	0·36
Boiled spinach, spinach in cream sauce, spinach burger with breadcrumbs									
% first item correct	45	55	63	54	25	47	28	41	0·28
% last item correct	34	37	41	38	28	18	28	24	0·22
Thick slice of bread, with thin slice of cheese, thin slice of bread with thick slice of cheese	58	67	75	67	31	21	27	32	0·27
What is the most healthy†									
Fristi, chocolate milk, milk‡	90	96	97	94	11	3	7	10	0·24
Mayonnaise, ketchup‡	54	71	76	67	34	32	25	40	0·53
Ham‡, ham sausage, salami	55	59	62	59	44	18	28	30	0·54
Fish sticks (in breadcrumbs), cod‡	43	71	81	73	42	36	25	49	0·52
Fresh fruit salad‡, fruit cocktail	88	99	100	95	25	2	0	12	0·36
Orange‡, orange juice	78	93	95	89	37	15	12	24	0·41
Raisins, grapes‡	91	89	87	89	10	11	17	6	0·43
To bake: olive oil‡, margarine	25	34	58	39	21	45	38	47	0·48
Spread on bread: margarine, butter, Minarine‡	30	34	29	31	27	21	32	19	0·40
Muesli‡ or rice crispies	48	76	80	68	44	38	20	45	0·50
Crisps, popcorn‡, Smarties, sugared Nicnacs	46	46	47	46	11	24	28	20	0·52
Chocolate milk‡, sugared iced tea, lemonade, cola	61	71	81	71	9	24	15	18	0·59
Chocolate spread, jam‡	90	96	97	94	22	6	2	12	0·63
Children should preferably eat…									
3 meals & no snacks, 3 meals and 1 or 2 healthy snacks‡, 3 meals and unlimited healthy snacks	41	78	88	69	32	20	25	32	0·36
Select all healthy snacks†									
Chocolate roll: no	78	96	97	90	20	8	5	20	0·45
Rice toast: yes	34	52	64	50	13	26	38	13	0·43
Crisps: no	92	98	99	97	14	6	2	14	0·13
Marzipan: no	80	96	98	91	21	6	3	21	0·41
Apple: yes	86	95	97	93	22	0	5	22	0·23
Mango: yes	56	82	85	74	39	30	23	39	0·46
Slice of bread with jam: yes	68	80	70	73	29	21	17	29	0·39
Yoghurt: yes	50	80	83	71	27	18	20	27	0·34
Average healthy choices	64	76	80	73	26	21	19	26	0·41

Table 1 *Continued*

	Difficulty index				Discrimination index				κ
	G2	G4	G6	Tot	G2	G4	G6	Tot	Tot
Nutrient content									
Less/equal/more‡ fibre in whole wheat *v.* white pasta	18	39	48	35	17	49	63	44	0·43
Less/equal/more‡ vitamins in brown *v.* white bread	50	86	93	76	53	25	19	47	0·37
Frozen vegetables always contain more vitamins than fresh vegetables: yes *v.* no‡	25	22	16	19	44	38	33	34	0·13
Less‡/equal/more energy in light *v.* regular cola	39	40	58	45	53	54	58	53	0·35
Equal amount of fat in whole fat, semi- and skimmed milk: yes *v.* no‡	44	77	83	68	74	41	49	60	0·34
Average	42	63	72	59	48	42	45	48	0·32
Main function (multiple choice from four responses, only the correct response is presented)									
Milk: strong bones and teeth	31	78	80	63	51	52	44	71	0·54
Vitamins: protect against virus	19	20	31	23	25	41	63	42	0·26
Fibre (e.g. in brown bread): good for intestines	21	34	38	31	38	59	63	55	0·34
Meat: helps to built muscles	36	62	70	56	59	69	53	70	0·30
Rice: gives energy	21	19	12	17	28	34	15	23	0·21
Average	26	42	46	38	40	51	48	52	0·33
Food categorization† (superscript letter indicates the correct response)									
Apple sauce^{F}, carrots^{V}, Brussels sprouts^{V}, broccoli^{V}	54	85	96	78	51	29	8	48	0·48
Pear^{F}, tomato^{V}, prume^{F}, banana^{F}	72	91	95	86	56	21	8	33	0·52
Muesli^{G}, nuts^{M}, rice toast^{G}, pasta^{G}	16	15	11	14	21	21	25	14	0·39
Ham^{M}, cooked egg^{M}, cheese^{D}, salami^{M}	6	7	6	6	2	6	15	6	0·30
Yoghurt^{D}, milk^{D}, cheese^{D}, butter^{O}	22	40	44	35	24	58	72	54	0·40
Cola^{T}, fanta^{T}, iced tea^{T}, sparkling water^{W}	69	86	91	82	53	26	10	38	0·50
Water^{W}, coffee^{W}, tea^{W}, milk^{D}	20	39	45	35	25	61	60	57	0·48
Sandwich^{G}, bread^{G}, roll^{G}, chocolate roll^{T}	42	64	72	59	47	67	45	62	0·38
Average	38	53	57	49	35	36	30	39	0·43

All items, except the ranking items, had 'don't know' as last the response option.
F, fruit; V, vegetables; G, grains and potatoes; M, meat and meat substitutes; D, dairy; O, oils and fats; T, top of the active food triangle; W, item belongs to the water group.
*Boiled potatoes and mashed potatoes were considered as correct as this might depend on the preparation. In future studies only one of both items should be kept.
†Response options were visualized with food images.
‡Correct response.

Table 2 Responses, difficulty index (percentage correct) and discrimination index by grade (G) and in the total sample (Tot) at T1, and test–retest agreement (κ) between T1 and T2 for all grades, of the recommended portions scale of the children's nutritional knowledge questionnaire: Belgian children (aged 7–12 years) from fourteen primary schools, February–March 2011

	%				Discrimination index				κ
How much should one eat according to doctors and dietitians?	G2	G4	G6	Tot	G2	G4	G6	Tot	Tot
Fruits									
1–2 pieces a week	15	9	9	11	34	52	62	58	0·33
3–4 pieces a week	30	24	12	22					
1 piece a day	16	9	23	16					
2–3 pieces a day*	30	54	54	46					
Don't know	10	4	3	6					
Vegetables/day†									
100 g carrots and peas	11	3	5	7	35	47	50	44	0·36
200 g carrots and peas	15	16	8	13					
2 plates: 50 g tomatoes and 100 g carrots and peas	13	30	26	23					
2 plates: 100 g tomatoes and 200 g carrots and peas*	53	48	55	52					
Don't know	8	3	5	6					
Water/day†									
1 glass	25	4	1	10	22	27	29	29	0·58
3 glasses	37	35	18	30					
5 glasses	15	40	51	35					
7 glasses*	21	19	30	23					
Don't know	2	2	1	2					
Slices of bread/day									
1–2 slices	28	18	12	19	23	30	21	28	0·29
3–4 slices	41	59	64	54					
5–9 slices*	10	18	18	15					
7–12 slices	8	3	2	4					
Don't know	13	3	4	7					
Fish									
Once or twice a month	24	25	11	20	60	45	29	48	0·42
1/week*	30	43	61	45					
2 times/week*	18	18	18	18					
At least 3 times/week	16	5	4	8					
Don't know	12	10	5	9					
Milk and milk products/day									
1 glass	12	14	13	13	40	39	40	34	0·21
2 glasses	43	52	48	48					
3–4 glasses*	25	28	28	27					
5–6 glasses	14	4	3	7					
Don't know	6	3	7	5					
Plate with†									
2 cordon bleu's, 3 potatoes, half a plate of broccoli	16	8	8	10	46	30	61	44	0·32
1 cordon bleu's, 3 potatoes, half a plate of broccoli*	22	25	39	28					
1 cordon bleu's, 3 potatoes, 1/4 of a plate of broccoli	15	37	36	30					
2 cordon bleu's, 2 potatoes, 1/4 of a plate of broccoli	21	20	9	17					
1 cordon bleu's, 6 potatoes, 1/4 of a plate of broccoli	16	8	6	10					
Don't know	10	2	3	5					
Spreadable fat/slice†									
Not necessary	26	22	22	23	30	33	37	45	0·36
Picture of 5 g/slice (slice half spread)*	20	39	53	37					
Picture of 10 g/slice (slice half spread)	21	24	12	19					
Picture of 15 g/slice (slice fully spread)	26	8	3	12					
Don't know	7	8	11	9					

κ = that between test and retest of dichotomized (correct *v.* wrong) responses.
*Correct response, the percentage of this option = the difficulty index.
†Response options visualized by food images.

nutritional knowledge questionnaire proved to be a reliable tool (test–retest ICC = 0·76).

The test–retest correlations of the subscales varied between 0·33 and 0·75 and are comparable with what has been found in the literature. In a study of Anderson *et al.*[25], test–retest correlations of different domains of knowledge in a sample of 11-year-olds (n 37) were 0·458 (applied nutrition knowledge), 0·577 (knowledge of food preparation) and 0·380 (confidence in cooking skills), although their values may have been attenuated due to some changes in the questions between the first and second measurement. In a study of Calfas *et al.*[14] in which children aged 4–8 years were presented with pairs of food images and asked to point to the food that would make their baby (a doll) healthy, big and strong, test–retest reliability was 0·72, with the highest reliability in 5–6-year-olds and an unexpectedly low value (r = 0·3) in the 7–8-year-olds. In a study of Gower *et al.*[23] among

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Table 3 Test–retest statistics of the nutritional knowledge scales: mean and standard deviation of T1 and T2, significance of the difference (paired *t* test), and intra-class correlation (ICC) by grade (G) and in the total sample (*n* 386); Belgian children (aged 7–12 years) from fourteen primary schools, February–March 2011

	T1		T2			G2		G4		G6		Total	
	Mean	SD	Mean	SD	*P*	ICC	95 % CI	ICC	95 % CI	ICC	95 % CI	ICC	95 % CI
Healthy food choices (HFC)	6·0	1·6	5·9	1·6	0·023	0·64	0·51, 0·74	0·73	0·63, 0·81	0·56	0·45, 0·65	0·75	0·70, 0·79
Abbreviated healthy HFC	4·0	1·4	3·9	1·4	0·157	0·58	0·43, 0·70	0·67	0·56, 0·77	0·59	0·48, 0·68	0·71	0·66, 0·76
Nutrient content	1·3	1·7	1·3	1·8	0·754	0·11	−0·09, 0·30	0·25	0·06, 0·42	0·23	0·09, 0·37	0·33	0·23, 0·41
Main function of item	1·3	1·4	1·2	1·4	0·166	0·12	−0·08, 0·31	0·34	0·16, 0·49	0·45	0·32, 0·56	0·44	0·35, 0·51
Food categorization	2·9	1·8	2·8	1·8	0·720	0·40	0·21, 0·55	0·57	0·43, 0·69	0·56	0·45, 0·65	0·61	0·54, 0·67
Recommended portions	1·6	2·0	1·4	2·1	0·107	0·18	−0·01, 0·37	0·43	0·26, 0·57	0·50	0·38, 0·60	0·47	0·39, 0·55
Total knowledge	13·1	5·6	12·8	5·7	0·019	0·51	0·34, 0·64	0·65	0·52, 0·75	0·66	0·56, 0·73	0·76	0·72, 0·80
Abbreviated knowledge	11·1	5·4	10·6	5·6	0·037	0·47	0·30, 0·61	0·64	0·52, 0·74	0·65	0·56, 0·73	0·75	0·70, 0·79

children 6–10 years of age, the test–retest correlation of a fifteen-item scale was 0·54, with a correlation of $r = 0{\cdot}51$ for the subscale food groups, $r = 0{\cdot}65$ for healthful foods and $r = 0{\cdot}49$ for food functions. In a group of children in grades 3 to 5, test–retest correlation of a ten-item knowledge of high fat foods was 0·52[39]. Very low ICC were found in a study of Wilson *et al.*[40] (fruit knowledge: ICC = 0·16, vegetables: ICC = 0·36); however, they used single items in stead of scales. Also in our questionnaire several single items and even some of the sum scales (e.g. ICC = 0·33 for the nutrient content scale) showed low reliability and this even more in the lowest grade (nutrient content, main function and recommended portions: ICC ≤ 0·18).

Unexpectedly, a significant decrease was found between T1 and T2 for children's healthy choices score and children's total knowledge score. We suspect that some might have been less motivated the second time due to questionnaire fatigue, leading to more superficial and less accurate responses[41].

Comparison of the children from the different grades showed that the questions were more difficult for the second graders. Considering their lower cognitive abilities this is not surprising. Low cognitive ability and difficult questions may also lead respondents to provide more superficial responses instead of optimal ones[41]. This in turn may lead to more randomness and lower reliability[41], explaining the lower reliability found in the second graders. The higher ICC in the total sample in comparison with the ICC of each of the grades can be explained by the higher heterogeneity in the total sample[38].

Based on the analyses some changes are suggested. In general, most children identified water, milk, fresh fruit salad, jam, oranges and grapes as the healthiest choice, most knew that an apple was a healthy snack and identified the three unhealthy snacks. If all or most respondents answer an item in the same way then this item is not capable of discriminating between respondents[32]. Moreover, deleting these items from the healthy choices score did not change test–retest statistics substantially; as a consequence these items are not likely to contribute and may be removed in future studies.

In the nutrient content section, we suggest to replace the item 'Frozen vegetables always contain more vitamins than fresh vegetables? yes *v.* no' by 'Fruits contain more vitamins and minerals than vegetables/Vegetables contain more … than fruit/Some vitamins and minerals are more available in fruits, others more in vegetables' based on the difficulty index and the low κ value of this item. In the section on the main function of food items, a low difficulty index was found for the item on the main function of rice; we suggest replacing this item with a question on the main function of potatoes, as this is more common in Flemish food culture. In the categorization task a low difficulty index was found for the series of 'muesli, nuts, rice and pasta' and the series 'ham, cooked

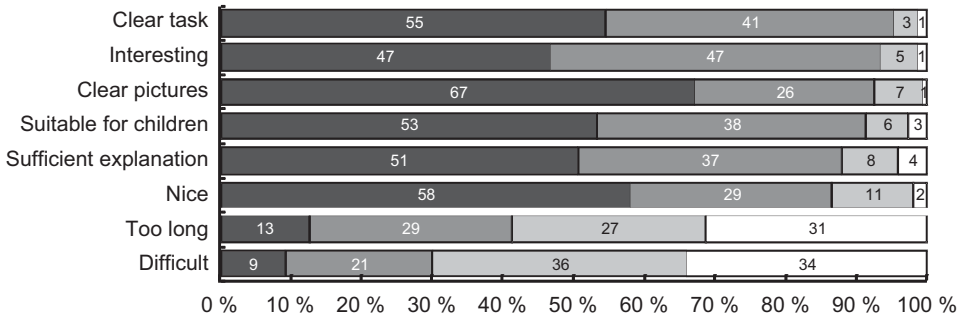

Fig. 1 Appreciation of the test (■, completely agree; ■, rather agree; □, rather disagree; □, completely disagree) among Belgian children aged 7–12 years (*n* 150) from fourteen primary schools, February–March 2011

egg, cheese and salami'. We suggest replacing the 'rice toast' with a more familiar food such as 'rice' or 'cooked potatoes', and the 'cooked egg' with an 'omelette', so that the shape is more equal to the other food items.

Children were in general positive about the questionnaire, even after a second measurement. This is not unimportant, especially when in the framework of an intervention children have to complete the same instrument more than once.

Finally some limitations should be noted. Representativeness cannot be assumed as the sample was a convenience sample and the response rate was rather low (56 % of parents gave consent). A second limitation is that only a small number of items could be included in each domain; however, in each domain the different main food groups were represented as much as possible. Finally, despite that a pilot test was done, some questions/remarks turned up during the data collection, which can help to further refine the instrument (e.g. rice crispies would better be replaced by a more familiar breakfast cereal). A strength of the study is the large sample size for a study of test–retest reliability and the multiple age groups included.

Conclusions

The instrument is a promising, practical, inexpensive, pleasing and easy-to-administer tool with an acceptable reliability for fourth and sixth graders. For ranking second graders according to nutritional knowledge, the healthy food choices and food categorization might be useful. Further research with the instrument to evaluate the effect of a web-based tailored intervention is warranted. But the instrument could also be useful outside an intervention study, for example as part or a starting point of a school-based nutrition education programme to highlight gaps in nutritional knowledge.

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