Development of a brief, reliable and valid diet assessment tool for impaired glucose tolerance and diabetes: the UK Diabetes and Diet Questionnaire

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Abstract

Objective: Dietary advice is fundamental in the prevention and management of type 2 diabetes (T2DM). Advice is improved by individual assessment but existing methods are time-consuming and require expertise. We developed a twenty-five-item questionnaire, the UK Diabetes and Diet Questionnaire (UKDDQ), for quick assessment of an individual's diet. The present study examined the UKDDQ's repeatability and relative validity compared with 4 d food diaries.

Design: The UKDDQ was completed twice with a median 3 d gap (interquartile range = 1–7 d) between tests. A 4 d food diary was completed after the second UKDDQ. Diaries were analysed and food groups were mapped on to the UKDDQ. Absolute agreement between total scores was examined using intra-class correlation (ICC). Agreement for individual items was tested with Cohen's weighted kappa (κ_w).

Setting: South West of England.

Subjects: Adults (*n* 177, 50·3 % women) with, or at high risk for, T2DM; mean age 55·8 (SD 8·6) years, mean BMI 34·4 (SD 7·3) kg/m^2; participants were 91 % White British.

Results: The UKDDQ showed excellent repeatability (ICC = 0·90 (0·82, 0·94)). For individual items, κ_w ranged from 0·43 ('savoury pastries') to 0·87 ('vegetables'). Total scores from the UKDDQ and food diaries compared well (ICC = 0·54 (0·27, 0·70)). Agreement for individual items varied and was good for 'alcohol' ($\kappa_w = 0·71$) and 'breakfast cereals' ($\kappa_w = 0·70$), with no agreement for 'vegetables' ($\kappa_w = 0·08$) or 'savoury pastries' ($\kappa_w = 0·09$).

Conclusions: The UKDDQ is a new British dietary questionnaire with excellent repeatability. Comparisons with food diaries found agreements similar to those for international dietary questionnaires currently in use. It targets foods and habits important in diabetes prevention and management.

Following a healthy diet is key in the management of type 2 diabetes (T2DM)[1]. However, people with T2DM find dietary advice confusing, contradictory, and report that understanding and making healthy eating choices are the most challenging parts of living with the condition[2–4]. Therefore, national guidelines recommend that all patients with T2DM should receive individualised, ongoing dietary advice from a health professional with expertise in nutrition[1,5].

In the UK, most people with T2DM receive their routine dietary advice from nurses and general practitioners[6]. These professionals have only a few minutes of time to discuss dietary matters and can struggle to identify individualised goals[7,8]. Thus, there is a need for brief tools that allow health professionals with only general nutrition knowledge to assess peoples' diets and set dietary goals more rapidly[9]. These tools cannot match the accuracy and precision of a detailed nutrient assessment undertaken by an expert, but clinicians can use them to guide dietary change when managing chronic conditions[10,11].

We recently conducted a review of brief dietary questionnaires that can be used to rapidly assess diets in a clinical setting[12]. These tools demonstrated good-to-excellent relative test–retest reliability (correlation

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coefficients ranged from 0·59 to 0·95) and moderate-to-good relative agreement with diet records (correlations ranged from 0·16 to 0·79; the majority of tools demonstrated correlations of between 0·30 and 0·50). Only two of the questionnaires included were developed in the UK; the most recent, the Dietary Instrument for Nutrition Education (DINE), was developed in 1994[13,14]. These tools focus primarily on assessing fat intake and thus are not tailored for diabetes management. There is therefore a need in the UK for a new questionnaire that assesses dietary habits in patients with, or at risk for, diabetes, that is easy to use in day-to-day health-care and diabetes prevention programmes.

The purposes of the present study were to: (i) develop a brief dietary questionnaire, the UK Diabetes and Diet Questionnaire (UKDDQ); (ii) examine test–retest reliability and relative validity; and (iii) compare UKDDQ reliability and validity with published results from existing questionnaires.

Methods

UK Diabetes and Diet Questionnaire

The UKDDQ was developed by a panel of thirty-six health professionals with expertise in diabetes and thirteen people with T2DM in a modified two-round, online Delphi study[15]. Thirty-five items were generated from the 2011 nutrition guidelines for the prevention and management of T2DM[16], Diabetes UK food-based guidelines[17], from an analysis of food-based changes made by people with T2DM who took part in the Early ACTivity In Diabetes study[18,19] and the experts suggested a further twelve items for consideration. Twenty-five items from the final total of forty-seven were selected for inclusion as a result of the Delphi process (see the online supplementary material, 'The Delphi study', for full details). The resulting questionnaire was presented to a small sample of four health professionals and one person with T2DM, asking for comments on clarity, relevance and ease of use, allowing changes to wording and refinement of the scoring procedure to be made. The study was approved by the National Research Ethics Service Committee North West – Lancaster (reference number 12/NW/0131) and was conducted from August 2013 to November 2013. A sample copy of the UKDDQ is shown in the online supplementary material, Fig. S1. The interviewer-scored and self-scored versions of the UKDDQ are available for download (https://sps.online surveys.ac.uk/the-uk-diabetes-and-diet-questionnaire-ukddq).

Test–retest reliability and relative validity

Participants

Test–retest reliability and relative validity were conducted within the Sedentary Time And Metabolic health in People with Type 2 diabetes (STAMP-2) study[20]. STAMP-2 was an observational study of sedentary behaviour in adults with, or at high risk for, T2DM that included an assessment of diet. Inclusion criteria were: (i) 5–12 months from clinical diagnosis of T2DM, BMI >25·0 kg/m² and aged 30–70 years; or (ii) BMI >35·0 kg/m² and aged 30–70 years. Exclusion criteria were unstable angina, myocardial infarction within the previous 3 months and a pre-existing condition precluding physical activity.

STAMP-2 was approved by the National Research Ethics Service Committee South West – Central Bristol (reference number 13/SW/0187); recruitment occurred from January 2014 to July 2015 in the South West of England.

Measurements

Participants were asked to attend for two visits, 1 week apart. Prior to attending visit 1, participants were asked to complete a copy of the UKDDQ. At visit 1, the completed UKDDQ was collected and a research nurse measured height, weight, waist circumference, blood pressure and obtained fasting bloods for measurement of lipids and glycated Hb (HbA1c), using standard techniques. Participants completed a second copy of the UKDDQ and were instructed on completing a 4 d food diary. They were asked to include details of brands and to estimate portion sizes using household measures, weights on packs and using portion size pictures included in the food diaries. The food diaries were returned a week later and participants completed a final diet questionnaire, specific to STAMP-2, asking for details of common food and drinks (e.g. type of milk and how much was used in tea/coffee and on cereal).

Food diary coding and scoring

Food diaries were coded and analysed using Dietplan7 Pro dietary assessment software (Forestfield Software Limited, Horsham, UK). Diaries were coded by one coder and checked for accuracy and agreement by a second independent coder. If portion size information was not recorded, appropriate weights were assigned using portion size data from the Food Standards Agency[21] or from manufacturer's data available online. The nutrient databases used were the Composition of Foods Integrated Dataset, 2015[22], food composition data from the 2002 UK National Diet and Nutrition Survey[23] and from Pepsico International.

Reported foods were assigned food group codes corresponding to UKDDQ items and aggregated. The median daily frequency of consumption of each food group was calculated. Daily portions of fruit and vegetables were calculated by the non-disaggregated method described in the National Diet and Nutrition Survey, excluding fruit juice and including pulses[23]. This method counts a portion as 80 g, fruit pies are estimated to contain 45 % fruit, and vegetable dishes such as vegetable stew estimated to contain 40 % vegetables. Starchy vegetables such as potatoes, yams and taro are not included as vegetables. Participants noted time of waking on their food diaries, allowing breakfast to be identified as 'the first

Table 1 Mapping food diary frequencies on to adjusted UKDDQ scoring

Item	Adjusted UKDDQ score	Mapped ranges of daily frequencies from food diaries	Adjusted UKDDQ category
Vegetables	5	0	'Never'
Fruit	4	>0 to <0·285	'Once a week or less'
Cakes and biscuits	3	0·285 to <0·71	'2–4 times a week'
Confectionery			
Sugary drinks	2	0·71 to <1·0	'5–6 times a week'
Full-fat spread	1	1·0 to <3·0	'1–2 times a day'
	0	≥3·0	'3 or more times a day'
Full-fat cheese	1	>0 to <0·14	'Never/less than once a week'
Processed meat	2	0·14 to <0·285	'Once a week'
Salty snacks	3	0·285 to <0·857	'2–5 times a week'
'Fast foods'	4	0·857 to <2	'Nearly every day/daily'
Pudding	5	≥2	'Twice or more per day'
Alcohol			
Oily fish	2	0 to <0·14	'Never/less than once a week'
	1	0·14 to <0·285	'Once a week'
	0	≥0·285	'Twice of more per week'
3–4 meals/d	4	>0 to <0·14	'Never/less than once a week'
Breakfast	3	0·14 to <0·285	'Once a week'
High-fat/sugar snacks	2	0·285 to <0·71	'2–4 times a week'
	1	0·71 to <1·0	'5–6 times a week'
	0	≥1·0	'Every day'
Frequency of bread	0	0	'Never'
	1	>0 to <0·285	'Once a week or less'
	2	0·285 to <1·0	'2–6 times a week'
	3	1·0 to 3·0	'1–2 times a day'
	4	3·0 to 4·0	'3–4 times a day'
	5	>4·0	'More than 4 times a day'
Frequency of cereal	1	0 to <0·14	'Never/less than once a week'
	2	0·14 to <0·285	'Once a week'
	3	0·285 to <0·857	'2–5 times a week'
	4	0·875 to <2	'Nearly every day/daily'
	5	≥2	'Twice or more per week'
Percentage of high-fibre bread/cereal	4	0	'Never'
	3	>0 to 40 %	'Less than half the time'
	2	>40 % to 60 %	'About half the time'
	1	>60 % to <100 %	'Most of the time'
	0	100 %	'Always'

UKDDQ, UK Diabetes and Diet Questionnaire.

meal that occurred within 2 h of waking' as defined on the UKDDQ. Other meals and snacks were identified by considering time of day, the amount and type of food consumed and an individual's pattern[19]. The proportions of high-fibre bread, cereals and the type of milk reported were identified.

The mean daily frequency of consumption for each aggregated item was mapped on to the UKDDQ to allow the food diaries to be given a UKDDQ score for each item of interest. For relative validation, the responses 'never' and 'less than once a week' were combined for the UKDDQ, as 4 d food diaries cannot capture this response. Table 1 shows the adjusted scoring used.

Analysis

Demographic characteristics and nutrient intakes were derived using descriptive statistics. Test–retest reliability was examined between time 1 and time 2 for the UKDDQ total scores for the whole sample, for men and women separately and for each individual item separately. The UKDDQ total scores were normally distributed so were examined for absolute agreement using a two-way random, absolute intra-class correlation (ICC)[24]. Differences in the group means between total scores at time 1 and time 2 were examined using paired-sample t tests.

For individuals, simple agreement between tests was explored by identifying the percentage of participants who were placed in the same category for each item. For the purpose of these analyses, disagreement was defined as the percentage of respondents who shifted by more than one category. For items on an ordinal scale, Cohen's weighted kappa (κ_w) using quadratic weighting[24] with weights from 0 to 1 based on the squared distance between categories was employed to adjust for agreement that could have occurred by chance. The item on type of milk was nominal, so no weighting was applied. Typically the ranges proposed by Landis and Koch[25] are used to describe levels of agreement: $\kappa_w = 0$–0·20, slight agreement; $\kappa_w = 0·21$–0·40, fair; $\kappa_w = 0·41$–0·60, moderate; $\kappa_w = 0·61$–0·80, good; and $\kappa_w > 0·80$, excellent; and we have followed this convention. To establish relative agreement, correlations were also examined. The analyses for relative validation were conducted in the same

manner. Analyses were performed using the statistical software package IBM SPSS Statistics Version 21, with an SPSS Python Extension to calculate κ_w.[26]

Results

A total of 177 participants were recruited into STAMP-2, 162 participants provided a 4 d food diary and 162 completed the UKDDQ twice. Of these, 151 participants completed both a 4 d food diary and the UKDDQ.

Demographic characteristics and results from the nutrient analysis of food diaries are reported in Table 2. Participants were predominantly White British (90·9 %), half were women and mean age was 56 years. Over three-quarters of participants had T2DM. Blood glucose control was above the recommended target of 48 mmol/mol (6·5 %), with a mean HbA1c of 52 mmol/mol (6·9 %). Participants reported a moderate-carbohydrate diet (42·4 % of energy). Mean reported saturated fat intake was higher than recommended (12·3 % of energy), although diets were low in *trans*-fats (0·7 % of energy) and no one reported a *trans*-fat intake greater than the recommended maximum of 2 %.

Test–retest and relative validation

Test–retest reliability

Twenty-two (14 %) of the test–retest participants were missing the date of completion for the first questionnaire. For the remaining 140 (86 %), the median time between tests was 3 d (interquartile range = 1–7 d). All participants who provided UKDDQ at times 1 and 2 were included in the analysis.

The mean non-adjusted total UKDDQ score for test 1 was 26·5 (SD 10·5) and for test 2 was 27·0 (SD 10·9; $t = 0.31$, $P = 0.757$). There was complete data for the two tests from 102 people (66·7 %), and the ICC for the total scores was excellent: 0·90 (95 % CI 0·85, 0·93). When stratified by gender, the ICC was 0·90 (95 % CI 0·82, 0·94) for both men (n 50) and women (n 52). Pearson's correlation was 0·90 for the total score for the whole group (0·89 for women, 0·90 for men).

Table 3 shows the test–retest reliability results. For individual items, simple agreement between tests ranged from 49·4 % ('high-fat/sugar snacks') to 89·7 % ('type of milk'). More than 70 % of people agreed on both tests for thirteen items, although for two of these items, 'sweet drinks' and '3–4 meals/d', 10·2 % and 11·3 %, respectively, of people disagreed between tests. Overall, 'high-fat/sugar snacks' showed the greatest discrepancy between tests, with 17·1 % disagreement.

Cohen's κ_w ranged from 0·43 ('savoury pastries') to 0·87 ('vegetables'). Nine items showed excellent agreement and a further ten showed good agreement. Spearman's correlation ranged from 0·66 ('savoury pastries') to 0·93 ('alcohol') for individual items.

Table 2 Demographic characteristics and estimated dietary intake of adults (n 177) participating in the test–retest reliability and relative validity study of the UKDDQ, South West England, January 2014–July 2015

Characteristic	%	n
Women	50·3	89
Men	49·7	88
Ethnicity (n 176)		
White British	90·9	160
Other White	2·8	5
Asian	1·7	3
Black or Black-British Caribbean	0·6	1
Mixed race	4·0	7
Smoker (n 174)	11·3	20
Diabetes	78·5	139
Medications		
Hypoglycaemic medication	36·2	64
Lipid lowering medication	48·6	86
Anti-hypertensive medication	48·6	86
	Mean	**SD**
Age (years)	55·7	8·59
IMD score	17·8	12·3
Weight (kg)	98·0	21·4
BMI (kg/m²)	34·4	7·3
Waist circumference (cm)	110	15
Total cholesterol (mmol/l)	4·7	1·2
LDL cholesterol (mmol/l)	2·7	1·0
HDL cholesterol (mmol/l)	1·3	0·3
TAG (mmol/l)	1·7	1·2
Systolic blood pressure (mmHg)	131	16
Diastolic blood pressure (mmHg)	83	9
Time since diagnosis (months)	8·9	3·7
HbA1c (mmol/mol (%))		
With diabetes (n 139)	51·6	13·0
%	6·9	
Without diabetes (n 38)	38·4	4·6
%	5·7	
Energy intake (kJ)	7405·7	2117·1
Energy intake (kcal)	1770·0	506·0
Protein (% of energy)	18·0	3·8
Fat (% of energy)	35·4	6·9
Saturated fat (% energy)	12·3	3·5
Trans-fat (% of energy)	0·7	0·3
Carbohydrate (% of energy)	42·4	7·6
Fibre (AOAC method) (g)	20·8	7·5
Alcohol (g)	12·9	23·7
Vegetable portions/d	1·9	1·1
Fruit portions/d	1·7	1·5

UKDDQ, UK Diabetes and Diet Questionnaire; IMD, Index of Multiple Deprivation (obtained from full home postcode); HbA1c, glycated Hb; AOAC, Association of Official Analytical Chemists.

Relative validation: comparison with food diaries

The mean adjusted UKDDQ score for the first questionnaire (n 125) was 28·9 (SD 8·8) and the derived score from the food diaries was 33·8 (SD 8·4; $t = -6.7$, $P < 0.001$). There was complete data from 119 participants; the ICC between the total scores was 0·54 (95 % CI 0·27, 0·70). When stratified by gender, the ICC was 0·63 (95 % CI 0·45, 0·77) for men (n 60) and 0·47 (95 % CI 0·00, 0·72) for women (n 59). Pearson's correlation for total scores was 0·61 ($P < 0.001$) for the whole group (0·63 for men and 0·64 for women).

Table 4 shows the results of the comparison tests for the twenty-one food frequency items. Simple agreement

Table 3 Test–retest reliability results for the UKDDQ

Dietary habits	Test 1 score			Test 2 score			Agreement between test 1 and test 2 scores					
	n	Median	IQR	n	Median	IQR	n	Same category for test 1 and test 2 (%)	Change by >1 category (%)	κ_w*	95 % CI	ρ*
Vegetables†	160	2	1–2·75	161	2	1–3	159	73·0	3·1	0·87	0·81, 0·93	0·84
Fruit†	160	1	1–3	159	1	1–3	158	74·1	5·7	0·84	0·78, 0·91	0·82
Cakes and biscuits‡	159	1	0–2	159	1	0–2	156	63·5	7·1	0·67	0·53, 0·81	0·76
Chocolate and sweets‡	158	1	0–2	159	1	0–2	155	65·2	4·5	0·59	0·42, 0·77	0·74
Sweet drinks‡	158	0	0–2	161	0	0–2	157	74·5	10·2	0·71	0·54, 0·88	0·79
Full-fat spread‡	158	1	0–2	159	1	0–2	155	72·3	5·2	0·70	0·57, 0·83	0·88
High-fat cheese§	161	2	1–3	161	2	1–3	160	69·4	5·0	0·74	0·64, 0·84	0·84
Processed meat§	159	2	1–3	161	3	1–3	158	67·7	5·1	0·71	0·61, 0·81	0·76
Salted snacks§	158	2	1–3	161	1	0·5–3	157	54·8	10·2	0·62	0·48, 0·76	0·68
Savoury pastries§	161	1	0–1	160	1	0–1	159	62·6	5·0	0·43	0·24, 0·62	0·66
Fast foods§	161	1	0–1	160	1	0–1	159	69·2	2·5	0·59	0·41, 0·77	0·74
Puddings§	158	1	0–2	160	1	0–2	156	62·6	10·9	0·68	0·55, 0·81	0·73
Alcohol‖	153	1	0–3	156	1	0–3	147	76·9	2·0	0·82	0·73, 0·91	0·93
Oily fish¶	157	1	0·5–2	155	1	0–2	151	76·2	2·0	0·82	0·73, 0·91	0·85
3–4 meals/d**	161	0	0–2	161	2	1–3	160	74·4	11·3	0·81	0·67, 0·95	0·72
Breakfast**	160	0	0–1	160	0	0–1	158	77·8	6·3	0·84	0·73, 0·96	0·81
High-fat/sugar snacks††	159	2	1–3	161	2	1–3	158	49·4	17·1	0·63	0·52, 0·73	0·72
All bread‡‡	160	2	2–3	156	3	2–3	154	72·1	1·9	0·67	0·55, 0·79	0·69
High-fibre bread§§	161	1	0–2	161	1	0–1	160	69·4	5·0	0·81	0·70, 0·91	0·78
All breakfast cereals‖‖	160	3	2–4	161	3	2–4	159	77·4	6·9	0·80	0·72, 0·86	0·87
High-fibre cereal§§	154	1	0–2	157	0	0–1·5	150	71·3	8·7	0·84	0·72, 0·97	0·70
Type of milk¶¶	157	Semi-skimmed		50	Semi-skimmed		N/A	89·7	N/A	0·82	N/A	N/A
Concerned about weight***	159	3	2–4	160	3	2–4	157	79·0	3·8	0·77	0·66, 0·88	0·80
Importance of change†††	159	8	6–10	161	8	7–10	N/A	N/A	N/A	N/A	N/A	0·88
Confident about change†††	159	7	5–8	161	7	5–8	N/A	N/A	N/A	N/A	N/A	0·83
Total‡‡‡	125	25·0	19–34	131	25·0	20–35	108	N/A	N/A	N/A	N/A	0·90

UKDDQ, UK Diabetes and Diet Questionnaire; IQR, interquartile range; κ_w, Cohen's weighted kappa, ρ, Spearman's correlation; N/A, not applicable.
*P for all tests <0·001.
†'Never/very rarely' = 5; 'once a week' or less = 4; '2–4 times a week' = 3; '5–6 times a week' = 2; '1–2 times a day' = 1; '3 or more times a day' = 0.
‡'Never/very rarely' = 0; 'once a week' or less = 1; '2–4 times a week' = 2; '5–6 times a week' = 3; '1–2 times a day' = 4; '3 or more times a day' = 5.
§'Never/very rarely' = 0; 'less than once a week' = 1; 'once a week' = 2; '2–5 times a week' = 3; 'nearly every day/daily' = 4; 'twice or more per day' = 5.
¶For test–retest, alcohol is scored: 'never/very rarely' = 0; 'less than once a week' = 1; 'once a week' = 2; '2–5 times a week' = 3; 'nearly every day/daily' = 4; 'twice or more per day' = 5.
‖For test–retest, oily fish is scored: 'never' = 3; 'less than once a week' = 2; 'once a week' = 1; 'twice or more per week' = 0.
In use, oily fish is scored: 'never' = 5; 'less than once a week' = 4; 'once a week' = 1; 'twice or more per week' = 0.
**'Never/very rarely' = 5; 'less than once a week' = 4; 'once a week' = 3; '2–4 times a week' = 3; '5–6 times a week' = 1; 'every day' = 0.
††'Never/very rarely' = 0; 'less than once a week' = 1; 'once a week' = 2; '2–4 times a week' = 3; '5–6 times a week' = 4; 'every day' = 5.
‡‡For test–retest, bread is scored: 'never/very rarely' = 0; 'once a week' or less = 1; '2–6 times a week' = 2; '1–2 times a day' = 2; '3–4 times a day' = 4; 'more than 4 times a day' = 5.
§§'All of the time' = 0; 'most of the time' = 1; 'about half the time' = 2; 'less than half the time' = 3; 'never' = 4; 'I did not eat bread/cereal' = 5 (this category not included in correlations and scores 0 in use).
‖‖For test–retest, cereal is scored: 'never/very rarely' = 0; 'less than once a week' = 1; 'once a week' = 2; '2–5 times a week' = 3; 'nearly every day/daily' = 4; 'twice or more per day' = 5.
¶¶For test–retest, milk is scored: 'full fat' = 4; 'varies' = 3; 'semi-skimmed' = 2; 'non-dairy milk' = 1; 'skimmed' = 0' 'none' = 5. Unweighted κ used for this test.
***For test–retest, weight concern is scored: 'not concerned' = 1; 'a little concerned' = 2; 'moderately concerned' = 3; 'very concerned' = 4.
†††Scored 1–10.
‡‡‡Test–retest for questionnaire scored according to use (Pearson's).

ranged from 27·7 % ('high-fat/sugar snacks') to 68·0 % ('type of milk'). Over 50 % of people agreed between the UKDDQ and the food diaries for nine items, although for one of these items ('high-fibre cereal') a quarter of people disagreed. Disagreements were particularly acute for 'cakes and biscuits' where there was 33·1 % agreement and 36·5 % disagreement and for 'high-fat/ sugar snacks' where there was 27·5 % agreement and 33·8 % disagreement.

Cohen's κ_w ranged from 0·08 ('vegetables') to 0·71 ('alcohol'). Overall, results for sixteen items suggested fair or

better agreement. However, once the CI were considered, six items ('vegetables', 'full-fat spread', 'savoury pastries', 'oily fish', '3–4 meals/d' and 'breakfast') showed no agreement. Spearman's correlation ranged from 0·10 ('savoury pastries') to 0·73 ('alcohol' and 'all breakfast cereals').

Discussion

The present study describes the development and evaluation of the UKDDQ, a new brief dietary questionnaire

Table 4 Comparison of UKDDQ scores with food diaries

Dietary habits	Adjusted UKDDQ score*			Food diary score (*n* 163)		Agreement between food diary and UKDDQ scores				
	n	Median	IQR	Median	IQR	Same category for UKDDQ score (%)	Change by > 1 category (%)	κ_w	95 % CI	ρ
Vegetables	150	2	1–2·25	1	1–1	32·0	22·7	0·08	−0·10, 0·25	0·28
Fruit	149	1	1–3	1	1–3	43·0	25·5	0·35	0·17, 0·52	0·52
Cakes and biscuits	148	1	0–2	2	0–4	33·1	36·5	0·20	0·04, 0·37	0·35
Chocolate and sweets	148	1	0–2	0	0–1	40·5	16·2	0·42	0·13, 0·70	0·36
Sweet drinks	147	0	0–2	1	0–4	44·9	32·0	0·41	0·14, 0·68	0·34
Full-fat spread	147	2	1–3	0	0–2	41·5	28·6	0·22	−0·05, 0·48	0·37
High-fat cheese	150	2	1–3	2	1–3	38·0	15·3	0·45	0·33, 0·56	0·45
Processed meat	148	2	1–3	3	2–3	40·5	16·9	0·34	0·19, 0·50	0·36
Salted snacks	147	2	1–3	1·5	1–3	50·3	17·0	0·42	0·28, 0·56	0·43
Savoury pastries	150	1	1–1	1	1–1·25	64·7	8·6	0·09	−0·08, 0·26	0·10
Fast foods	150	1	1–2	2	1–3	52·0	19·3	0·20	0·08, 0·32	0·28
Puddings	147	1	1–2	1	1–2	50·3	21·1	0·22	0·06, 0·38	0·26
Alcohol	142	1	1–3	1·5	1–3	58·5	9·9	0·71	0·61, 0·81	0·73
Oily fish	146	1	0–2	2	1–2	53·4	10·3	0·17	−0·09, 0·44	0·49
3–4 meals/d	150	0	0–2	0	0–2	48·0	24·7	0·11	−0·33, 0·55	0·42
Breakfast	150	0	0–1	1	0–2	46·7	22·0	0·25	−0·05, 0·54	0·36
High-fat/sugar snacks	148	2	2–3	3	2–4	27·7	33·8	0·30	0·16, 0·45	0·32
All bread	149	2	2–3	3	2–3	45·6	6·7	0·24	0·11, 0·37	0·30
High-fibre bread	150	1	0–2	1	0–3	34·0	24·0	0·36	0·16, 0·57	0·35
All breakfast cereals	149	3	2–4	3	2–4	55·7	10·1	0·70	0·61, 0·80	0·73
High-fibre cereal	144	0·5	0–1	0	0–4	50·7	25·7	0·35	0·14, 0·55	0·44
Type of milk	147	Semi-skimmed		Semi-skimmed		68·0	N/A	0·51	*P*<0·001	N/A

UKDDQ, UK Diabetes and Diet Questionnaire; IQR, interquartile range; κ_w, Cohen's weighted kappa, ρ, Spearman's correlation; N/A, not applicable.
*Adjusted according to scoring detailed in Table 1 (lower scores indicate healthier food habits).

designed for clinical and non-clinical use in people with or at high risk for T2DM. The results indicate that the UKDDQ has excellent test–retest reliability, both for the total score and for almost all the individual items. The UKDDQ total scores correlated well with 4 d food diaries, indicating that the questionnaire can rank people according to dietary habits. It demonstrated good agreement for men and moderate agreement for women.

Comparison with other evaluation studies of brief dietary questionnaires

Our systematic review found wide variation in methodology in the evaluation of brief dietary questionnaires[12]. Test–retest studies reported correlations from 0·59 to 0·92, and the majority did not explore absolute agreement between tests. Where absolute agreement was assessed, the ICC ranged from 0·75 to 0·89. The UKDDQ demonstrated a correlation of 0·90 and ICC of 0·91, and is therefore highly reliable and superior in this aspect to many available questionnaires.

The UKDDQ compares as well with food diaries as other brief questionnaires for relative agreement. Few tools included in our review considered absolute agreement for scores derived from food diaries; those that did reported ICC of about 0·30. Only two questionnaires, the Norwegian SmartDiet Questionnaire (NSQ)[27] and the Mediterranean Diet Adherence Score (MEDAS)[28], examined absolute agreement for individual items. In comparison with 7 d weighed intakes, κ values for the NSQ ranged from 0·14 ('vegetables') to 0·73 ('type of butter/ margarine'). For the evaluation of MEDAS, the κ statistics for individual items were compared with scores derived from a longer FFQ. The scoring was a binary 'yes/no' score; agreement ranged from 0·03 ('consuming a sauce of tomato, garlic, onion or leeks sautéed in olive oil') to 0·81 ('wine'). The UKDDQ results are comparable to the results obtained for the NSQ and MEDAS. Formal evaluation of the time to complete the UKDDQ was not conducted; however, informal feedback from patients and nurses indicates that most people took about 5–10 min, which is consistent with similar-length questionnaires[12].

Strengths and limitations

The strengths of the current study are that the UKDDQ is the only dietary questionnaire for people at high risk for, or with, T2DM that has been evaluated in a UK population. The study examined absolute agreement, using κ_w and ICC, and compared the UKDDQ with food diaries. Habitual intake was compared with a 'snapshot' intake and it is important to emphasise that low agreement between the food diaries and the UKDDQ scores does not indicate that the UKDDQ is 'inaccurate'[29] since there is no 'true' measure of dietary intake[30]. The mean reported energy intake estimated from food diaries in our participants was 7405·7 kJ (1770 kcal) so it is likely that

under-reporting, or a change to eating habits, occurred. Ideally validation studies would include the use of nutritional biomarkers, but currently few biomarkers exist for specific foods and these still may not measure habitual intake[31]. Multiple non-consecutive 24 h recalls do not change eating habits, although they are reliant on memory and under-reporting can still occur[32]. Their use should be considered for future validation studies for the UKDDQ.

Absolute agreement for vegetables was particularly low, although for relative validity, a correlation coefficient of 0·28 indicates that the UKDDQ performs as well as some longer FFQ[29]. Similar poor agreement between brief questions asking about vegetable intake and food records/ 24 h recalls has been reported elsewhere[33,34]. A key issue is that different participants may disagree on what to count as a vegetable and estimating vegetables included in composite meals is challenging both for researchers and the general public[35]. However, advice to eat several portions of vegetables each day is an extremely important component of healthy eating and inclusion of this question reinforces this message[27]. It is worth noting too that there appears to be no published research evaluating the reliability and validity of routine dietary assessments conducted in clinical or non-clinical practice. Consequently it is not clear how closely dietary assessment in health settings approximates to an individual's dietary habits, or how closely it approximates to the more structured assessment methods used in research. Nevertheless, there is evidence that dietary advice, given by dietitians in clinical practice, improves patient outcomes[36–38]. The UKDDQ has not yet been evaluated in this setting, but the NSQ is successfully used by health professionals with general nutritional knowledge as a structured way to introduce discussion about diet and to assist in providing specific, individualised dietary advice[39].

It is important to highlight that 91 % of the participants were White British, with good literacy levels and generally good reported dietary habits. Consequently the sample does not reflect the reliability and validity of the UKDDQ in other demographic groups. The same results may not be observed for other ethnic groups with differing dietary habits, people with lower literacy levels or poorer diets. Future research should evaluate the UKDDQ in an ethnically and socio-economically diverse sample of participants. Stratifying results by socio-economic status or diabetes status was not possible due to small sample sizes. It is unclear as to why the absolute agreement between the UKDDQ and food diaries was lower for women than for men, but the questionnaire ranked men and women equally well, thus appearing suitable for use with both genders. It is also important to highlight that the median test–retest time was short, which means there could have been a memory effect between tests. Participants were posted the UKDDQ in advance and were asked to complete it at least a week before the first appointment. However, the majority did not do this and resources and

time meant that we were unable to recruit replacement participants. In common with most brief dietary questionnaires, the UKDDQ cannot provide an estimate of nutrient intakes and is unable to provide an estimate of diet quality, as provided by dietary indices[40].

Conclusion

The UKDDQ is a new, twenty-first century, brief dietary questionnaire that, in the present study, demonstrated excellent test–retest reliability and showed agreement with food diaries comparable to agreement found for other, similar, brief questionnaires. It can be confidently used to rapidly assess the diets of White British people in clinical and non-clinical settings. The UKDDQ needs to be trialled in practice to examine its reliability, validity and acceptability in ethnically and socio-economically diverse patients. In addition, it should be assessed for sensitivity to change and evaluated to determine if its use can promote dietary change, improve health outcomes, and improve patients' and practitioners' experiences of receiving and delivering dietary advice.

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Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1368980016002275

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