

# A systematic review of brief dietary questionnaires suitable for clinical use in the prevention and management of obesity, cardiovascular disease and type 2 diabetes

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## Title page

### A systematic review of brief dietary questionnaires suitable for clinical use in the prevention and management of obesity, cardiovascular disease and type 2 diabetes

Running title: A systematic review of brief dietary questionnaires

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#### Declaration

This submission represents original work that has not been published previously and it is not being considered for publication elsewhere. The authors declare no conflicts of interest.

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Authors' contributions: The work contained in this article is part of the PhD of Clare England which is supervised by Drs' Andrews, Jago and Thompson. All authors assisted in the design of the data extraction form and development of the search strategy. Ms England screened all titles and abstracts and extracted the data with advice on clinical application from Dr Andrews and final inclusion from Professor Thompson. Professor Jago provided analytical guidance. The first draft of the manuscript was prepared by Ms England with critical input and revisions by all other authors. All authors approved the final manuscript.

1 A systematic review of brief dietary questionnaires suitable for clinical use in the prevention  
2 and management of obesity, cardiovascular disease and type 2 diabetes

3 Abstract

4 The aim of this systematic review was to identify and describe brief dietary assessment tools  
5 suitable for use in clinical practice in the management of obesity, cardiovascular disease and  
6 Type 2 diabetes. Papers describing development of brief (<35 items) dietary assessment  
7 questionnaires, that were accessible, simple to score and assessed aspects of the diet of  
8 relevance to the conditions of interest were identified from electronic databases. The  
9 development of 35 tools was described in 47 papers. Ten tools assessed healthy eating or  
10 healthy dietary patterns, 2 assessed adherence to the Mediterranean diet, 18 assessed dietary  
11 fat intake and 5 assessed vegetable and/or fruit intake. Twenty tools were developed in North  
12 America. Test-retest reliability was conducted on 18 tools; correlation coefficients for total  
13 scores ranged from 0.59 to 0.95. Relative validation was conducted on 34 tools. The most  
14 common reference variable was percentage energy from fat (15 tools) and correlation  
15 coefficients ranged from 0.24,  $p < 0.001$  to 0.79,  $p < 0.002$ . Tools that have been evaluated for  
16 reliability and/or relative validity are suitable for guiding clinicians when providing dietary  
17 advice. Variation in study design, settings and populations makes it difficult to recommend  
18 one tool over another, although future developers can enhance the understanding and use of  
19 tools by giving clear guidance as to the strengths and limitations of the study design. When  
20 selecting a tool, clinicians should consider whether their patient population is similar in  
21 characteristics to the evaluation sample.

23 Introduction

24 The World Health Organisation estimates that in 2008, 18.3 million deaths worldwide were  
25 due to cardiovascular disease and type 2 diabetes.<sup>1</sup> In 2010, unhealthy dietary habits,  
26 including low fruit and vegetable consumption, high salt intake and low wholegrain and fish  
27 consumption, combined with physical inactivity, are estimated to account for 10% of the  
28 global burden of disease. Assisting people with dietary modification is, therefore, a key  
29 challenge for health professionals.

30 In clinical care, dietary assessment is important for providing individualised dietary advice<sup>2</sup>  
31 and is essential for evaluating the success of interventions aimed at improving dietary habits,  
32 such as cardiac rehabilitation programs.<sup>3</sup> Dietitians typically use food diaries and take diet  
33 histories to obtain an overview of a patient's usual diet, with dietary advice then given based  
34 on this assessment. This process is time-consuming and interpretation requires specialist  
35 skills.<sup>2</sup> However, a highly detailed assessment of nutrient intake is not always necessary in a  
36 clinical setting. It is often enough to review an individual's dietary habits to determine the  
37 potential benefit of changing specific dietary behaviours and foods/food groups.<sup>4</sup>

38 Brief dietary screening tools have been developed to assist with dietary assessment in clinical  
39 practice. These tools take the form of a brief questionnaire that can be self-completed prior  
40 to, or administered during, a consultation. The answers allow health professionals and  
41 patients to quickly identify whether a diet is appropriate or if there are areas of concern.

42 Dietary changes, based upon the patient's current dietary habits, can be discussed and food-  
43 based dietary goals set.<sup>5</sup> For dietary tools to be useful in clinical practice they need to be  
44 interpretable with minimal nutrition knowledge, quick to complete and easy to score. They  
45 must provide immediate guidance on healthy dietary changes or allow clinicians to quickly  
46 identify patients who may benefit from more intensive dietary counselling. Dietary screening  
47 tools have been designed to assess specific foods or nutrients<sup>3, 6, 7</sup>, dietary behaviours

48 associated with obesity<sup>8</sup> or cardiovascular disease,<sup>9-11</sup> adherence to specific diets<sup>12, 13</sup> or as  
49 specific aids in dietary counselling with a prompt sheet provided to guide discussion.<sup>14, 15</sup>  
50 They take the form of short food frequency questionnaires (FFQs), with<sup>16</sup> or without<sup>17</sup> portion  
51 estimates, behavioural questionnaires<sup>18</sup> or a combination of FFQ and behavioural questions.<sup>7</sup>  
52 They are unable to give estimates of absolute intake but can classify individuals as high,  
53 medium or low consumers of nutrients or foods of interest, allowing dietary advice to be  
54 targeted to an individual. Questionnaires have also been developed to rapidly evaluate the  
55 success of dietary interventions, for example to measure the effect of advice to increase fruit  
56 and vegetable intake<sup>19</sup> or follow a lipid lowering diet.<sup>20</sup> These are responsive to change and  
57 can provide outcome data to determine whether an intervention has succeeded in improving  
58 dietary habits. Brief questionnaires are of interest to dietary researchers,<sup>21</sup> but the current  
59 review focuses on instruments that might be applicable in a clinical setting to obtain a picture  
60 of an individual's diet.

61 A review of brief dietary assessment tools for potential clinical use was published in 2000,<sup>22</sup>  
62 but many additional tools have been developed since then and there is a need for an update.  
63 More recently the US National Cancer Institute (NCI) published an on-line registry of  
64 validated brief dietary assessment instruments.<sup>23</sup> Although the registry provides an overview  
65 of the tools, it does not facilitate comparisons and provides no summarised information about  
66 applicability to clinical practice.

67 Our aims were to: 1) identify and describe available brief dietary screening tools that can be  
68 used in clinical practice for the prevention and management of obesity, cardiovascular  
69 disease and type 2 diabetes in adults; 2) examine the acceptability, reliability and/or relative  
70 validity of the tools; and 3) summarise the data so that clinicians can quickly assess which  
71 tool is most suitable for use with their patient group. Details are also provided about the  
72 availability of the tools and whether there are costs associated with their use.

73 Methods

74 *Search strategy*

75 Electronic databases MEDLINE, EMBASE, PsycINFO, AMED (Ovid versions) and  
76 CINAHL (EBSCOhost version) to June 2013 (week 26) were searched using MeSH terms  
77 and text words. Search terms were based around general terms for nutritional and dietary  
78 assessment and were designed to identify brief questionnaires. Terms included nutrition  
79 assessment, diet screen, food questionnaire, nutrient questionnaire and short, brief, rapid and  
80 adult. The full list of search terms is included in the supplementary information (appendix 1).  
81 One author (CE) screened all titles and abstracts. Full text articles were retrieved if abstracts  
82 appeared to meet the inclusion criteria. Additional studies were identified from reference lists  
83 and screened similarly. Studies were initially assessed for inclusion by one author (CE).  
84 Where it was unclear whether a study or questionnaire met the inclusion criteria a second  
85 author (JT) screened the reports.

86 *Inclusion and exclusion criteria*

87 Dietary habits or foods relevant to adults at risk for cardiovascular disease, overweight,  
88 obesity or type 2 diabetes were derived from national and international guidelines.<sup>24-26</sup> Risk  
89 increases with high consumption of energy-dense foods, trans-fats, saturated fats, sodium and  
90 alcohol and decreases with high consumption of high fibre foods, fruit and vegetables, fish  
91 and low glycaemic index foods. Dietary patterns emphasising high fibre foods, low fat dairy,  
92 poultry, fish, non-tropical vegetable oils and nuts, whilst limiting red and processed meats  
93 and high fat or sugar foods and drinks, are advised. Questionnaires assessing components of  
94 the diet that increase or decrease risk were identified.  
95 Tools were included if they had been evaluated for reliability or relative validity against a  
96 biomarker or against another self-reported measure of dietary intake (dietary reference). In  
97 common with the previous review<sup>22</sup>, sample size was not considered. Based on the clinical

98 expertise of two authors (CE, RA) tools were deemed to be practical for clinical settings if  
99 they were brief, available in paper format or freely accessible on the Internet, could be scored  
100 at administration without specialist computer software and were capable of providing  
101 immediate feedback to patients and practitioners on an individual level. Questionnaires were  
102 defined as 'brief' if they were estimated to take no more than 15 minutes to complete. Mean  
103 allocated appointment times for new patients in primary care have been reported as being  
104 between 16-32 minutes and complete physicals as 12-36 minutes.<sup>27</sup> Consequently,  
105 questionnaires taking more than 15 minutes to complete were judged as not feasible for use in  
106 clinical practice. However, most studies did not estimate completion time. Preliminary work,  
107 prior to conducting the full review, identified mean completion times of 15 minutes for a 25  
108 item questionnaire,<sup>28</sup> 10 minutes for 31-item,<sup>29</sup> 20 item<sup>9</sup> and 16 item<sup>10</sup> questionnaires and 5-  
109 10 minutes for a 29 item questionnaire.<sup>5</sup> Taking these measures into account it was estimated  
110 that questionnaires of up to 35 items could feasibly be completed in 15 minutes. Tools  
111 designed to be administered by a practitioner or completed independently by the patient were  
112 both included.

113 Tools that assessed micronutrient intakes, protein intake, malnutrition screening tools or  
114 those aimed at identifying hazardous drinking were excluded. Questionnaires for single food  
115 groups, such as oily fish and pulses and fruit and vegetable questionnaires containing over 10  
116 items, were considered to be of limited use in clinical practice and were excluded. Studies  
117 were excluded if they only reported the use of a questionnaire during an intervention or  
118 observational study, or described tools that were not tested for either reliability or relative  
119 validity. Due to the limitations of time and cost, studies not published in English were  
120 excluded. It was not possible to obtain copies of 2 tools, despite contacting the institutions  
121 where they were developed, so these tools were excluded from the review.<sup>30, 31</sup> A full list of  
122 inclusion and exclusion criteria is available in the supplementary information (appendix 1).

123 *Data extraction*

124 The data extraction form was developed by all authors and piloted with four studies. One  
125 author (CE) extracted data from all studies. Data from 25% of studies were also extracted by  
126 an independent reviewer for cross-checking.

127 *Study characteristics*

128 The following data were extracted: study design, study setting, sample size, population and  
129 country. Age, gender, socio-economic status (SES), education, disease state and ethnicity  
130 may all impact on the results of a relative validation study.<sup>32</sup> As such the sample profiles  
131 were categorised.

132 *Questionnaire characteristics*

133 Data were collected on the number of items, type of questions, scoring system and the  
134 language of the tool, the method of administration and whether the tool was designed for a  
135 specific population or for use in a particular setting.

136 *Questionnaire items*

137 Data were extracted on item generation as it is important to know whether a questionnaire has  
138 been tailored to the population of interest.<sup>4</sup> Data were extracted on whether a questionnaire  
139 had been tested for acceptability (face validity, ease of use or an assessment of usefulness)  
140 and readability.

141 *Reliability and relative validity*

142 Results were extracted from test-retest reliability studies determining whether tools were  
143 consistent over two or more administrations,<sup>33</sup> and from internal reliability studies  
144 determining whether items measuring the same dietary characteristic were consistent within  
145 a tool.<sup>34</sup> Data from relative validity studies were extracted. In true validation studies a new  
146 measure is compared with an accurate measurement of the truth, but this is very difficult for  
147 habitual diet.<sup>35</sup> The gold standard for dietary intake is a recovery biomarker such as doubly

148 labelled water, for energy intake, or urinary nitrogen for protein.<sup>36</sup> These are expensive to  
149 administer, only available for a limited number of nutrients and inappropriate for brief  
150 questionnaires that do not measure the whole diet. Even direct observation is unsuitable as a  
151 true measure of habitual diet in free living individuals due to the need for 24 hour, possibly  
152 covert, surveillance. Consequently, short dietary assessment tools are evaluated against  
153 imperfect reference measures. These include self-reported dietary measures, for example food  
154 diaries, a longer FFQ or 24 hour recalls; a concentration biomarker such as plasma vitamin  
155 levels,<sup>37</sup> or biomarkers of pre-clinical disease<sup>38</sup> such as blood lipids or anthropometric  
156 measures. None of these are true measures of habitual intake. Dietary measures are subject to  
157 measurement error, which vary depending upon the method. For example, those reliant on  
158 memory, such as FFQs, are subject to recall bias whereas food records can change dietary  
159 behaviour.<sup>4</sup> The use of food tables for nutrient analysis further introduces error in both self-  
160 report and direct observation of diet.<sup>35</sup> Furthermore, if errors in the reference measure  
161 correlate with errors in the new measure, for example if both methods are subject to recall  
162 bias, relative validity of the new measure could be overestimated.<sup>35</sup> Concentration biomarkers  
163 and biomarkers of pre-clinical disease are affected by metabolic and lifestyle factors. For  
164 example, levels of plasma  $\beta$ -carotene are determined by dietary intake but also by fat intake,  
165 BMI, low density lipoprotein levels and smoking.<sup>37</sup> However, these biomarkers can provide  
166 additional evidence of accuracy of a questionnaire when used in conjunction with other  
167 reference measures.

168 Internal reliability is typically tested using Cronbach's  $\alpha$  which assesses how closely items  
169 correlate with each other.<sup>34</sup> Values of  $>0.70$  indicate high internal reliability, although strong  
170 correlation between items in a dietary questionnaire may not be required if each item is  
171 designed to assess different aspects of the diet.<sup>39</sup> Test-retest reliability and relative validity  
172 are commonly tested at the individual level using correlation statistics.<sup>35</sup> The use of mean

173 values alone can only assess these at the group level.<sup>40</sup> Correlation coefficients of  $\geq 0.4$  for  
174 the nutrient of interest are considered to be adequate for food frequency questionnaires when  
175 compared with another dietary reference measure.<sup>4</sup> Correlations of  $\leq 0.4$  are more usual when  
176 FFQs are compared with a biomarker.<sup>37</sup> Studies calibrating long FFQs against other dietary  
177 assessment methods such as food diaries have reported coefficients between -0.16 to 0.86 for  
178 total fat in grams (mean 0.51), -0.01 to 0.71 for fruit and 0.16 to 0.72 for vegetables.<sup>41</sup> Test-  
179 retest reliability studies for long FFQs quote coefficients of 0.50 to 0.70 for energy, fat and  
180 selected micronutrients.<sup>41</sup>

181 The practice of only examining the correlations between scores to determine test-retest  
182 reliability or validity has been criticised and it has been recommended that the Bland Altman  
183 method is used in conjunction.<sup>33</sup> Details of the statistical tests used were summarised.

## 184 Results

185 A total of 1802 separate records were identified, 1795 via the electronic databases and a  
186 further 7 from hand searching references. One hundred and twenty two full text papers were  
187 screened and 47 met the inclusion criteria (figure 1). The development and testing of 35 tools  
188 were described in these papers, although 2, the Block Fat, Fruit and Vegetable Screeners (B-  
189 F&FV)<sup>6</sup> and the Hispanic Fat, Fruit and Vegetable Screeners (H-F&FV),<sup>42</sup> can be split into 2  
190 distinct sets of questions which provide scores for different aspects of the diet. In addition 2  
191 different versions of 2 tools, the Rapid Eating Assessment for Patients (REAP<sup>29</sup> and REAP-  
192 S<sup>14</sup>) and the Food Behaviour Checklist (FBC-T<sup>10</sup> and FBC-V<sup>43</sup>), are currently available and  
193 the FBC-V has been translated into Spanish (FBC-SV) and evaluated<sup>32, 44</sup> One, the Fat  
194 Related Diet Habits Questionnaire (FRDHQ), appears to have been used in several different  
195 versions. Papers describing relative validity testing of the 20-item and 24-item questionnaires  
196 are detailed here<sup>21, 45-47</sup> although 21-<sup>48</sup> and 23-<sup>49</sup> item versions have been used in  
197 interventions. The current version, available on-line, contains 25 distinct items

198 (<http://sharedresources.fhcrc.org/documents/fat-related-questionnaire>). For the purposes of  
199 this review B-F&FV and H-F&FV were regarded as single tools, REAP and REAP-S and  
200 FBC-T and FBC-V were regarded as distinct tools, with FBC-SV as a subsidiary to FBC-V.  
201 All the versions of FRDHQ were regarded as one tool.

202 Table 1 summarises the study and tool characteristics. Over half (n=20) were developed and  
203 tested in the USA or Canada with the remainder in European countries (n=10) and Australia  
204 or New Zealand (n=5).

### 205 *Dietary assessment*

206 Fifteen papers described 10 tools assessing healthy eating or healthy dietary patterns<sup>8, 10, 13, 14,</sup>  
207 <sup>28, 29, 32, 43, 44, 50-55</sup> and 2 assessing adherence to the Mediterranean diet.<sup>13, 56</sup> Twenty-four  
208 papers described 18 tools providing information on the intake of dietary fats or dietary  
209 behaviours associated with fat intake. Of these, 11 were specific for dietary fats alone,<sup>3, 12, 15,</sup>  
210 <sup>20, 21, 39, 45-47, 57-64</sup> 1 assessed dietary fat and free sugars,<sup>65</sup> 4 assessed dietary fat and fibre  
211 intakes<sup>5, 7, 9, 18</sup> and 2 assessed dietary fat and fruit and vegetable intake (although these can be  
212 used separately as one screener for fat and one for fruit and vegetables).<sup>6, 42</sup> Four tools  
213 assessed fruit and vegetable intake<sup>16, 17, 19, 66, 67</sup> and 1 assessed fruit intake alone.<sup>68</sup> With the  
214 exception of questionnaires specific for fruit and vegetable intake, no tool was designed to  
215 characterise diets by food groups, although 3 broader tools also provided a fruit and vegetable  
216 sub-score.<sup>10, 43, 50</sup>

217 Fifteen tools were short FFQs and asked questions on the frequency of consumption of  
218 specific foods.<sup>3, 5, 6, 12, 13, 42, 58, 60, 69</sup> All of the fruit and vegetable questionnaires were in this  
219 form.<sup>16, 17, 19, 66, 68</sup> Four exclusively asked about food behaviours, for example, “In the past  
220 month how often did you eat fish or chicken instead of red meat?” or, “In an average week,  
221 how often do you skip breakfast?”<sup>14, 18, 29, 45</sup> The remaining 16 contained a mixture of FFQ  
222 and behavioural questions.<sup>7-10, 15, 20, 28, 39, 44, 50, 54-57, 59, 61</sup>

223 All except 6<sup>8, 10, 14, 29, 44, 52, 55</sup> were scored numerically, with a total score or subscales for  
224 separate nutrients or fruit and vegetable intakes. The 6 that were not scored in this manner  
225 give individual guidance for each item, and 2<sup>14, 29</sup> also provide a prompt sheet to aid advice.  
226

227 *Item generation*

228 Item generation was described for 27 tools, with 8 employing more than one method.  
229 Fourteen were adapted from longer FFQs and other questionnaires,<sup>3, 7, 12, 14, 15, 18, 20, 39, 43, 50, 54,</sup>  
230 <sup>56, 59, 69</sup> of which 6 were initially based upon other tools included in this review.<sup>14, 15, 18, 20, 43, 54</sup>  
231 Six used national databases to identify foods most commonly consumed from a particular  
232 category, or foods that contributed most to the nutrient of interest in the population of  
233 interest.<sup>5, 42, 54, 57, 68, 69</sup> Seven used recommendations or clinical guidelines<sup>5, 10, 29, 53, 55, 56, 58</sup> and  
234 4 were developed using an expert panel.<sup>9, 10, 45, 53</sup> Five were developed from data collected  
235 from participants, either quantitative in the form of dietary patterns<sup>51</sup> or through qualitative  
236 work.<sup>10, 18, 42, 54</sup>  
237 Fourteen reported being evaluated in some way for acceptability to check that wording was  
238 clear, questions were relevant and the general lay-out of the tool was appropriate. Four  
239 employed cognitive interviewing,<sup>29, 32, 43, 51, 68</sup> 3 used survey methods,<sup>7, 50, 55</sup> 5 used  
240 unspecified qualitative interviews<sup>10, 18, 42, 53, 58</sup> and 2 used unspecified pilot testing.<sup>20, 59</sup> Only  
241 the FBC-T and the visual versions derived from it were evaluated for reading  
242 comprehension.<sup>32, 43, 52</sup> The FBC-T and FBC-SV were of low reading difficulty and the colour  
243 version of the FBC-SV was “very easy”.

244 *Reliability and relative validity*

245 Table 2 summarises the results of reliability and relative validity studies. Just over half the  
246 tools (n=18) were tested for test-retest reliability,<sup>7, 9, 18-20, 29, 39, 42, 44, 52, 55, 57-61, 69</sup> with 1 being  
247 tested in 3 different samples.<sup>21, 45, 47</sup> Test-retest time varied from several hours<sup>7</sup> to 1 year<sup>18, 19,</sup>  
248 <sup>57</sup> and different studies employed different statistical tests, although correlations were most  
249 often used (14 tools).<sup>7, 9, 18-20, 29, 39, 42, 44, 45, 52, 55, 57, 59</sup> Test-retest correlation coefficients for  
250 total scores ranged from 0.59<sup>21</sup> to 0.95.<sup>7</sup> Four studies did not calculate a total score but used  
251 individual items, group classifications or derived nutrient intakes from the screener as test-

252 retest variables.<sup>52, 55, 58, 60</sup> One study<sup>61</sup> was evaluated exclusively at the group level. Internal  
253 reliability was tested in 9 tools<sup>3, 8, 39, 44, 54, 58, 69</sup> with 2 employing more than 1 sample.<sup>10, 45-47,</sup>  
254 <sup>52</sup> Values for Cronbach's  $\alpha$  were reported from 0.47<sup>54</sup> to 0.83.<sup>47</sup> All tools were examined for  
255 relative validity at the individual level against a reference measure except 1.<sup>42</sup> A number of  
256 different reference measures, with a range of different times between tests, different test  
257 variables and different statistical tests were used to determine relative validity. No study  
258 employed a recovery biomarker. Nine tools were compared with an FFQ that had previously  
259 reported relative validity against food diaries or dietary recalls<sup>6, 9, 14, 15, 18, 55, 59, 60, 66</sup> and 13  
260 were compared with food diaries<sup>5, 16, 50, 57, 61</sup>, recalls<sup>13, 17, 44, 54, 67</sup> or a diet history.<sup>58, 68</sup> One was  
261 compared with a different brief questionnaire that had been previously tested for relative  
262 validity against 24 hour recalls.<sup>39</sup> Nine tools were compared with more than one reference  
263 measure,<sup>8, 10, 12, 20, 21, 28, 29, 45-47, 52, 53, 56, 62-64, 69</sup> and 3 were compared with more than one dietary  
264 reference.<sup>12, 21, 29, 45-47, 62-64</sup> Alongside a dietary reference, 4<sup>10, 28, 56, 58</sup> were compared with  
265 biomarkers of preclinical disease, 4<sup>28, 53, 56, 69</sup> with anthropometric measures, and 2<sup>10, 28</sup> with  
266 concentration biomarkers. Two did not use a dietary reference measure but compared change  
267 in total score with change in BMI<sup>3</sup> and change in total score with change in plasma  
268 carotenoids and plasma vitamin C.<sup>19</sup> The variation in study designs makes direct comparisons  
269 between tools problematic, but total score (or fat score) from 11 tools<sup>5, 9, 12, 15, 18, 20, 21, 29, 45-47,</sup>  
270 <sup>54, 59, 62-65</sup> were reported to have been compared with % energy from total fat from food  
271 diaries or FFQs. Correlation coefficients ranged from 0.24<sup>46</sup> to 0.79.<sup>12</sup> Total scores from 2 of  
272 these tools were compared with % energy from total fat from a dietary reference in more than  
273 one population: the FRDHQ reported correlation coefficients ranging from 0.24<sup>46</sup> to 0.60<sup>45</sup>  
274 and MEDFACTS from 0.30<sup>63</sup> to 0.79.<sup>12</sup>

275 Table 3 gives an 'at a glance' summary of the characteristics of each tool, the evaluation  
276 studies and provides information on access.



278 Discussion

279 *Main findings*

280 This systematic review identified 35 tools with potential application to dietary assessment in  
281 clinical settings. Around half assess dietary fat intake, with or without other nutrients, a third  
282 assess the overall diet for healthy eating or adherence to the Mediterranean diet, and the  
283 remainder assess fruit and vegetable intake. More tools have been developed and evaluated in  
284 the USA than in any other country.

285 Fewer than half the tools reported evaluations for clarity of language and acceptability with  
286 users. Due to the variation in methodology, it is not possible to determine if tools that were  
287 evaluated for acceptability show greater reliability or relative validity than those that were  
288 not. However, best practice in food frequency questionnaire design involves pre-testing.<sup>41</sup>

289 All tools, except 1, were tested for relative validity against one or more reference measures,  
290 although there was a wide variation in the design of studies, the variables used and the  
291 statistical tests employed. Three quarters were tested against a different dietary reference  
292 measure, with over a quarter using a FFQ or a different brief questionnaire. Since the  
293 majority of brief questionnaires were themselves FFQs, or included many food frequency  
294 questions, errors between the tools and the FFQs may have been correlated and the relative  
295 validity of these questionnaires overestimated. Around half were evaluated for test-retest  
296 reliability with similar variation in study design. This variation makes direct comparison  
297 between tools difficult and as a consequence it is not possible to state that one tool is superior  
298 for a particular nutrient or population. However, correlation coefficients for relative validity  
299 against food diaries and biomarkers and those for reliability studies are similar to those  
300 obtained in studies which evaluate longer FFQs against food diaries. This indicates that these  
301 brief dietary screening tools can be expected to produce a fair approximation of dietary habits  
302 and consequently could be of use in clinical practice for the dietary management of

303 cardiovascular disease, obesity and Type 2 diabetes. It is worth noting however, that few  
304 tools reported sensitivity, specificity or predictive values<sup>28 55, 62-64, 66, 68</sup> and only 6 (17%) have  
305 assessed sensitivity to change over time;<sup>3, 18-20, 39, 54</sup> therefore their utility in an intervention  
306 setting is unclear.

### 307 *Strengths and limitations of the review*

308 The strengths of this review are the application of a systematic search strategy and systematic  
309 data extraction techniques. Dietary assessment tools developed since Calfas et al's review in  
310 2000<sup>22</sup> and validated tools that are not listed in the NIC registry have been identified and  
311 described. Tools that were not included in study reports were obtained on-line or from the  
312 original authors to ensure they met the inclusion criteria. The results are presented so that  
313 clinicians and researchers can select available tools that are most suitable for their purposes.  
314 The review has some important limitations. The piloting and use of dietary screening tools in  
315 practice has not been examined, which means it is not possible to determine whether use of a  
316 tool has a positive effect on patient behaviour. The inclusion and exclusion criteria were  
317 developed for this review and assessment of whether a tool would be useful in clinical  
318 practice was derived from the expert opinion of only 2 clinicians. Other reviewers or  
319 clinicians may disagree with the criteria and may have included or excluded different brief  
320 tools. Calfas et al<sup>22</sup> judged that tools suitable for use in primary care would take 15 minutes to  
321 complete or be around 50 items long but provided no justification for this. The current review  
322 based an estimate of completion time on preliminary data obtained from brief dietary  
323 questionnaires. We excluded tools assessing single food groups since there is limited clinical  
324 benefit in a detailed assessment of one food group, with the exception of fruit and vegetable  
325 intake. However, fruit and vegetable questionnaires of greater than 10 items were excluded  
326 because increased patient burden reduces feasibility in clinical practice. Only peer-reviewed  
327 studies published in English were included. There may be evaluated tools that are used in

328 clinical practice in other countries, or that have not been peer-reviewed that have not been  
329 identified here. However, due to the heterogeneity of studies, this would be unlikely to  
330 change the broader conclusions of this review.

### 331 *Comparison with other studies*

332 Calfas et al's review<sup>22</sup> used wider inclusion criteria than this current review and did not  
333 consider whether a tool could be easily scored in practice. They identified 14 dietary  
334 assessment tools, of which 7 are included in the present review.<sup>5, 6, 11, 12, 15, 20, 55</sup> All measured  
335 dietary fat, making comparisons between tools more straightforward. Four were evaluated for  
336 test-retest reliability, with correlation coefficients ranging from 0.67 to 0.91. The 11 validated  
337 tools were either validated against a food diary or a longer FFQ, and correlation coefficients  
338 for % energy from fat ranged from 0.30 to 0.80. These ranges are similar to coefficients  
339 reported in the current review.

340 In 2003, Kim et al reviewed tools reported as validated, containing up to 16 items, and  
341 designed to assess fruit and vegetable intake.<sup>70</sup> They identified 10 instruments, of which 1 is  
342 included in the current review.<sup>17</sup> The remainder were excluded in the current review for  
343 reasons of length or because the scoring algorithms were complex and unlikely to be used in  
344 clinical practice. Tools were reported as validated against longer FFQs, food diaries or 24-  
345 hour recalls. Correlation coefficients for total fruit and vegetable intakes ranged from 0.29 to  
346 0.80. Since the tools measured the same aspect of the diet, comparisons were possible and  
347 this review concluded that more detailed tools that asked about portion sizes and the  
348 consumption of mixed vegetable dishes showed greater relative validity. Cade et al<sup>41</sup> also  
349 comment that FFQs asking people to estimate their own portion sizes are more reliable. Only  
350 one tool included in the current review asks people to estimate their portion sizes by  
351 providing a multiple choice list of three different sizes.<sup>12</sup>

352 All the studies previously reviewed used correlations alone to assess reliability and relative  
353 validity. This remains the most common method and only 5 studies in the present review  
354 made use of the Bland-Altman method. Correlation coefficients are not measures of absolute  
355 agreement but are instead measures of relative agreement, assessing whether an individual  
356 has maintained their ranking relative to other participants. The intra-class correlation  
357 coefficient (ICC) was used to evaluate 4 tools, but this measure has also been criticised and  
358 data simulations have shown that high correlations can be achieved with low absolute  
359 agreement.<sup>71</sup> The Bland Altman method assesses limits of agreement (LOA) which define the  
360 range that 95% of the differences between the measures lie within, and may include graphical  
361 presentation of the data. Clinical knowledge must be used to decide if the LOA are  
362 acceptable.<sup>72</sup> Of the studies that used the Bland Altman method, one was published in 2002<sup>7</sup>  
363 and the remainder after 2010, with 3 studies conducted by the same team.<sup>13, 56, 68</sup>

#### 364 *Clinical implications*

365 It is important that clinicians are clear about their purpose when selecting a tool for use. In  
366 clinical practice, dietary assessment is required to assist in the provision of dietary advice or  
367 to measure the impact of dietary intervention.<sup>4</sup> Brief dietary questionnaires used for the  
368 former purpose are those that give clear guidance on moving to healthier dietary habits rather  
369 than obtaining a detailed, quantitative assessment of an individual's diet. Assessment may be  
370 focussed on certain nutrients to be disease specific or may be concerned with overall diet  
371 quality. Typical questions from tools included in the current review include asking about the  
372 frequency of consumption of sweet foods or savoury snacks, with responses ranging from  
373 less than once a week to more than 3 times a day. The answers can be used to target dietary  
374 advice to the individual. Tools suitable for measuring the impact of a dietary intervention  
375 must also be able to measure change.

376 This review provides evidence that tools developed and tested in one population may not  
377 have the same relative validity in a different population. Equally tools developed in different  
378 countries will include different food items, also affecting relative validity. It should be noted  
379 that English translations of tools developed in Spanish, French, Norwegian or Dutch have not  
380 been validated and that older tools may no longer be appropriate due to shifts in food habits  
381 and processing.<sup>73</sup> In common with previous reviews<sup>22,70</sup> studies with small sample sizes were  
382 not excluded. Cade et al<sup>41</sup> report a wide range of sample sizes for relative validation studies  
383 of long FFQs and found no difference in reported correlation coefficients between studies  
384 with large sample sizes compared to small sample sizes. However, with small sample sizes,  
385 confidence intervals are likely to be wide and consequently sample sizes of around 100 to  
386 200 are advised.<sup>40</sup> Clinicians should consider the sample sizes of test-retest and relative  
387 validation studies if tools are to be used 'off the shelf'.

388 Developers of future tools can enhance understanding of the development, relative validity  
389 and reliability of tools by clearly describing: 1) how items were derived; 2) the population of  
390 interest; 3) the characteristics of the sample for reliability and relative validation studies; 4)  
391 the results of these studies; and 5) whether stratification by age, gender, ethnicity and  
392 socioeconomic status affected results. Tools that are most helpful for clinical use need to  
393 have a clearly described and simple scoring system, and ideally a copy presented in the paper  
394 or in an on-line appendix for evaluation with clear information about copyright. Table 4  
395 provides a checklist to assist practitioners when choosing a brief dietary questionnaire for  
396 clinical use.

## 397 Conclusion

398 This review identified and summarised 35 short dietary assessment tools of potential use in  
399 clinical practice for the dietary management of cardiovascular disease, obesity and Type 2  
400 diabetes. In general, tools demonstrated adequate reliability and/or relative validity, although

401 around half have been developed and evaluated exclusively in US populations. It is not  
402 possible to determine if any one tool is clearly better than another for a given population or  
403 purpose due to differences in the design of reliability and relative validity studies. If tools are  
404 to be used in different countries or populations, they need to be adapted and evaluated locally  
405 to ensure they are reliable and have acceptable levels of relative validity.

406 Supplementary information is available on the European Journal of Clinical Nutrition's  
407 website

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#### Figure Legend

Figure 1: Prisma diagram. Brief dietary questionnaires