Figure 1

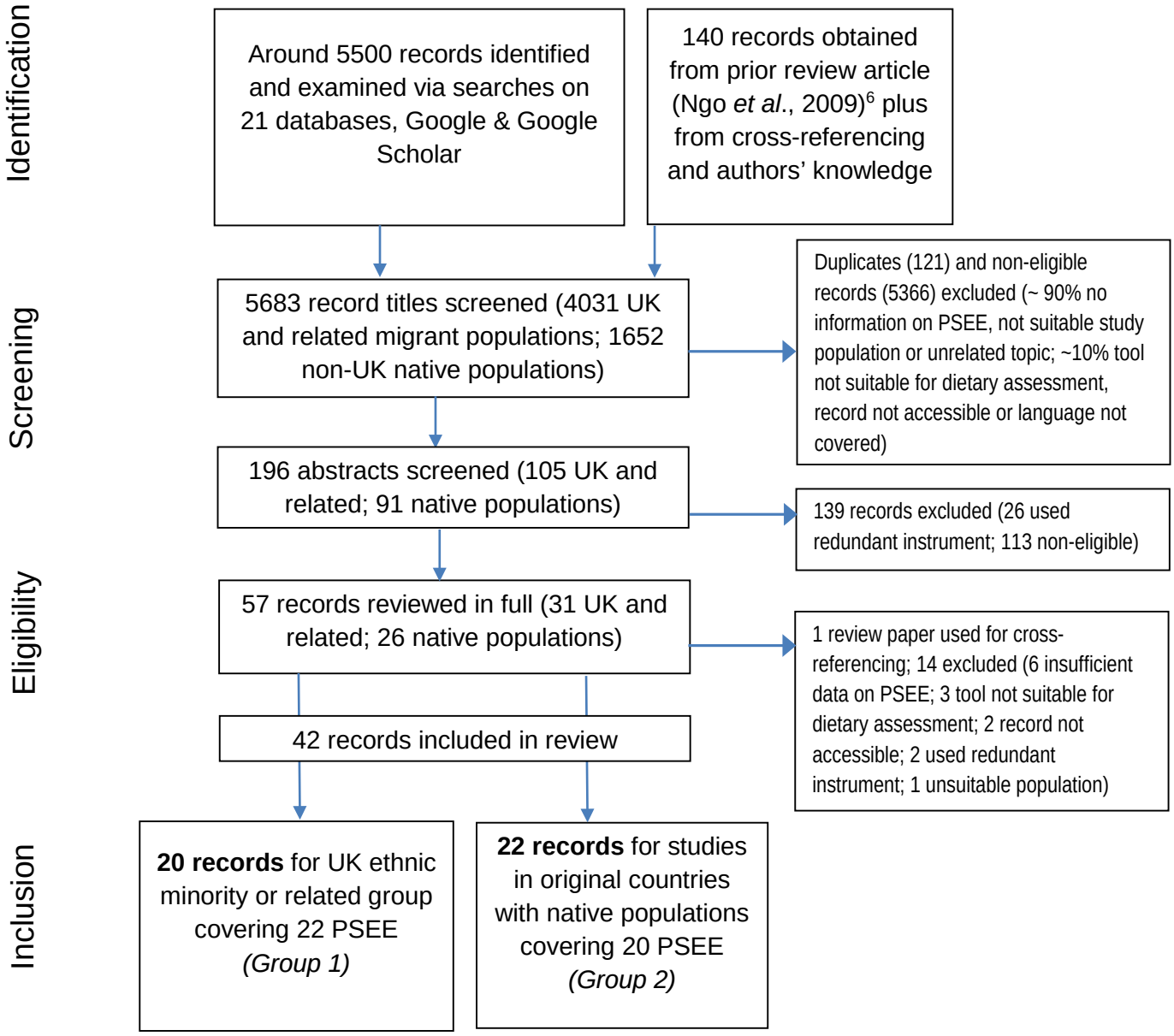
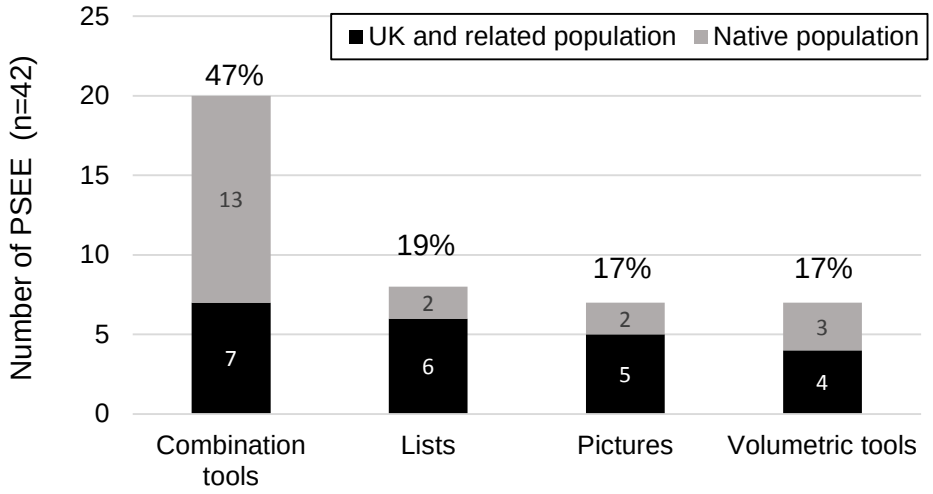

Identification
Screening
Eligibility
Inclusion
Around 5500 records identified and examined via searches on 21 databases, Google & Google Scholar
140 records obtained from prior review article (Ngo *et al*., 2009)[6] plus from cross-referencing and authors' knowledge
5683 record titles screened (4031 UK and related migrant populations; 1652 non-UK native populations)
Duplicates (121) and non-eligible records (5366) excluded (~ 90% no information on PSEE, not suitable study population or unrelated topic; ~10% tool not suitable for dietary assessment, record not accessible or language not covered)
196 abstracts screened (105 UK and related; 91 native populations)
139 records excluded (26 used redundant instrument; 113 non-eligible)
57 records reviewed in full (31 UK and related; 26 native populations)
1 review paper used for cross-referencing; 14 excluded (6 insufficient data on PSEE; 3 tool not suitable for dietary assessment; 2 record not accessible; 2 used redundant instrument; 1 unsuitable population)
42 records included in review
20 records for UK ethnic minority or related group covering 22 PSEE *(Group 1)*
22 records for studies in original countries with native populations covering 20 PSEE *(Group 2)*

Figure 2

(a)


25
20
15
10
5
0
Number of PSEE (n=42)
UK and related population
Native population
47%
19%
17%
17%
13
7
2
6
2
5
3
4
Combination tools
Lists
Pictures
Volumetric tools

(b)

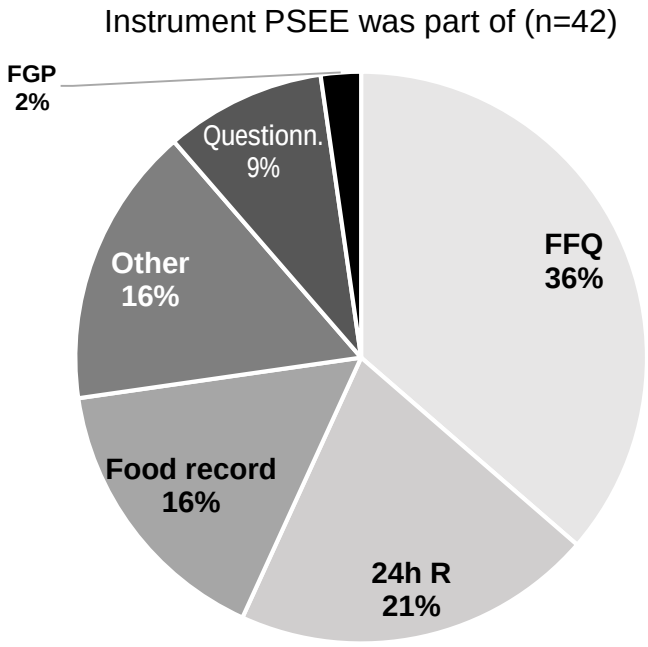
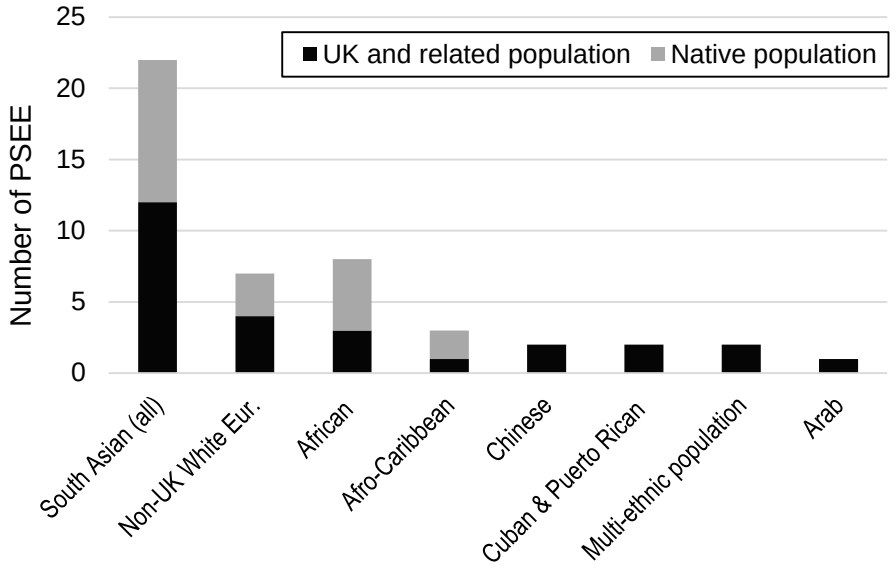
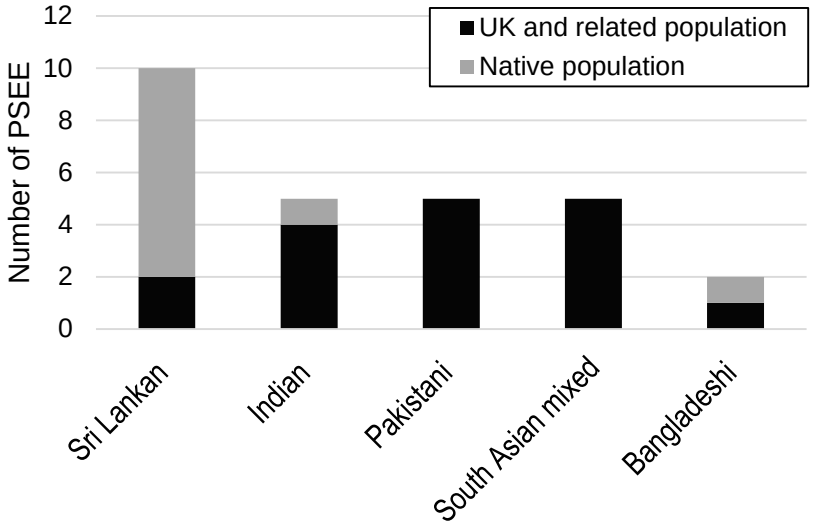

Instrument PSEE was part of (n=42)
FGP 2%
Questionn. 9%
Other 16%
FFQ 36%
Food record 16%
24h R 21%

Figure 3a



3b



3c

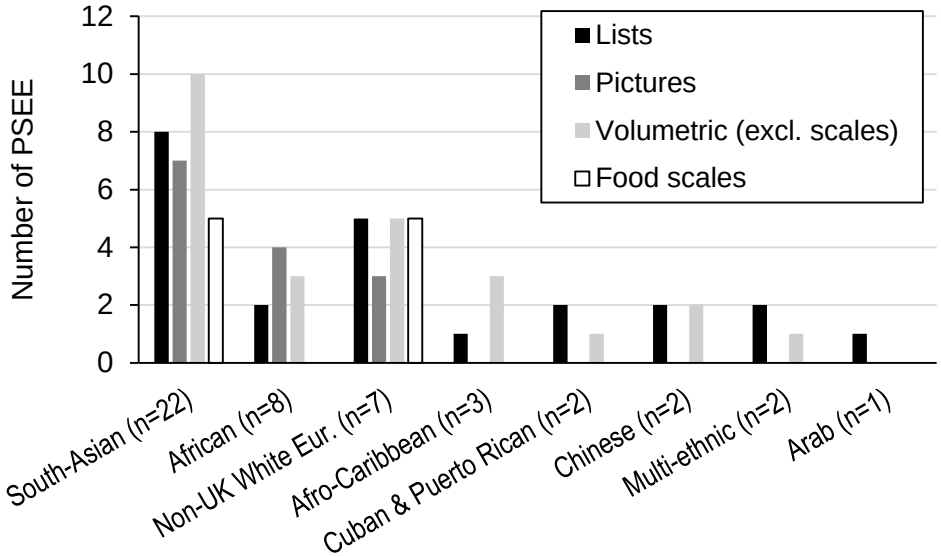
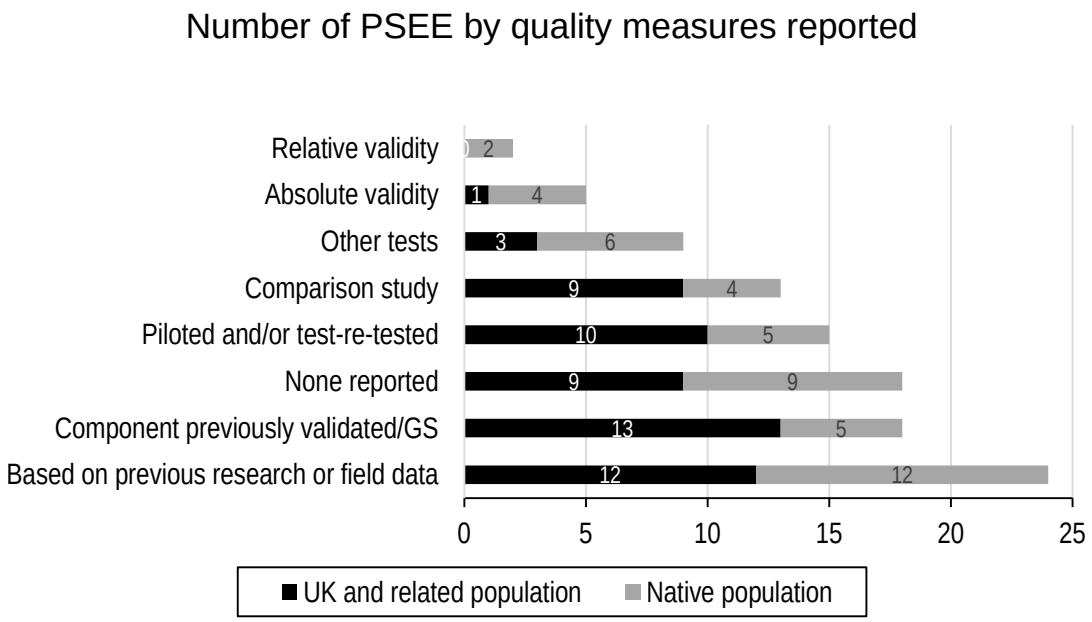
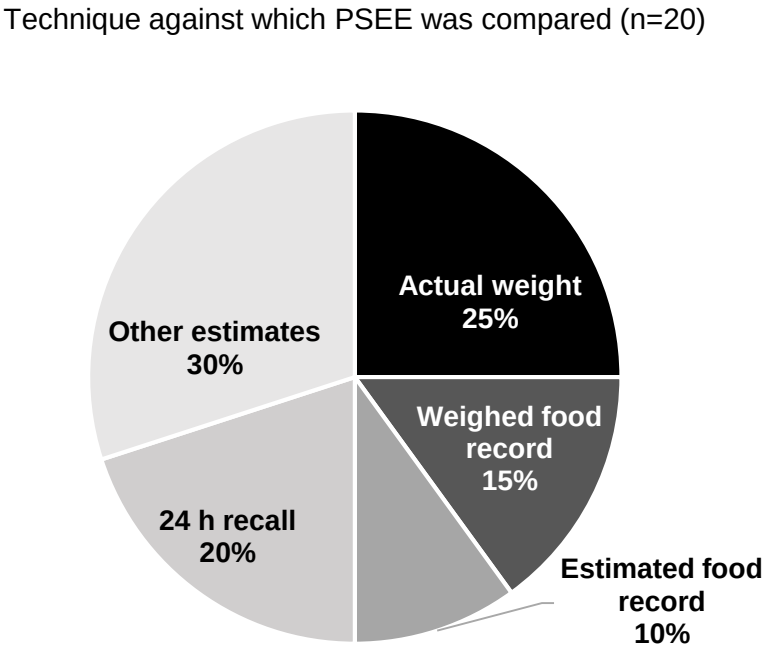


Figure 4

(a)


Number of PSEE by quality measures reported
Relative validity
Absolute validity
Other tests
Comparison study
Piloted and/or test-re-tested
None reported
Component previously validated/GS
Based on previous research or field data
0
2
1
4
3
6
9
4
10
5
9
9
13
5
12
12
0
5
10
15
20
25
UK and related population
Native population

(b)


Technique against which PSEE was compared (n=20)
Actual weight 25%
Weighed food record 15%
Estimated food record 10%
24 h recall 20%
Other estimates 30%

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1, 2, 5
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number. *Review not registered as does not meet inclusion criteria for PROSPERO or clinical trial sites.*	Page 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 5; Table 1
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number. *Stated on manuscript "Protocol available by contacting the authors"*	Page 5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Table 1, Page 5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Pages 5-7; Figure 1
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 2 in Supplem. Information
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Figure 1; Pages 5-6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Page 7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis. *Stated on manuscript: "Meta-analysis was not applicable, a narrative synthesis is provided"*	Page 7
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies). *Bias was analyzed at study level only. According to EPOC[i] an overall summary assessment in this review is not applicable (review to inform decisions across a variety of settings).*	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables 1, 2 Appendix 3 (all tables) Pages 7-14
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Appendix 3 (table S3), Page 11
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Figures 1-4, Tables 1-5 Appendix 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency. *Results shown as descriptive figures and tables in text (pages 8-16) and supplementary information*	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 14-20; 22-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 22
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Pages 20-23

FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Page 24

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

[i] *Effective Practice and Organisation of Care (EPOC). Suggested risk of bias criteria for EPOC reviews. EPOC Resources for review authors. Oslo: Norwegian Knowledge Centre for the Health Services; 2015. Available at: http://epoc.cochrane.org/epoc-specific-resources-review-authors.* Accessed 14 Aug 2015.

Appendix 2

Search Pathway

To reduce the number of ineligible titles the following rule can be used in combinations: Portion* near/3 size* (any abstract where "portion" and "size" are within 3 words of each other are included). Titles from searches 11-29 will be imported into Endnote (or other reference manager system) for screening.

Site: (insert name of database site *e.g. Web of Knowledge*)	Date: (insert date when search was done)
Databases: (insert databases covered by site *e.g. Web of Science Core Collection, BIOSIS Citation Index and MEDLINE*).	Limits: Language other than English, Spanish, French, Italian, Portuguese, Urdu, Punjabi and Arab

Terms in (tick one or delete as appropriate): ☐ **Abstract only** ☐**Title only** ☐ **Abstract/Title** ☐**Abstract/Title/Text**	**Number of hits**
1. Helping* OR portion* OR serving* ("Portion Size")	
2. Tool* OR utensil* OR appliance* OR guide* OR instrument* ("Tool")	
3. Measur* OR valid* OR evaluat* OR method* ("Measures")	
4. Asses* OR underestimat* OR overestimat* OR Training ("Assessment")	
5. Size* OR amount* OR volume* OR shape* OR 3D ("Quantities")	
6. Plate* OR bowl* OR spoon* OR cup* OR glass* OR container* OR carton* ("Dietary")	
7. Software* OR image* OR photo* OR digital* OR computer* ("Electronic")	
8. Food* OR nutri* OR diet* OR meal* OR snack* OR beverage* OR drink* OR eat* OR intake* ("Foods")	
9. Solid* OR liquid* OR amorphous* OR *solid ("Texture")	
10. ("Target Characteristics") **Group 1 studies**: : 'Ethnic OR Asian OR Indian OR Pakistani OR Bangladeshi OR Chinese OR Black OR Caribbean OR African OR Arab OR Polish OR Irish traveller OR Gypsy traveller' **Group 2 studies**: 'Asia* OR India* OR Pakistan* OR Bangladesh* OR China OR Chinese OR Caribbean OR Africa* OR Arab OR Poland OR Polish OR Romania* OR Ireland OR Irish OR Sri Lanka*'.	

11. (1) AND (2) AND Portion* near/3 size*	
12. (1) AND (3) AND Portion* near/3 size*	
13. (1) AND (4) AND Portion* near/3 size*	
14. (1) AND (5) Portion* near/3 size*	
15. (1) AND (2) AND (5) Portion* near/3 size*	
16. (1) AND (2) AND (4) Portion* near/3 size*	
17. (1) AND (4) AND (5) Portion* near/3 size*	
18. (1) AND (2) AND (3) Portion* near/3 size*	
19. (1) AND (3) AND (5) Portion* near/3 size*	
20. (1) AND (2) AND (6) Portion* near/3 size*	
21. (1) AND (5) AND (6) Portion* near/3 size*	
22. (1) AND (2) AND (7) Portion* near/3 size*	
23. (1) AND (5) AND (7) Portion* near/3 size*	
24. (1) AND (2) AND (8) Portion* near/3 size*	
25. (1) AND (5) AND (8) Portion* near/3 size*	
26. (1) AND (2) AND (9) Portion* near/3 size*	
27. (1) AND (5) AND (9) Portion* near/3 size*	
28. (1) AND (2) AND (10) Portion* near/3 size*	
29. (1) AND (5) AND (10) Portion* near/3 size*	

Table S1. Description of portion size estimation elements (PSEE) identified across 21 publications referring to major migrant groups in the UK, or related groups elsewhere. Original questionnaires used in the development of specific ethnic FFQs are shown in brackets, e.g. Block questionnaire (Block *et al.,* 1986)[1]; NCI-HHHQ Questionnaire (Subar *et al.,* 2010)[2]; Willett questionnaire (Willett *et al.,*1985)[3].

Abbreviations: CHO = carbohydrate; CSDLH = Canadian Study of Diet, Lifestyle and Health; FFQ = food frequency questionnaire; IRAS = Insulin Resistance Atherosclerosis Study; NCI-HHHQ = National Cancer Institute Health Habits and History Questionnaire; OIHS = Oslo Immigrants Health Study; oz. = ounces; PSEA = portion size estimation aid; PSRS = portion size reference scheme; SA = South-Asian; SHARE = Study of Health Assessment and Risk in Ethnic groups (Canada); SWAN = Study of Women's Health Across the Nation; Tbsp. = tablespoon).

PSEE name and description	PSEE classification and units	Technique used by the PSEE	Link to portion size reference scheme	PSEE purpose and outcome	Population group & setting where applied	Reference
African American and other ethnicity FFQ (NCI-HHHQ/Block modified) Semiquantitative FFQ with portion options for 'small', 'medium' or 'large' based on subjective estimation vs. other men/women; modified to include ethnic & regional food choices	1-Dimensional (estimated size)	Indirect measurement (comparison to the assumed portion size consumed by "other men/women of your age")	Does not correspond with a published PSRS (original ref. portion sizes in Block questionnaire were removed)	Dietary assessment of African American, Hispanic and non-White Hispanic women living in Colorado and California (USA)	Specific for USA migrants, designed to evaluate ethnic and non-ethnic diets in same study	Mayer-Davis *et al*. (1999)[4]
African American and other ethnicity food photographs of selected foods shown in 3 portion sizes, part of quantitative FFQ for American ethnic minority groups	2-Dimensional (photographic FFQ)	Indirect measurement (comparison against one of three portion sizes shown for each food category, to quantify a usual serving)	Does not correspond with a published PSRS. Portion sizes were derived from 3 day weighed food records in the corresponding ethnic groups	Portion estimation in quantitative FFQ used in multi-ethnic cohort study[a]	African American; Japanese American; Latino & White groups USA (Hawaii & Los Angeles)	Stram *et al*. (2000)[5]
Afro-Caribbean British combined PSEE for FFQ, including food models of traditional, commonly consumed	1 & 3-Dimens. tools (estimated size and/or volume; unit	Indirect measurement by comparison of food model vs. habitual portion size	Does not correspond with a published PSRS	Portion size estimation as part of Afro-Caribbean FFQ	British Afro-Caribbean, free living adults	Sharma *et al*.(2002)[6]

[a] The Hawaii-Los Angeles Multiethnic Cohort Study of diet and cancer is a prospective follow-up cohort study of over 215,000 adults who completed a mailed survey instrument that included a quantitative FFQ designed to assess typical food intake of adults from five principal ethnic groups—African-Americans, Japanese-Americans, Latinos, Native Hawaiians, and Whites—living in Hawaii and Los Angeles, California.

Afro-Caribbean foods; stainless steel serving spoons, soup dishes and number of units (i.e. 1 egg; 1 slice of bread)	numbers)	(e.g. "equal amount"; "half as much"); n. of household measures (e.g. how many Tbsp) for West Indian soup dishes; n. of units vs. one shown (e.g. how many slices)				
Arab Food Guide Dome Diagram based on dietary guidelines for the Arab countries, including suggested number of daily servings of main food groups with examples of what a serving is	2-Dimensional (pictures and list of weights for selected foods)	Indirect measurement (comparison to given amount e.g. 30g of cornflakes; household utensil i.e. 1 cup milk; natural units i.e. a slice of bread)	Does not correspond to a published PSRS. Serving sizes (portion sizes) reported to be similar to those in developed countries	General dietary guidelines for healthy eating	Arab people living in Arab countries or elsewhere	Musaiger (2012)[7]
Black American/US Food Atlas Book containing 3 different ''life-size'' portion photographs for more than 100 most frequently consumed foods in the US[8]	2-Dimensional tool (estimated volume)	Indirect measuring (comparison of usual portion to amount shown on 3 different life-size portions for 12 foods); fruit and veg. intake and beverages were assessed via piloted questionnaire[9]	American Dietetic Association/USDA Guidelines 2005[10,11]	Dietary assessment in general US population	Black American Women taking part in a weight loss intervention	Gans *et al*. (2009)[12]
Chinese American combined PSEE for Diet Habits Survey (DHS) incl. portion lists, food models and list of sample foods (including names of kinds of food, amount of food and	1 & 3- Dimens. tools (estimated weights and volumes)	Indirect measuring by comparison to model (e.g. 3 oz. of chicken, pork, beef); cup of rice; noodles; cup of veg.; fruits; slice of	No data available on PSRS; portions mentioned for meat and veg. match American Diabetes Association/USDA	Assessment of dietary behaviour as part of a survey used for a health promotion intervention[c]	Chinese-American college students	Sun *et al*. (1999)[13] Connor *et al*. (1992)[14]

[c] The survey had 4 sections of which section 4, the Diet Habits Survey, assessed dietary behaviour by asking about 38 items, including (i) meat, fish and poultry; (ii) dairy products and egg; (iii) fats and oils; (iv) sweets and snacks; (v) grains, beans, fruits and vegetables; (vi) beverages; (vii) salt; and (viii) restaurant foods. The other 3 sections of the survey covered predisposing factors, including nutritional knowledge and perceptions of diet and health; enabling factors, including dietary instruction; and reinforcing factors, including media influence and social support.

seasonings on the food)		pizza; serving of hamburger, hot dog; sandwich, salad, French fries, others); lists of portion sizes	portion size scheme Original DHS used household utensils, natural units, oz. and qualitative descriptors[b] some matching USDA portion sizes			
Chinese American combined PSEE for FFQ (Willett adapted), incl. ref. portion size list plus open ended question for n. of portions per dish (only for foods consumed more than 1 x week); actual size food models for traditional Chinese dishes and dish components)	1 & 3-Dimens. tools (weight in oz; household measure or unit number; estimated volume)	Indirect (participants asked to describe usual portion size as a multiple or fraction of the ref. portion during an interview; comparison with food model type & amount as prompted by interviewer)	Portion sizes chosen to match commonly consumed amounts (see entry under Nath & Huffman)[15]	Portion size estimation as part of semiquantitative FFQ	Chinese American women from San Francisco (USA)	Lee *et al*. (1994)[16]
Cuban American FFQ (Willett) FFQ including reference portion size list plus open ended question for portion size of non-listed foods	1-Dimensional (weight or unit number)	Indirect (comparison to reference portion weight or unit number)	Portions based on customary portions[17], natural units (e.g. 1 slice of bread); household units (8 oz. glass); and from authors' experience	Portion size estimation as part of semiquantitative FFQ	Cuban American adults residing in Miami	Nath and Huffman (2005)[15]
Indian British combined PSEE for 24 h recall incl. food models for meat pieces and chapattis (150, 200 and 250 mm (6, 8 and 10 inch); household utensils (cups, glasses and spoons of various sizes)	3-dimensional tools (estimated volume)	Indirect measuring (by comparison to displayed or measured volume from various sizes of cup, glass and spoon; questions used for	Information on PSRS not available	To help quantify portion sizes during 24 h recalls in pregnant women from India, recently moved to the UK	Pregnant women from India living in Birmingham, UK (2nd-3rd trimester); clinic setting	Eaton *et al.* (1984)[18]

[b] Examples of qualitative descriptors included "average" [amount], "typical amount", "1/2 typical amount", "lightly spread (can see the bread through it)", "scrape (can barely see the spread)"; household units included cups, tablespoons, teaspoons; bowl; natural units included number of visible" eggs, number of slices, rolls, pancakes; volumes in ounces were given for a can of soda, Espresso coffee drinks and alcoholic drinks (SL Connor, *personal communication*).

		shared meals, e.g. cooked to serve 10-12 people)				
Indian British food scales (for weighed 3 day food diary); table compression scales or hand-held extension spring scale used, plus accompanying utensils (e.g. measuring jug)	3-dimensional tool (actual weights)	Direct measuring	No information available on PSRS	To help quantify portion sizes during 24 h recalls in pregnant women from India, recently moved to the UK	Pregnant women from India living in Birmingham, UK (2nd-3rd trimester); setting was in own home	Eaton *et al.* (1984)[18]
Multi ethnic combined PSEE for FFQ (Block modified); SWAN study FFQ with 3 portion size options i.e. 'small', 'medium' or 'large portion' based on a reference 'medium' portion; and food models	1 & 3-Dimens. tools incl. portion size list and 3-D food models (estimated size)	Indirect measurement (comparison to reference portion size shown in ounces, size (e.g. 'medium' orange), household measures (e.g. 1/3 cup) or units (e.g. 1 slice)	Medium ref. portion set as the median gram weight of portion sizes in NHANES II, with 50 percent of the medium defined as small and 150 percent as large	Dietary assessment of American multi-ethnic female population incl. African Am., Caucasian, Chinese, Japanese, and Hispanic. across 7 sites in US (20-52 year olds)	Block questionnaire is designed for US; current version was modified to include 16 Japanese and 12 Chinese ethnic foods in addition to the 103 core foods; FFQ administered in person by trained interviewers	Hu *et al*. (2009)[19]
Pakistani & White European[d] combined PSEE for 3 d food diaries incl. household measures, volume models; pack sizes; actual weights (scales)	1 & 3-Dimens. tools (estimated volumes and sizes)	Indirect & direct measurements (estimated portions based on household measures, volume models and pack sizes; actual weights measured by research staff or based on customarily consumed amounts)	For the customarily consumed amounts, the FSA reference scheme was used (Crawley, 1988)[11]	Food diaries used for the development of Pakistani and White European FFQs	Pakistani and White European migrants living in central Manchester, U.K. Trained interviewers assisted in completion of food diary in participant's home	Vyas *et al*. (2003)[20]

[d] The authors also report the use of a previously developed African-Caribbean FFQ in the same study, which has been entered separately under Sharma *et al*. (2002)[3].

Pakistani & White European food models for FFQ[11]	3-Dimensional tool (estimated volume)	Indirect measurement (comparison of usual amount to portion model)	No information on PSRS	To report nutrient intakes and explore under-reporting in Pakistani, White European and Afro-Caribbean migrants (separate FFQs used, see Sharma *et al*. 2001)[21] in the U.K.	Pakistani and White European migrants living in central Manchester, U.K., from larger internat. survey of risk factors for diabetes and hypertension Trained interviewers assisted in filling in FFQ at GP practice	Vyas *et al*. (2003)[20]
Puerto Rican American combined PSEAs for FFQ (Block modified); FFQ with open ended question for portion size and food models	1 & 3-Dimens. tools incl. portion sizes list; NASCO food models[22] and household utensils such as cups, Tbsp. (estimated volume)	Indirect measurement (comparison to food model or household utensil volume; for foods coming in natural units, number of units was also used)	Information not available (replica models assumed based on USDA)	Dietary assessment of Puerto Rican and other Hispanic and non-Hispanic White populations living in the NE of the USA, as part of the Massachusetts Hispanic Elders Study	May be adaptable for assessing dietary intake of Caribbean populations in the UK provided that food lists and portion sizes are representative	Tucker *et al*. (1998)[23]
South Asian British & Italian British food scales (for weighed 7 day food diaries, complemented with household measures)	3-dimensional tool (actual weight)	Direct measurement technique (all foods)	Weights were not compared to any reference scheme (used for nutrient analysis only)	Comparison of diet between 1st and 2nd generation migrants from SA and Italy, and general UK population living in Scotland	Free-living, migrant and control women from the general population of Greater Glasgow, UK; interviewed in their own homes	Anderson *et al.* (2005)[24]
South Asian British food photographs (section of food atlas) 8 colour photographs of	2-dimensional tool (estimated size)	Indirect measuring of ethnic foods (e.g. curry dishes)	1 portion size used for unit foods (e.g. egg, slice). For non-traditional foods,	FFQ development for SA women from the largest South Asian	Women from SA ethnic minorities living in the UK	Kassam-Khamis *et al*. (1999)[27]

traditional SA foods/dishes from Nelson *et al*., 1994, 1996[e] on everyday crockery			average portion sizes derived from MAFF (1994)[25], based on Gregory *et al*. (1990)[26]	communities in Britain (Gujarati Hindus, Punjabi Sikhs, Pakistani Muslims, Bangladeshi Muslims)	To be used in the volunteers' homes via a translator	
South Asian British food photographs Colour photographs of 10 traditional foods and dishes (for FFQ and 24 h recall, already based on household measures)	2-dimensional (estimated size)	Indirect measuring of ethnic foods (veg. curry; cereal; biryani; chicken curry; dhal; fruit salad; keema; palak; rice; soup)	No information on PSRS	Dietary assessment of SA children (FFQ to be used by mothers)	UK South-Asian community (Indian and Pakistani mothers and children) For home use	Husain and Khokhar (2011)[28] Garduño-Diaz *et al*.(2014)[29]
South Asian British food scales (for weighed 4 day food diary)	3-dimensional tool (actual weight)	Direct measurement technique (all foods)	Weights compared to standard MAFF portions[11].	Development & validation of dietary assessment methods for SA community living in the UK	UK South-Asian community only Home and out-of-home	Karim (1997)[30]
South Asian British serving spoon and table spoon portion size guide Coding and portion size manual developed for South Asian foods using serving spoons and tablespoons commonly used by South Asians	1-dimensional tool (list of weights)	Weighed food amounts (average weight of Tbspoon and serving spoon of various meat, vegetable and rice dishes) used to calculate portion size for each recipe	Not matched to any published PSRS (based on field data)	Used as part of 24 h dietary recalls in the validation of a South-Asian FFQ (see entry for Kassam-Khamis *et al*.1999)[27].	South Asian population living in the UK	Sevak *et al*. 2004[31]
South Asian Canadian FFQ Ethnic FFQs with portion size fraction list designed for South	1-Dimensional (estimated volume)	Indirect (comparison to given amount for a medium portion, half	Does not correspond with a published PSRS	Portion size estimation as part of quantitative	South Asian, Chinese, and European	Kelemen *et al*. (2003)[32]

[e] Each set of 8 photos illustrates portion sizes ranging between the 5th - 95th percentiles of distribution of portion sizes observed in the British Adult Dietary survey from1990 (Gregory et al., 1990)[23]. Dishes were photographed with crockery most commonly associated with that dish i.e. rice, meat, vegetable & bean curries on a plate, and dhal in a bowl.

Asian (37% unique food items) and for Chinese (33% unique food items) migrants in Canada (CSDLH)		a medium portion ("small"), or 1.5x or more a medium portion ("large")		FFQ	immigrants to Canada	
South Asian Canadian portion size pictorial guide Developed by the Canadian Diabetes Association	2-dimensional tool (colour drawings incl. measurements in inches, cups and natural units (e.g. Paratha 6"; Raita ¾ cup; mango ½ of 1 medium)	Indirect measurement (comparison to image and size given for grains & starches; fruits; legumes; desserts; snacks; vegetables; protein & fat groups)	Does not correspond with a published PSRS. Portion sizes derived from focus groups with South Asian community in Southern Ontario plus wide range of literature	To facilitate diabetes/nutrition counselling for migrants from SA regions (India, Pakistan, Sri Lanka & Bangladesh) living in Canada	Food range not representative of all foods commonly consumed by all SA migrants, as there are wide variations in diets	Brauer and Mian (2006)[33] http://www.diabetes.ca/clinical-practice-education/professional-resources/food-nutrition-tools-for-south-asian-populations
South Asian Norwegian and other ethnicities health questionnaires (OIHS) Weights & volume lists for beverages (alcoholic and non-alcoholic); units of bread; staples; sugar	1-dimensional (list of weights and volumes; units)	Indirect measurement (choice of amount with frequency e.g. '1-6 glasses/week for drinks'; n. of daily cups of coffee/tea; glasses of alcoholic drink per occasion; n. of bread slices/day; proportion of the whole meal as staple i.e. rice, chapatti, potatoes; amount of sugar in cubes, sweets or spoons per day)	Does not correspond to a published PSRS but questions on food habits piloted in one of the ethnic groups to make it culturally appropriate	Dietary assessment in large cross-sectional study conducted in Norway in 2002	Adult and children (15-76 y) Pakistani, Turkish, Sri Lankan, Iranian and Vietnamese migrants living in Oslo	Norwegian Institute of Public Health (2005)[34] Kumar and Meyer (2002)[35]

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Table S2. Effectiveness, validation and generalisability of portion size estimation elements (PSEE) identified across 22 publications referring to major migrant groups in the UK, or related groups elsewhere.

Abbreviations: CHO = carbohydrate; CSDLH = Canadian Study of Diet, Lifestyle and Health; Corr. coeff. = correlation coefficient; FFQ = food frequency questionnaire; IRAS = Insulin Resistance Atherosclerosis Study; NCI-HHHQ = National Cancer Institute Health Habits and History Questionnaire; OIHS = Oslo Immigrants Health Study; PUFA = polyunsaturated fatty acid; PSEA = portion size estimation aid; PSRS = portion size reference scheme; SA = South-Asian; SHARE = Study of Health Assessment and Risk in Ethnic groups (Canada); SWAN = Study of Women's Health Across the Nation; Tbsp. = tablespoon).

PSEE name and description	Tool efficacy	Relevance	Validity and reliability measures	Feasibility measures	Generalisability	Reference
African American and other ethnicity FFQ (NCI-HHHQ/Block modified) Semiquantitative FFQ with 'small', 'medium' or 'large' options; modified to include ethnic & regional food choices	Able to assess minority ethnic group's diet and control group in same study but educational level to be considered Reasonable valid and reliable for most nutrients	Relevant for the target populations; includes a number of ethnic foods which improves sensitivity although estimates are generally higher for micronutrients than with 24 h recalls	Validated against 8 x 24 h recalls; PSEA used for 24 h recall (previously piloted visual aids mailed to participant) Sig. corr. coeff. for most nutrients (mean *r* =0.41-0.62 (0.50 for African American 0.30 for those with <12 y of education). Reproducibility for nutrients was good and equal across groups (mean r=0.42 for energy-adjusted nutrients)	Cheap & simple to administer (via telephone); requires trained interviewer; low respondent burden	Specific for Hispanic, & African Americans populations but may be adaptable to related groups Allows comparison with non-Hispanic whites (USA) so may be applicable to other countries (i.e. Europe, Canada, Australasia)	Mayer-Davis *et al*. (1999)[1]
African American and other ethnicity food photographs of selected foods shown in 3 portion sizes, part of quantitative FFQ for American ethnic minority groups	Comparable to 24 h recalls in all ethnic groups for nutrient densities and absolute nutrient values but requires adjusting for energy intake	Relevant across various ethnicities	FFQ first version incl. photos previously validated against four 7-day estimated food records in White, Native Hawaiian, Japanese, Chinese, and Filipino migrants[2] Current version calibrated	Photograph method is cheap and simple to administer; low respondent burden	Generalisable within ethnic minorities or related background (e.g. African origin); however may vary with education level and culture Not applicable to UK main Asian groups	Stram *et al*. (2000)[3] Hankin *et al*. (1991)[2]

			for ethnic minorities using 24 h recalls (highest correlations for Whites and lowest for African Am. In unadjusted models);		but may be adaptable to other groups e.g. Afro-Caribbean	
Afro-Caribbean British combined PSEE for FFQ, including food models of traditional, commonly consumed Afro-Caribbean foods; stainless steel serving spoons, soup dishes and number of units (i.e. 1 egg; 1 slice of bread)	Able to identify differences in the nature, frequency and amount of foods consumed by Afro-Caribbean vs. by White population	Relevant for both study population and target outcome	Validated as part of FFQ against Schofield equations – see entry for Vyas *et al*. (2003)[4]	Feasibility measures not reported however tool is transportable and affordable Needs to be demonstrated by trained staff to avoid biased answers	Specific to the Afro-Caribbean population living in the UK	Sharma *et al*. (2002)[5]
Arab Food Guide Dome Diagram based on dietary guidelines for the Arab countries, incl. suggested n. of daily servings of main food groups with examples of what a serving is	Efficacy not measured	Specific for Arab diets Portion sizes given as 'serving' with quantities for selected foods	Not validated	Cheap and simple to administer; low respondent burden	Applicable to migrants of Arab culture	Musaiger (2012)[6]
Black American/US Food Atlas ''Life-size'' portion photographs for frequently consumed foods in the US	Tool effective in comparing intake against USDA recommended serving sizes for cake, cheese, chips, ice-cream, fried chicken, burger, red meat, pasta dishes,	Designed for general US population but applicable to African Am. as this group is one of the largest migrant Black groups	PSEE piloted but not validated in the study; moderate face validity based on association between portion size score and BMI ($r=0.19$; $p<0.001$)	Simple to administer, low literacy level required; relatively costly (~$100/atlas)	Applicable to multi-ethnic populations although foods included are typical from US	Gans *et al*. (2009)[7]

	bread and butter, salad dressing; broccoli/veg					
Chinese American combined PSEE for Diet Habits Survey (DHS) incl. portion lists, food models and list of sample foods	Effective in assessing diet changes during a community intervention when both tools used in combination	Relevant for both study population and target outcome; includes Western-type foods commonly consumed by college students	PS instrument validated before as part of the Diet Habits Survey vs. a 24 h recall, including reliability tests (Connor *et al*., 1992)[8] Reliability tested in 30 Chinese students in the Chinese version (correl. coeff. 0.72-0.82 for entire survey)	Food models easy to use but require trained staff; Diet Habit Survey is 32 items long; some questions require computation to estimate portion size (e.g. total oz in 4 cans of soda)	Originally developed for the general American population and tested with Chinese-American college students; adaptable to other groups by including ethnic foods	Sun *et al*. (1999)[9] Connor *et al*. (1992)[8]
Chinese American combined PSEE for FFQ (Willett adapted), incl. ref. portion size list plus open ended question for n. of portions per dish; traditional dishes food models	Combination PSEE incl. bespoke food models, allows flexibility in assessment Full method not precise for nutrient intake assessment but able to rank individuals across relative levels of intake	Relevant for target outcome (includes wide range of shapes for traditional dish components) 18% of respondents were American-born	Validated vs. typical day diet record[1] in 74 middle-aged Chinese women participating in larger population study Corr. coeff. 0.21 to 0.66 (lowest for total fat; highest for Ca); FFQ misclassified 10% of subject vs. typical day record by quartile method	Relatively feasible however requires construction of bespoke food models and compilation of typical portion sizes	Specific for Chinese population; requires adaptation for application to other groups	Lee *et al*. 1994[10]
Cuban American FFQ (Willett)	Intakes correlated moderately with	Relevant for this specific Caribbean	Compared with 3 day estimated food records, it	Long to complete (24	Developed for American	Nath and Huffman (2005)[11]

[1] Respondents are asked to think about everything they eat and drink since they get up to when they go to bed for one day over the past month, but not linked to a specific day as in the 24 h recall. Cited: "a typical day's diet may present a more usual dietary pattern than a single 24-hour recall. In fact, due to measurement errors, several multiple 24-hour diet records are needed to represent a "true" usual intake (Lee *et al*., 1994)[10].

FFQ including reference portion size plus open ended question for portion size of non-listed foods	unweighed food records (best for PUFA and worst for protein)	group and for the general American population (for whom this FFQ was originally developed)	estimates intakes for energy, CHO, fats and alcohol similarly. No correlation for protein and cholesterol (may underestimate)	pages, 131 items) but allows automatic processing	population; may require optimisation in the portion size estimation component for wider application	
Indian British combined PSEE for 24 h recall incl. food models for meat pieces and chapattis; and household utensils	Allowed identification of low nutrient intake in socially deprived pregnant women - results in the recall method were generally a little below those obtained by 3 d weighed food record	Relevant for target population and outcome	Household utensil part previously validated and tested for reliability in 7 day estimated food records (Edington *et al*., 1989)[12] – see text for details	Low complexity, does not require literacy; quickly conducted compared with food records	Widely applicable to any groups	Eaton *et al.* (1984)[13]
Indian British food scale (for weighed 3 day food diary) plus accompanying utensils (e.g. measuring jug)	Allowed identification of low nutrient intake in socially deprived pregnant women	Relevant for target population as using specific ingredients and recipes; requires degree of literacy though	Published protocol (assumed validated) followed[2]; reliability measures conducted (data not available)	Requires a degree of literacy & skill plus considerable time; specific utensils needed for certain foods (e.g. curries)	User needs to be able to operate equipment and understand instructions	Eaton *et al.* (1984)[13]
Multi ethnic combined PSEE for FFQ (Block modified); SWAN study FFQ with 3 portion size options i.e. 'small', 'medium' or 'large portion' based on a reference	Combination tool effective for evaluation of dietary glycaemic load and dietary glycaemic index in a multi-ethnic population	Applicable to target outcome (glycaemic profile) but also for general dietary assessment; relevant for Japanese and	Based on a previously validated questionnaire (Block FFQ, validated against a 24 h recall)[14]	Allows automatic processing; low respondent burden; requires trained interviewers	May be adaptable to related groups beyond US e.g. Japanese and Chinese Americans	Hu *et al*. (2009)[15]

[2] Cited: "The precise weighing technique set out in ***Human Biology, a Guide to Field Methods*** (International Biological Programme, 1969) was modified to suit the conditions found, e.g. it was rarely possible for a woman to keep her own daily supply of butter or milk separate from the household stock so her intake of such items had to be measured at each meal."

'medium' portion; and food models		Chinese Am. but not specific for African American & Hispanic				
Pakistani & White European[3] combined PSEE for 3 d food diaries incl. household measures, volume models; pack sizes; actual weights (scales); food models for FFQ	Combination tool used effectively for the development of ethnicity-specific FFQs; food models used in FFQ effective for micronutrient intake but participant underreported energy intake	Relevant across various ethnicities for the target outcomes	Combination PSEA not validated per se however household measures validated before (Edington *et al*.,1989)[12] FFQs validated using Schofield equations; mean ratio of energy intake to predicted BMR =1.03 for overall sample incl. Afro-Caribbean; 74% of men and 78% of women underreported energy (more in higher BMI groups)	Combined PSEA is cheap and portable; FFQ is quick and easy to administer; but both techniques required assistance from trained staff	Combination tool effective for FFQ development stages Use of food models alone in FFQ may not be sensitive enough as energy was underreported across all ethnic groups	Vyas *et al*. (2003)[4]
Puerto Rican American combined PSEAs for FFQ (Block modified); FFQ with open ended question for portion size and food models	Allows assessment of minority ethnic group's diet and of control group in same study Including open-ended portion questions yielded estimates closest to 24 h recall means for all nutrients except vitamin B_{12}	Relevant to measure Hispanic dietary intake in comparison with non-Hispanic Whites; food lists and portions are very specific to Puerto Rican groups though	Based on a previously validated questionnaire (Block FFQ)[14] Calibrated using 24-hour recalls from 90 elderly Hispanics and 35 elderly non-Hispanic whites in 3 towns in the NE of USA	Cheap & simple to administer; low respondent burden	Specific for Hispanic populations but may be adaptable to related groups (e.g. Caribbean) Allows comparison with non-ethnic group diet so may be applicable to other countries (i.e. Europe, Canada, Australasia)	Tucker *et al*. (1998)[16]
South Asian British &	Allowed	Relevant for certain	Normally used as gold	Participant	Applicable to all	Anderson *et al*.

[3] The authors also report the use of a previously developed African-Caribbean FFQ in the same study, which has been entered separately under Sharma *et al*. (2002)[5].

Italian British food scales (for weighed 7 day food diaries, complemented with household measures)	identification of differences in nutrient intakes between migrant groups and general UK population	groups only (requires degree of skill and literacy for completing food diary)	standard technique	burdensome; requires trained staff to administer and process data	groups as long as able to operate equipment, understand and follow instructions	(2005)[17]
South Asian British food photographs (section of food atlas) 8 colour photographs of traditional SA foods/dishes from Nelson *et al*., 1994[18], 1996[19] [4] on everyday crockery	Photographs used successfully to develop a SA-specific FFQ (validity and reliability tested)[5]. Volunteers easily found the eaten portion size	Instrument relevant for target outcome only	Previously validated (Nelson's Food Atlas)	Low complexity (simple, easy to administer, low cost; low respondent burden; no language barriers); currently applied to dietary surveys	Generalisable within ethnic minorities	Kassam-Khamis *et al*. (1999)[20]
South Asian British food photographs Colour photographs of 10 traditional foods and dishes (for FFQ and 24 h recall, already based on household measures)	Photographs used successfully to improve estimations of average weekly intakes based on FFQ/24 h recalls using household measures only	FFQ relevant for SA population studies that include more sensitive methods e.g. 24 h recalls, as a complement; photos could be applied to both FFQ and 24 h recall	FFQ not validated Estimated weight of 10 ethnic items using food photographs was accurate in 83% of comparisons vs. actual weight (n=36 women; 360 estimations) Reliability measures not reported	Easy to produce tool, applicable to various methods e.g. FFQ and 24 h recall	Specific for SA, tested in Indian and Pakistani women only	Husain and Khokhar (2011)[21] Garduño-Diaz *et al*. (2014)[22]
South Asian British food scales (for weighed 4 day food diary)	High accuracy but low effectiveness when weights	Low relevance (not targeted for those with low literacy	Used as gold standard in validation of FFQ, 24 h recall and food check list	Cheap to administer but complex to	Adaptable to other ethnic groups provided training is	Karim (1997)[23]

[4] Each set of 8 photos illustrates portion sizes ranging between the 5th - 95th percentiles of distribution of portion sizes observed in the British Adult Dietary survey from1990 (Gregory *et al.,* 1990)[30]. Dishes were photographed with crockery most commonly associated with that dish i.e. rice, meat, vegetable & bean curries on a plate, and dhal in a bowl.

[5] When compared with weighed food records, average nutrient intakes from the FFQ were slightly higher but the methods agreed for % energy intake from macronutrients (less so for absolute nutrient intakes). Additional validation results reported in Sevak *et al.,* (2004)[22].

	incorporated into food diary due to underreporting and high drop-out	level or non-English speaking)		process; burdensome for participants	given	
South Asian British serving spoon and table spoon portion size guide Coding and portion size manual developed for SA foods using serving spoons and tablespoons commonly used by SA	High accuracy. Integrated in 24 h recall methods used as 'silver standard' in validation studies	Specific for target population and outcome	Not validated (used as part of 'silver standard' method) for the validation of a FFQ in 100 SA women	Low user complexity, easy to apply; requires considerable resources for development	Applicable only to South Asian population living in the UK	Sevak *et al*. 2004[24]
South Asian Canadian FFQ Ethnic FFQs with portion size fraction list designed for South Asian and for Chinese migrants in Canada (CSDLH)	Reasonable valid and reliable for nutrients but measurement error detected for dietary fat in the Chinese FFQ	Relevant for the target populations as included good proportion of unique foods for each culture Useful for population studies or to rank persons into broad categories of intake but not accurate for individual intake	Validated in subset of 342 SA and 317 Chinese participating in SHARE Compared with 7 d estimated food records FFQs underestimated macronutrient and overestimated micronutrient intake. Low energy-adjusted corr. coeff. for dietary fats in Chinese (0.17-0.31). Intraclass corr. coeff. for reliability 0.33-0.89	Cheap & simple to administer; low respondent burden but requires processing time Memory bias possible	Generaliseable to other South Asian and Chinese immigrants to North America, UK & other countries of migration	Kelemen *et al*. (2003) [25]
South Asian Canadian portion size pictorial guide Developed by the Canadian Diabetes Association	Efficacy not measured/ reported	Relevant for South Asian diets (not all portion sizes available due to lack of info at the time of developing)	Not validated Reliability not measured	Method is cheap and simple to administer; low respondent burden	Applicable to SA minority groups represented in focus groups (see Table 1)	Brauer and Mian (2006) [26]

South Asian Norwegian and other ethnicities health questionnaires (OIHS) Weights & volume lists for beverages (alcoholic and non-alcoholic); units of bread; staples; sugar	Used to identify links between lifestyle factors and mental health in Norwegian migrants	Adapted to identify dietary acculturation in a variety of ethnic groups including Pakistanis	Food frequency questions validated in Norwegian adults but not in ethnic minorities; previously piloted in 130 Pakistanis and revised	Simple to complete; available in native languages; piloted amongst local migrants	Applicable to other ethnic minority groups consuming similar foods (e.g. CHO-rich staples)	Norwegian Institute of Public Health[27] Wandel *et al*. (2008) [28] Dalgard *et al*. (2006)[29]

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Table S3. Quality evaluation of published sources reporting portion size estimation elements (PSEE) applied to major migrant groups in the UK, or related groups elsewhere.

Abbreviations: CHO = carbohydrate; CSDLH = Canadian Study of Diet, Lifestyle and Health; FFQ = food frequency questionnaire; IRAS = Insulin Resistance Atherosclerosis Study; NCI-HHHQ = National Cancer Institute Health Habits and History Questionnaire; OIHS = Oslo Immigrants Health Study; PSEA = portion size estimation aid; PSRS = portion size reference scheme; SA = South-Asian; SHARE = Study of Health Assessment and Risk in Ethnic groups (Canada); SWAN = Study of Women's Health Across the Nation; Tbsp. = tablespoon).

PSEE name and description	Target population	Study design	Study design evaluation	Outcomes evaluation	Other strengths/ limitations	Reference
African American and other ethnicity FFQ (NCI-HHHQ/Block modified) Semiquantitative FFQ with 'small', 'medium' or 'large' options; modified to include ethnic & regional food choices	Culturally diverse populations incl. Hispanic & African Americans; non-Hispanic white women	Development and validation study of IRAS FFQ (modified from NCI-HHHQ to include ethnic & regional food choices based on experts' advice and field data) in non-Hispanic White, Hispanic & African Am. women	Only women tested in the validation study; 1st FFQ administered in person and 2nd via telephone, may introduce error; long-period between test and re-test (2-4 y), diets may change Reasonable total sample size n =186 (but small sub-group sample, n~60)	IRAS FFQ reasonably valid and reliable in a diverse cohort but low agreement with 24 h recall for those with low level education (mostly Hispanics)	Portion size assessment method may not be sensitive enough (only 3 options for size included and based on social norms; no PSEA used); not known if works equally in men	Mayer-Davis *et al*. (1999)[1]
African American and other ethnicity food photographs of selected foods shown in 3 portion sizes, part of quantitative FFQ for American ethnic minority groups	Aimed at USA ethnic groups incl. African-Americans, Japanese-Americans, Latinos, Native Hawaiians, and Whites	Development and calibration study to examine suitability of FFQ for ethnic minority groups in USA. Three unannounced 24 hr recalls used with 1 pre- and 1 post-recall FFQ Food lists based on 3 day weighed food diaries	Results comparable to EPIC study pilot phase Large sample size n=1,570 completed 3 recalls & 2nd QFFQ (n=123 to 264 per ethnic-sex group) for calibration sub study	Performance of the FFQ varied by ethnic Group (most suited for White females), sex, BMI and education level Underreporting detected and correlated in FFQ and 24h recall used to calibrate it	Self-administered; could be completed with less than high school education Covered many compositions of ethnic dishes but focused on USA minorities Study over 4 years – diets may not be comparable	Stram *et al*. (2000)[2] Hankin *et al*. (1991)[3]
Afro-Caribbean British combined	British Afro-Caribbean, free	Testing of dietary assessment tool for	FFQ food list may not be comprehensive as based	Measuring utensils validated within FFQ	Trained interviewers	Sharma *et al*. (2002)[4]

PSEE for FFQ, including food models of traditional, commonly consumed Afro-Caribbean foods; stainless steel serving spoons, soup dishes and number of units (i.e. 1 egg; 1 slice of bread)	living adults	Afro-Caribbean adults living in the UK	on 2-day food diaries & foods contributing most to energy and macronutrients	vs. predictive energy requirement equations Both West Indian and European foods included	Good sample size (n=210)	see also entry for Vyas *et al*. (2003)[5]
Arab Food Guide Dome Diagram based on dietary guidelines for the Arab countries, including suggested number of daily servings of main food groups with examples of what a serving is	Designed for those of Arab culture living in native country but applicable to migrants	Dietary guidelines position paper	Takes into consideration culture and religious background Needs testing to see if target population understand the message delivered by the food dome	Not applicable	Cheap, portable and reproducible Not clear on what evidence portion size data are based No data on effectiveness or application	Musaiger (2012)[6]
Black American/US Food Atlas Book containing 3 different ''life-size'' portion photographs for more than 100 most frequently consumed foods in the US	Obese black American women participating in weight loss trial (including African Am. and other Black ethnicities such as West Indian; Cape Verdean)	Assessment of dietary behaviours and portion sizes compared with USDA recommended serving sizes	Large sample size but considerable drop-out (~100 participants from 461 at baseline) Food atlas includes popular food portions shown in user friendly format	Only 3 portion size options in food atlas (low sensitivity?); fat used in cooking not assessed; not powered to examine ethnic sub-group differences	Tested in Black ethnic women from Boston with health oriented behaviour; may not apply to all SES groups (those without a cable TV and video recorder were excluded)	Gans *et al*. (2009)[7]
Chinese American combined PSEE for Diet Habits Survey (DHS) incl. portion lists, food models	Chinese-American college students in New York city	Community health promotion intervention Original Diet Habits Survey portion sizes	Broad scope behaviour change intervention based on recognized theoretical model	Wide range of outcome measures not limited to dietary intake (e.g. dietary perceptions; media	Representative sample size for Chinese college population (n=218)	Sun *et al*. (1999)[8] Connor *et al*. (1992)[9]

and list of sample foods		based on experts' knowledge	Dietary assessment component based on validated/reliable method Available in Chinese	influence; social support) Diet assessment tool focused on fat intake	Limited information on PSRS especially for list of sample foods	
Chinese American combined PSEE for FFQ (Willett adapted), incl. ref. portion size list plus open ended question for n. of portions per dish; traditional dishes food models	Chinese women living in San Francisco (USA) participating in larger epidemiological study (82% foreign born)	FFQ development and validation study Food models used in both FFQ development and validation study (as part of typical day's diet method) Food list developed from Willett's FFQ; informal interviews In community and direct observation in Chinese food supermarkets	Typical day diet record taken on same day as FFQ randomly before or after the FFQ Measurement error likely high as both methods depend on memory; also used same PSEA (systematic error); applied on same day (reporting bias)	Moderate agreement and correlation found between FFQ and comparison method (likely due to measurement error) Validated only in women (n=74)	USDA nutrient database used was based on historical data (not representative of current dishes at the time)	Lee *et al*. 1994[10]
Cuban American FFQ (Willett) FFQ including reference portion size plus open ended question for portion size of non-listed foods	Cuban Americans residing in Miami (USA)	Validation of the Willett FFQ in Cuban Americans against estimated 3-day food records. Pictures of standard portion sizes were used as portion estimation aids for the food records	Small sample size (n=20), mostly women Food records used estimated portion sizes	Adjusting for energy did not change correlation coefficients except for CHO (became significant)	Tool needs to be optimised for accurate measure of all nutrient intakes in this ethnic group	Nath and Huffman (2005)[11]
Indian British combined PSEE for 24 h recall incl. food models for meat pieces and chapattis; and household utensils;	Indian pregnant women of poor background, participating in a protein-energy supplementation trial in the UK	Women completed either a 3 day, weighed food record during 18-38th weeks; and/or had a 24 h recall (to complement food record information);	Published, precise protocol followed for weighing; dietitian present when participant was illiterate or did not speak English Reasonable sample	Illiteracy and inability to speak English limited n. of food records Some meals weighed in duplicate for	Detailed questioning used to ascertain portions for shared meals, drinks, and foods measured in spoons	Eaton *et al.* (1984)[12]

food scale with accompanying utensils (e.g. measuring jug) used for 3 day food diary		pregnancy-related increases in intake noted	reached despite drop-out and non-response (n=17 food records; n=72 recall method)	verification Interpreters used	Some of the recall women came from East Africa	
Multi ethnic combined PSEE for FFQ (Block modified); SWAN study FFQ with 3 portion size options i.e. 'small', 'medium' or 'large portion' based on a reference 'medium' portion; and food models	Multi-ethnic population in the US, including Caucasian controls	Observational study describing the intakes and correlates of dietary glycaemic parameters using year 5 data from the SWAN study	Used widely validated FFQ; nationally representative sample (n=2025); food list for the Chinese & Japanese FFQs based on focus groups and 24-hour recall data FFQs available in native languages	Considerable sample of ethnic groups (27.8% African Am., 10% Chinese; 11% Japanese) No information on food models actually used	Tools designed for dietary assessment of ethnic group and control in same study; results applicable only to women (42-52 y old)	Hu *et al*. (2009)[13]
Pakistani & White European[1] combined PSEE for 3 d food diaries incl. household measures, volume models; pack sizes; actual weights (scales); food models for FFQ	Multi-ethnic population aged 25–79 y incl. 86 White European (28% Irish); 246 Afro-Caribbean; and 84 Pakistani men and women living in central Manchester, UK; some low income families	Cross-sectional survey assessing nutrient intakes and underreporting in 3 different ethnic groups from Manchester, UK	FFQ piloted in 20 participants from each ethnic group Portion sizes for male and females obtained from focus groups as well as recipe data Small sample sizes in some gender groups and in pilot study	Thoroughly developed food lists and portion size information for FFQs; however high under-reporting rates especially in those with higher BMI incl. Pakistani women (may require special training)	Difficulties in portion size assessment; grouping of mixed dishes on FFQ; incomplete food composition tables; potential under-reporting & omission of some food items European FFQ may not be representative of all countries (e.g. East European)	Vyas *et al*. (2003)[5]

[1] The authors also report the use of a previously developed African-Caribbean FFQ in the same study, which has been entered separately under Sharma et al. (2002)[4].

Puerto Rican American combined PSEAs for FFQ (Block modified); FFQ with open ended question for portion size and food models	Elderly Puerto Rican Americans, other Hispanic and non-White Hispanics living in the NE of USA (Massachusetts Hispanic Elders Study)	FFQ development and validation study; the NCI/Block questionnaire was adapted in 2 phases to match the study population diet (open & closed potion size options tested)	Combination of PSEA used successfully for assessing portion size as part of FFQ; FFQ well adapted and extensively tested; calibration against 24 h recalls (n=125)	Final version accurate for assessment of energy intake and other nutrients in both ethnic and control groups	Specific for Hispanic minorities including Puerto Rican thus may be applicable to related groups but requires adaptation; Easy to administer	Tucker *et al*. (1998)[14]
South Asian British & Italian British food scales (for weighed 7 day food diaries, complemented with household measures)	SA and Italian women (1st and 2nd generation) living in Scotland, and control participants	Observational study assessing health, diet and food choice amongst SA and Italian migrants in Scotland (both UK and non-UK born), compared with UK population	Powered to detect soub-group differences (n=30+ per group); thorough dietary data collection method; analysis adjusted for age and n. of children in household	Results apply only to normal weight women aged 20-40 y; portion sizes for food groups not analysed (only for nutrients); unclear how much collected using household measures vs. food scale	Study shows that migrant SA and Italian women from 1st and 2nd generations are able to complete 7d weighed food diaries and data are sufficiently sensitive for comparing across groups	Anderson *et al*. (2005)[15]
South Asian British food photographs (section of food atlas) 8 colour photographs of traditional SA foods/dishes from Nelson *et al*., 1994, 1996[b] on everyday crockery	Women from SA ethnic minorities living in the UK	Development of an interviewer-administered FFQ for SA women in the UK, and validation against 7 d weighed food record	Adequate tool for low literacy populations; used open ended questions and pictures of different portion sizes Small sample used to test validity (n=11) and reliability (n=14)	First SA-specific FFQ Applicable to SA diets and difficult to measure foods	Diets for reliability study difficult to compare as not homogenous; validated against food records from 2 years ago[c]; Large range of foods explored (>200)	Kassam-Khamis *et al*. (1999)[16]

[b] Each set of 8 photos illustrates portion sizes ranging between the 5th - 95th percentiles of distribution of portion sizes observed in the British Adult Dietary survey from1990 (Gregory et al., 1990)[31]. Dishes were photographed with crockery most commonly associated with that dish i.e. rice, meat, vegetable & bean curries on a plate, and dhal in a bowl.

[c] The reliability of the FFQ was assessed in a group of volunteer South Asian women (n = 14) of differing regional and religious backgrounds. A preliminary validation exercise was conducted in a group of Punjabi Muslim women (n = 11) who had kept 7-day weighed records 2 years previously

South Asian British food photographs Colour photographs of 10 traditional foods and dishes (for FFQ and 24 h recall, already based on household measures)	SA children 1.5-11 y (n=300) for 24 h recalls SA adults aged 30/+ (n=100) for FFQ Indian and Pakistani mothers (n=36) for PSEE validation study	Review paper including discussion of experimental work with children and adults (application of 24h recalls and FFQ); conference abstract reporting validation study for photographic PSEE	Large sample sizes used for dietary assessment studies; unclear info on how PSEE improved accuracy of 24h recall Photographs validated in adequate sample; reported % number of accurate estimations only; no reliability/ other measures	FFQ food list based on literature and pilot data; instrument not fully validated Unclear information on all PSEEs used for the 24h recall	Scarce information on tool development and psychometric properties Only 10 foods covered by PSEE	Husain and Khokhar (2011)[17] Garduño-Diaz *et al*. (2014)[18] Garduño-Diaz and Khokhar (2013)[19]
South Asian British food scales (for weighed 4 day food diary)	UK South-Asian community	Validation study for three dietary assessment instruments (FFQ, food check list, 24 h recall), against 4 day weighted food records[d]	Unknown sensitivity of the instruments used to measure PS in the FFQ; check list and 2h h recall[e]. Small sample size due to high drop-out (FFQ: 23 men and 35 women; food check list and 24 h recall: 44 women)	Initial characterization of SA community's response to dietary assessment methods[f] 24h recall and check list misclassified subjects for energy and macronutrient intakes	Low statistical power	Karim (1997)[20]
South Asian British serving spoon and table spoon portion size guide Coding and portion size manual developed for South Asian foods using	South Asian women living in the UK	Development & validation study of FFQ, used Mc-Cance and Widdowson's food composition tables[21,22] and UK Aga Khan Health Board [23]	First coding and portion size manual for common SA foods developed by weighing foods in serving spoons and tablespoons, applied to 24 h recalls	Precise methodology used; weighing, coding and allocation of portion sizes conducted independently by several nutritionists; disagreements	Subsequently applied to other dietary assessment methods (24 h recall)	Sevak *et al*. 2004[24]. Bhakta *et al*. 2005[25]

[d] A mixture of household measures, natural units for unit foods (e.g. 1 egg) and commonly consumed portions (Crawley, 2001) were used for the FFQ and checklist but these are not analysed here due to lack of information on their content.

[e] A mixture of household measures, units for unit foods and commonly consumed portions (Crawley, 2001) were used for the FFQ and checklist but none of them constituted a concrete instrument *per se* (e.g. list of all the household measures used; ruler and units of measure, etc.).

[f] For the SA community in this study the FFQ, food list and 24 h produced better response than the weighed food record. Reasonable agreement between FFQ and weight record estimates in both genders.

serving spoons and tablespoons commonly used by South Asians				discussed within team		
South Asian Canadian FFQ Ethnic FFQs with portion size fraction list designed for South Asian and for Chinese migrants in Canada (CSDLH)	Chinese, South Asian and European migrants in Canada	FFQ development and validation study Food list based on 4 day food diaries and 24 h recalls. FFQ tested in separate sample of participants from SHARE (n=342 SA; n=317 Chinese); validated in subset of participants vs. 7d food diaries (at baseline & 8-10 mo later)	FFQs validated in a national cohort separate from the pilot study to avoid bias Reasonably large sample sizes for each group; Long time gap between test and re-test (8-10 mo), may induce memory bias	Tool useful for population studies but not precise for individual dietary assessment	Portion size assessment may not be sufficiently sensitive (i.e. only 3 options for size included) Inclusion of detailed questions on brand, type, and amount of oil consumed in specific dishes needed	Kelemen *et al*. (2003)[26]
South Asian Canadian portion size pictorial guide Developed by the Canadian Diabetes Association	Canadian South Asians	Educational on-line material. Portion sizes derived from focus groups with SA community living in Southern Ontario (n=53) or the literature, reviewed by dieticians	No information on effectiveness; not validated Not many curries & other dishes listed	Portions sizes may vary within South Asian cultural groups and based on individual cooking methods	Available in various languages; may be self-administered Cheap & portable but reduced range of recipes Portion quantification may be challenging as based on scaled down image	Brauer and Mian (2006)[27]
South Asian Norwegian and other ethnicities health questionnaires (OIHS) Weights & volume lists for beverages (alcoholic and	Pakistan, Sri Lanka, Turkey, Iran and Vietnam migrants living in Oslo in 2002	Large cross-sectional study in Norwegian migrants examining the link between socio-demographic and lifestyle factors, with	Dietary instruments not validated for ethnic minorities but based on published research; some piloted.	Both adult and young examined; Sufficient sample for subgroup analysis (compared psychol. distress amongst	Low response rate (40%, final n=3726) Not all instruments were validated or fully adapted to all cultural groups;	Norwegian Institute of Public Health (2005)[28] Kumar and Meyer (2002)[29] Dalgard *et al*.

non-alcoholic); units of bread; staples; sugar		distress & mental health		migrants from low vs. middle/high income countries)	Translations available	(2006)[30]

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31. Gregory J, Foster K, Tyler H, Wiseman M. The Dietary and Nutritional Survey of British Adults. London: HMSO; 1990

Table S4. Details of studies conducted in original countries relevant for UK ethnic minorities.

Abbreviations: CHO = carbohydrate; Est. wt = estimated weight; FFQ = food frequency questionnaire; Tbspn = tablespoon; tsp = teaspoon; PRO = protein; PSEA = portion size estimation aid; PSEE = portion size estimation element; PSRS = portion size reference scheme; Veg = vegetables; Wt = weight.

Country & target population	PSEE description including link to published PSRS	Technique used by the PSEE	Purpose of study and study design information	Reported psychometric measures and/or quality control steps	Overall tool effectiveness	Author
Bangladesh Bangladeshi children 1-11 y old with diagnosed rickets in a rural area in Chakaria (high poverty rates)	Combined PSEE including food scales for 24 h weighed food record; models; package information; and FFQ with open ended question Gold standard - no link to published PSRS	Staged weighing applied (i.e. container alone; then add rice; then add lentils); Models included household utensils (cup; tablespoon); and everyday objects (box of matches); package labels also used; calcium FFQ with open-ended question for amounts eaten at each meal	Dietary assessment of Bangladeshi children with rickets All foods included in the FFQ were local, traditional foods; information on recipes collected during the 24 h weighed records; Weighing conducted by field workers at home; left overs and spills, breastfeeding recorded	Method based on published research (see text); scales calibrated regularly; written protocol followed for staged weighing; records double-checked by investigator for completion	Calcium deficiency identified alongside blood analyses for vitamin D metabolites	Ahmed (2014)[1]
Burkina Faso Pregnant and non-pregnant women (n=257) from a rural district in the Tuy province, participating in a nutrient	Food atlas for a 24 h recall including 4 portion size photos (10x16 cm) per food for 8 selected food items	Indirect measure (comparison of shown portion to that consumed previously)	Validation study against weighed amounts; chosen portions based on 24 h recall data; Participants were shown a pre-weighed portion of food twice a	Out of 1028 estimations, 55% were accurate; women having attended school almost twice as likely to estimate correctly; those consuming medium to	At group level the food atlas allowed moderate to good estimation for most foods but under- and overestimations were detected in 5 out of the 8 foods ($p<0.05$	Huybregts *et al*. (2008)[2]

supplementation intervention to improve birth outcomes; 79% never attended school			day and asked to assess portion size using the food atlas on the following day; only 4 foods tested per person	large serving sizes were less likely to estimate correctly Food atlas pre-tested in 23 women	for rice and couscous). The magnitude of the overall differences was small though (-8.4% to 6.3% vs. Wt)	
Cameroon 123 adults from rural and urban sites in Youndé and Evodoula, Cameroon	Combined PSEE for food diary and for 24 h recalls (to be used in FFQ), including household utensils (e.g. cups & bowls); food models	Indirect comparison against volume shown	Development of a FFQ for Cameroonians[a] Includes extensive food list for traditional foods and dishes for Cameroon (76 food items) but no portion size information	Similar utensils used in the validation of the final FFQ (see Mennen *et al*., 2001[3], below)	Limited information on food models and utensils; estimated portions in the food diary were assigned a weight by weighing similar portions in a subsample of subjects' homes	Sharma *et al*. (1996)[4]
Cameroon Nutrient intake study: Adults of African origin from rural (n=743) and urban (n=1042) areas in Youndé and Evodoula, Cameroon (farmers, hunters, civil servants and businessmen)	Combined PSEE for FFQ Interviewer-administered quantitative FFQ used with PSEA including local cooking utensils, wooden food models, cutlery	FFQ with open ended question on portion size to be answered with the portion estimation aids	Application of the FFQ for estimating nutrient intake in urban and rural areas Good sample sizes	Not validated in Cameroonians. However a related questionnaire for Jamaicans of African origin was calibrated against 24 h recalls and 4 d weighed records in 96 adults of Afro-Caribbean origin living in the U.K. (corr. coefficients for nutrients 0.38-0.62) (Jackson *et al*.)[5]	FFQ estimated macronutrient intake well (within 5% of energy intake) but tended to overestimate micronutrient and alcohol intakes; higher underreporting rates detected with FFQ than with 24h recall at individual level esp. females	Mennen *et al*., (2001)[3]

[a] In the same paper the authors also report the development of a FFQ for Jamaicans living in Jamaica (see below under Caribbean Population), as well as Jamaica and Caribbean immigrants living in the UK (see accompanying Tables S1-S3 under Sharma et al., 2002[4]; Vyas et al., 2003).

India Pre-school children (1-2 y old) from peri-urban New Delhi assessed between 1993-1994	Simplified portion size assessment questionnaire to be completed during field observations, including list of portion size fractions	Assessing fraction of amount consumed vs. original portion presented, including 4 options: • All or most eaten (coded as x1.0) • half or more (x0.75) • less than half (x0.50) none (x0.0)	Validation study for a tool to be used in field observations by an investigator Limited validity as only 5 foods explored of which 2 were hardly consumed (2-4 g portions); low precision and sensitivity – descriptors do not match fraction factors used for estimating weights	Validated vs. weighed records accounting for leftovers, spillage; 930 observations over a 6 h period in 128 children, for 5 foods Correlation coefficient 0.61-0.93 (overall 0.88 across foods); est. vs. actual wt very close but significance values not reported; reliability not tested but measured previously[6]	Needs further testing in wider range of foods and ideally other age groups Potentially useful for large study samples as quick to complete, low cost; requires staff training Can be used in home setting to avoid disruption of eating environment	Dhingra *et al*. (2007)[7]
Ireland Irish children (n=594 , aged 5-12 years), adolescents (n=441, 13-17 years) and adults (n=1274, 18-64 years)	Combined PSEE for online database of food portion sizes including: digital food scales, food packaging; Nelson's food atlas[8], government publication[9]; local food shop menus; household measures (teaspoon, tablespoon for sugar, oils); standard units of measurement (pint); and estimations based on observations	Direct and indirect measures included for 545 foods (23 food groups derived from the National Children's Food Survey (2003-4), National Teen's Food Survey (2005-6) and National Adult Nutrition Survey (2008-10) in Ireland, which used both estimated and weighed food records)	Creation of online database for food portion sizes to use in future analyses (median, 25th and 75th percentile portion weights split by age and sex group). Also includes list of reference weights based on previous research/ government publications	The Nelson's food atlas is a validated tool. Loose fruit and veg. from local shops were weighed in triplicate. For foods with non-edible parts (e.g. skin, stones, bones), a factor was applied to convert to edible portion. Energy underreporting was accounted for.	Able to distinguish average portions between age and sex groups. Sensitive as based on large amount of weighed data. Inclusion of non-weighed acceptable as energy and nutrient intakes shown not to differ by method [10] Portions do not differentiate by eating occasion (i.e. main meal vs. snack)	Lyons *et al*., (2013)[11]

Ireland 500 Irish pre-school children (1-4 years)	Combined PSEE for portion size database including: food scales, food packaging; Young Person's food atlas[12] AND household measures.	Direct (~85%) and indirect measures (~15%) included, derived from the National Pre-School Nutrition Survey (2010-11) in Ireland, which used a 4 day weighed food record	Creation of food portion sizes database for pre-school children in Ireland to aid in dietary assessment and dietetic practice.	The Young Person's food atlas is a validated tool. 75% of the weights came from weighing (by caregivers) and 7% of weights were derived from manufacturers	Able to distinguish portion sizes between 1 year olds and older pre-school children. Sensitive as based on large proportion of weighed data.	Giltinan *et al*. (2013)[13]
Ireland 120 (61 males and 59 females) residents of the island of Ireland and aged 18-25 years, mostly normal weight and single, including 51% of students	Combination of PSEA for portion size tool comparison study including: food scales, measuring jug, fraction of a unit reference objects (matchbox, food photo, thumb tip, palm and hand, portion pack), household measures and utensils (Tbsp, tsp, portion pots, wine glass, measuring spoon) pack demarcations	Direct and indirect measures used	Evaluation of the precision, ease of use and likelihood of use of a wide range of existing PSEA for difficult-to-estimate foods (i.e. amorphous foods, liquids, solid, cooked and dried foods). Participants were offered a wide range of PSEA for a particular food so that they could choose	PSEA that came with manufacturer information e.g. on suggested serving size was included; only PSEA relevant for Ireland were tested. Several of the tools had not been validated but were of popular use (e.g. hand measures)	The food scales and jug were the most precise followed by household measures; food photographs were the least precise. Scales and jug were the least preferred and household utensils the most (especially for uncooked grain); pack demarcations, cutlery and portion pots were chosen for specific foods only	Pourshahidi *et al.* (2013)[14] later published in Faulkner *et al*. (2016)[15]
Jamaica 102 adults from district Kingston (Jamaica)	Combined PSEE for 24 h recalls (to be used in FFQ), including household utensils (e.g. cups & bowls); food models	Indirect comparison against volume shown	Development of a FFQ for Jamaicans Includes extensive food list for traditional foods and dishes for Jamaica (69 food	Similar utensils used in the validation of the final FFQ (see Mennen *et al*., 2001[3], below)	Limited information on food models and utensils; estimated portions in the food diary were assigned a weight by weighing similar portions in a	Sharma *et al*. (1996)[4]

			items) but no portion size information		subsample of subjects' homes	
Jamaica Nutrient intake study: 345 Jamaican adults from Spanish Town, incl. rural and urban dwellers Validation study: 73 Jamaican adults Reproducibility study: 123 Jamaican adults	Combined PSEE for FFQ Interviewer-administered quantitative FFQ used with PSEA including local household utensils, food models, measuring cups, measuring tape	FFQ with open ended question on portion size to be answered with the portion estimation aids	Calibration and reproducibility of a FFQ for Jamaicans of African origin The 24h recalls were conducted over 1 year period to reflect seasonal variation Good sample sizes in all studies	FFQ showed good reproducibility (nutrient corr. coeff test-retest, 0.42-0.71) and moderate to good comparability against 12 x 24 h recalls (r=0.20-0.86; estimated energy intakes as expected based on est. BMR at group level	FFQ estimated macronutrient intake well (within 5% of energy intake) but tended to overestimate micronutrient and alcohol intakes; higher underreporting rates detected with FFQ than with 24h recall at individual level esp. females The second FFQ correlated better with the 24h recall (learning process by participant?)	Jackson *et al*., (2001)[5]
Nigeria Healthy adult men and women from urban settings (mostly married and of low to moderate income)	Combined PSEE for 24 h recall, including household measures (table spoons, serving spoons, cups, milk tins) and food models Portion sizes determined based on nutrient content as specified by the ADA exchange system[16,17];	Indirect measure (comparison to displayed volume for household utensil or food model)	Cross-sectional study (n=413) to determine portion and serving sizes of commonly consumed Nigerian foods in Oyo State	No reported psychometric measures; also lacks information on food models employed	Produced list with average portion sizes (in weight) & serving sizes (in household measures) of traditional Nigerian foods. Largest portion sizes in the diet identified (from rice, bread and root/tubers)	Sanusi & Olurin (2012)[19]

	serving sizes compared with USDA guidelines[18]					
South-Africa North West region (extremes of poverty and affluence) n=169 (77% female, 76% educated at grade 8)	Food portion photograph book (food atlas) for FFQ Near life-size colour photographs (21 x 29.5 cm) of 37 foods, in 3 or 4 portion sizes and photographs of utensils (drinking glasses, cups, mugs, spoons and cartons)[b]	Indirect measuring (participants indicated portion size closest to their own using the photo that matched best)	Development and validation against actual weights for 20 of the 37 food items (62 portions; n=169 subjects) Primary data obtained via in-depth interviews and focus groups Foods and portion sizes randomly tested over 5 sessions, via native, trained interviewer Accuracy of estimation was high and not affected by gender, age or education (but most were educated	Sig. difference (P = 0.0) between mean % differences in est. vs. actual weights obtained 68% of the 2959 responses were accurate estimates (±10% of actual wt); 15% were over- and 16% under-estimations. Higher % of correct responses given for solid foods (77%) vs. amorphous foods (63%) (P<0.0001). Ratio of intra:inter-subject variation =0.91 (good reliability)	Convenient tool, more accurate for solid foods than amorphous ones; Large atlas - less practical to carry around and expensive than smaller atlases Successfully used to assess diet of South-African sample as PSEA for FFQ (see under psychometric measures)	Venter *et al*. (2000)[20]

[b] For stiff maize meal porridge; samp (crushed maize) & beans, four portion sizes were used. For sorghum beer and mageu, drinking glasses, cups, mugs, spoons and cartons were used. For margarine (5 g, 10 g and 15 g), this was spread on a 60-g slice of brown bread.

			women) Further tests reported in McIntyre *et al*. (2000; 2001)[c]			
Sri Lanka Urban children 10-16 yrs free living in Sri Lanka	Graduated food model (real life appearance) for 9 commonly consumed SA foods in 3 sizes (small, medium & large) Does not correspond with a published PSRS; Three model sizes informed by previous research in Sri Lankan adolescents using dietary recall and utensil aids	Direct measurement of 9 traditional foods i.e.: cooked rice, cooked noodles, boiled green gram, finely chopped veg/salad; carrot curry, lentil curry, fish curry, papaya slices and butter	Validation study for graduated food models (children were asked to compare food models portion size to actual food portion size) Low sensitivity method (only 3 portion sizes used for comparing to real food amounts) Reasonable sample size (n=80)	Estimated wt from models correlated well with actual wt of food ($r > 0.957$ $p < 0.001$). 91% of estimations (n=719) were within the limits of agreement. Good accuracy and precision for both amorphous and non-amorphous food but higher for amorphous. Reliability measures not reported	Moderate to good efficacy. Portions for all foods except fish were estimated correctly at least 50% of the times. Portions for rice (most commonly eaten staple) was estimated correctly 85% of the times Texture but not sex or age, affected estimations (OR=0.68 95% CI 0.48-0.94; $p<0.05$)	Lanerolle *et al*. (2013)[21]
Sri Lanka High school children 10-16 y from Sri Lanka	Stand-alone and combined PSEEs including small and life-size photographs, life-size line diagrams & standard household	Small photographs used to estimate cereal-based foods (e.g. rice, noodles); vegs; curry & gravy dishes; pulses, fish	Validation study (see text for background). Four different PSEA explored, all suitable for teenage children; comparisons made to	*Small photos*: est. wt correlated well with actual wt (r=0.72-0.89; $p < 0.001$); 48% (n=876) correct estimates	*Combined PSEE (all aids) performed* similarly to *diagrams* [e] *Photos*: Large format induced over-	Thoradeniya *et al*. (2012)[23]

[c] Subsequently re-validated as part of development and validation of a 145 item interviewer administered quantitative FFQ, in local language. Seven day weighed food diaries and biomarkers were used as gold-standards for validation. In the test-retest study, Spearman rank correlation coefficients between test and retest ranged from 0.14 for calcium to 0.75 for alcohol. The mean percentage difference between intakes was 8.5 (SD = 9.9). Energy, protein, carbohydrate and calcium gave differences within 10% (MacIntyre et al. (2001)[33].

[e] To identify one combination aid with the best performance, four PSEA (small and large photographs; line diagrams; household utensils) were compared across food items for % correct estimations. Food texture, but not age or sex, was associated with correct estimations in all of the PSEA, except household utensils.

	spoons (1 spoonful = small size; 2 = medium size; 3 = large size) Linked to government PSRS (Ministry of Health, Sri Lanka, 2002)[22], as well as non-institutional schemes (photos and drawing line diagrams)[d]	and meat dishes; whole and sliced fruit; liquids; butter Life-size photos used to estimate cereal-based foods and veg Line diagrams used to estimate cereal-based products, veg, fish, meat, fruit, milk and dairy Household utensils used cereal-based foods and for veg	actual weights of food Reasonable sample (80 participants, 3180 estimations); wide range of comparisons undertaken to determine best PSEA combination Portion sizes derived from consumption studies rather than weighed amounts No test-re-test measures conducted	*Large photos*: est. wt correlated well with actual wt (r=0.73-0.86; p<0.001); 57% (n=558) correct estimates *Diagrams*: estimations correlated well with actual wt for most foods esp. with defined shape (r=0.69-0.94; p< 0.001); 64% (n=1271) correct estimations; smallest % of over-/underestimates *Household utensils*: Est. and actual wt correlated for veg only (r=0.69; p<0.001); 0.6% (n=475) correct estimates *Combined PSEE of all four aids:* 68.3% correct estimates	estimation. More accurate and precise in amorphous foods; work well for veg when combined with line diagrams (68.3% correct estimations; 20% under- and 12% over-estimations). *Diagrams*: work well for veg combined with small photos or on their own; not good for all amorphous foods *Household utensils*: Very poor efficacy	

[d] For the photographs and line drawings, the large portion size was set as the maximum number of spoons recorded as a serving size in previous studies (Lanerolle & Atukorala (2006)[34] Thoradeniya *et al*., (2006)[35]) and the small portion size was the minimum number of spoons, with the medium portion being the midpoint between these 2 sizes. For vegetables, 3 Tbspn (recommended serving size based on dietary guidelines from the Ministry of Health[22]) was used as the large portion because previous studies have identified that consumption is lower than that recommended (T. Thoradeniya, 2009, University of Colombo, Colombo, unpublished PhD Thesis), 2 Tbspn = medium portion and 1 Tbspn = small portion. Liquids were quantified in glasses and mugs. Fruit juices/fizzy drinks were quantified as half full, ¾ -full and a full glass. Tea with milk was quantified with three different sizes of mugs.

Sri Lanka 1029 adults aged 30+ from rural area	Household utensil units for estimated 3 day food diary	Indirect measure based on estimated amount. A portion was defined based on government dietary guidelines[22] as: 3-4 spoonfuls of cooked or 10 spoonfuls of raw vegetables; one medium-size banana, orange and apple; 9-11 grapes or similar fruits; ¼ of a medium size pawpaw; ½ avocado; 100 ml cup of tea or undiluted juice	Case-control study looking at the association between beta-carotene from fruit and vegetable consumption and risk of oral cancer	No information reported on the accuracy or validity of estimated portions in this population	The tool was able to detect intakes of fruit and vegetable below recommendations (most participants eating <5/day and about 50% having only 2/day). There was no association between beta carotene, or fruit and vegetable intake with risk of oral cancer in adjusted models.	Amarasinghe *et al*. (2013)[24]
Sri Lanka Nationally representative sample of 20,390 individuals (all ages), across 4,747 households	Average food and drink portion sizes customarily consumed derived from the 2003/2004 consumption and finance survey (CSF)	Estimated intake per capita, based on household consumption data (in standard units of measurement)	Analysis of the socio economic conditions in Sri Lanka. Reports monthly per capita food consumption and expenditure for 349 food and beverages	Information not accessible	Survey covered 98% of all households in the country however traditional portions may have changed since publication (2003)	Central Bank of Sri Lanka (~2004)[25]
Sri Lanka Sri Lankan adults from urban, rural and estate (plantation) areas, of various ethnicities, enrolled in epidemiological study	Combined PSEE for 24h recall including household measures (plate, bowl, cup, glass, spoons), single portion food photographs (e.g. 200 g rice), plus two food	Indirect method (weighing was only carried out for ingredients in home-made recipes but not for portion sizes of the complete dish). Estimated average	The 24 h recall data were used in two studies: the development of a FFQ for Sri Lankan; and the assessment of nutrient intakes in Sri Lankan adults	Food list expanded with info from producers, local nutrition experts and participants regarding ethnic, seasonal and festive food	Allowed the collection of sufficient data to develop a 90 item FFQ but photographs were included for 4 foods and in 3 portion options only. Does not distinguish types of	Jayawardena *et al*. 2012 (development study)[27] Jayawardena *et al.* 2014 (nutrient intake

For the development study n=482 (66% women, mean age 48 years) For the nutrient intake assessment study n=463 (64% women, mostly 41-50 years)	atlases[8, 26]	portions for medium size coconut spoon=100g; full plate=400g, cup of liquid=150 ml, tsp =5g		The Nelson's food atlas is a validated tool. The Shahar food atlas is in Malay and contains >360 food items. Used by the Malaysian Assoc. for the Study of Obesity FFQ was piloted in 25 individuals of similar demographic traits	cooking oil; may lack sensitivity with micronutrients. PSEE also allowed the detection of energy intake differences across different demographic groups in a country under nutrition transition	assessment study)[28]
Sri Lanka Sri Lankan adults from urban, rural and estate (plantation) areas, of various ethnicities, enrolled in epidemiological study n=77 (65% women, mean age 46 years)	Combined PSEE for FFQ including portion size lists for 85 food items (average portion) plus food photographs of 3 different portion sizes for 4 items (rice, vegetable curry, lentil curry, chicken). Calibrated kitchen scales (Tanita DK-407) used for 7 day food records	Indirect method (comparison to average portion or photograph) For the food record, food eaten out of home was estimated based on participant's written description (not weighed)	Validation of a previously developed FFQ (see Jayawardena *et al*. 2012[27] above) against 7 day weighed food records showing acceptable validity and agreement compared with gold standard method	Compared with the food record, the FFQ slightly overestimated CHO (11.5 g/day) and fat (5.7 g/day) but correlated positively for energy (r=0.39), CHO (r=0.47), PRO (r=0.26), fat (r=0.17) and fibre (r=0.32) (all $p<0.05$). Methods showed fairly good agreement (mostly for carbohydrate)	Well developed and tailored for this population however CHO may be over-estimated and fat and fibre under-estimated. Portion sizes for food eaten out of home were derived from estimated amounts so may need verification	Jayawardena *et al.* 2013[29] later published in Jaywardena et al. (2016)[30]
Sri Lanka Elderly healthy subjects (n=200, aged >60 years) from the Dankotuwa and	Combined PSEE including household utensil units for 24 h recall (cups, Tbspn, coconut spoons, size of box of matches,	Indirect measure. Recommended servings were based on government dietary guidelines[22]	Validation of a food variety score (FVS), a dietary diversity score (DDS) and a dietary serving score (DSS) as indicators of	The three dietary scores correlated with mean adequacy ratios (MAR) (for FVS Pearson's r=0.45; for DDS r=0.48; for DSS	FVS, DDS and DSS were useful proxy indicators of nutrient adequacy for this population. Portion sizes improved the	Rathnayake et al. (2012)[31]

Pannala regions (mostly rural areas)	other) plus food serving photographs		nutrient adequacy, using the 24h recall data	r= 0.58 (all p< 0.01). Sensitivity and specificity analyses run to identify best cut-off points for predicting nutrient adequacy (DDS, FVS)	performance of the indicators. Only one recall pass conducted though	
Sri Lanka Pre-menopausal women (n=100), 20-45 years from urban and rural areas (Negombo and Pannala)	Household utensil units for estimated 3 day food diary	Indirect measure based on estimated amount. Weights converted into gr using standard reference tables for Sri Lankan foods (also providing average starch portion sizes)	Cross-sectional study looking at the link between dietary carbohydrate, physical inactivity and central obesity among premenopausal housewives in Sri Lanka	No information reported on the accuracy or validity of estimated portions in this population	The estimated food diary allowed to detect significant correlations between dietary CHO and central obesity markers; as well as nutrition imbalance (CHO contributed 70% of daily energy mostly coming from rice; vs. 19% energy from fat)	Rathnayake *et al.* (2014)[32]

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