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Global comparison of national individual food consumption surveys as a basis for health research and integration in national health surveillance programmes

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Individual food consumption surveys (IFCS) are performed to evaluate compliance with food/nutrient intake requirements or exposure to potential harmful dietary contaminants/components. In this review, we inventoried methods and designs used in national IFCS and discussed the methodologies applied across countries. Literature searches were performed using fixed sets of search terms in different online databases. We identified IFCS in thirty-nine countries from six world continents. National IFCS systems are available in most of the high-income countries, while such surveys are scarce in low- and middle-income countries (e.g. Africa, Eastern Europe and several Asian countries). Few countries (*n* 9) have their national IFCS incorporated into national health and nutrition surveys, allowing the investigation of dietary-related disease outcomes. Of the integrated surveys, most have the advantage of being continuous/regular, contrary to other IFCS that are mostly erratic. This review serves as the basis to define gaps and needs in IFCS worldwide and assists in defining priorities for resource allocation. In addition, it can serve as a source of inspiration for countries that do not have an IFCS system in place yet and advocate for national IFCS to be incorporated into national health and nutrition surveys in order to create: (1) research opportunities for investigating diet–disease relationships and (2) a frame to plan and evaluate the effect of diet-related policies (e.g. promotion of local nutrient-rich foods) and of nutrition recommendations, such as food-based dietary guidelines. Countries that integrate their IFCS within their national health and nutrition survey can serve as proof-of-principle for other countries.

Dietary intake: Food consumption survey: Health survey: Inventory: Review

Food consumption data at a country level

Food balance sheets

At a country level, dietary consumption is surrogated using indirect approaches that embed household food

purchases, or even food balance sheets (FBS) from which per capita food data availability can be estimated. In FBS, food availability for human consumption is calculated by taking into account production, imports, exports, stock variation and utilisation elements, such

Abbreviations: DIA, dietary intake assessment; FBS, food balance sheets; 24-HDR, 24-h dietary recall; IFCS, individual food consumption survey; NHANES, National Health and Nutrition Examination Survey.

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as feed, seed, losses and industrial uses⁽¹⁾. FBS are one of the most important sources of data on food availability for human consumption in most countries. However, it remains a challenge to collect accurate data about all the food groups, and the quality of the food data cannot always satisfy high-quality standards. As a result, FBS figures of food consumption are prone to measurement errors⁽²⁾. Furthermore, FBS neither give any indication of the differences that may exist in the diet consumed by different population groups, such as people of different socio-economic groups, ecological zones or geographical areas within a country⁽³⁾, nor do they provide information on seasonal variations in the total food supply.

Household expenditure surveys and individual food consumption surveys

Data obtained through household and individual food consumption surveys (IFCS) are often the preferred source of food consumption estimates because they provide more information on food actually consumed than FBS do⁽⁴⁾. However, it should be emphasised that the food data collected in household consumption and expenditure surveys reflect the quantity of food acquired by a household rather than that consumed by its members. Data on the latter are collected in IFCS, also called dietary intake surveys or diet monitoring surveys. Compared with the household consumption and expenditure survey method, the IFCS method yields a more reliable measure of dietary adequacy and exposure to contaminants at individual and household levels because it is based on actual food consumption rather than food acquisition⁽⁵⁾. Further, since the data are collected at the individual level, comparisons can be made across age and sex groups, and inequalities in intra-household food distribution can be identified. However, collection and processing costs for these individual data are considerably higher than for the data collected in household consumption and expenditure surveys. For this reason, implementation of the IFCS method at the country level may be challenging for low- and middle-income countries⁽⁶⁾, therefore limiting the use of this approach for cross-country comparisons.

Although dietary monitoring and surveillance is crucial in the development of targeted interventions among population groups at risk of nutritional inadequacies, several countries (particularly those in deprived regions such as Africa) have no representative national IFCS system in place yet⁽⁶⁾. Furthermore, in most countries where food consumption surveys are conducted, the data are not collected routinely, which undermines trend analyses^(7,8). Despite the challenges involved, IFCS are performed in several countries and serve as the basis to evaluate compliance with nutrient intake requirements or exposure to potentially harmful dietary contaminants/components. Opportunities and barriers identified in past and ongoing IFCS can serve as a basis to develop and optimise future surveys in regions where IFCS are still lacking. Furthermore, harmonisation of the methodologies of data collection in national surveys, as well as

of recruitment, training and supervision of interviewers will increase the comparability of the data collected. A cross-continental comparison of national food consumption survey methods has already been published, including studies reporting on IFCS from 1985 to December 2011⁽⁸⁾. This previous review described how few countries endeavoured to increase the potential of their national IFCS through implementation in other national health surveys (e.g. health interview surveys or health examination surveys), an approach likely to be cost-effective, especially in resource-constrained environments often reported in low- and middle-income countries⁽⁸⁾.

In this review, we compare national IFCS and their potential for health research through integration in national health surveillance programmes worldwide. More specifically, we inventoried methods and designs used in national IFCS. We further discuss and compare these methodological properties between nations and cross-continently and evaluate the potential for embedding food consumption survey in national health surveillance programmes.

Procedure for selecting the studies to be included in this review

This review builds on existing reviews that focused on one or a limited number of continents in order to create an exhaustive inventory of all published IFCS conducted all over the globe^(6,8-10). This extended systematic literature search followed a similar methodology as the one applied by De Keyzer *et al.*⁽⁸⁾, although extended with additional searches using search engines such as Google and Google Scholar, ScienceDirect and including also relevant non-English search terms, namely French and Spanish. The Inventory Framework constructed by De Keyzer *et al.*⁽⁸⁾ was used as a basis for describing the methodological properties of the IFCS included in this global review. After debate and brainstorming between the authors, it was decided to categorise the IFCS properties into eight aspects: (1) general survey information; (2) target population, survey design and sampling; (3) dietary intake and other assessments; (4) recruitment of participants; (5) fieldwork characteristics; (6) data/nutrient analyses; (7) recruitment and training of the interviewers; (8) characteristics of national IFCS integrated into broader health surveys. The framework was designed as a table listing IFCS in rows and property fields in columns. In total, forty-six fields were created. The fields to be completed per survey are presented in Annex 1.

As proposed by Blanquer *et al.*⁽¹¹⁾, a combined strategy for data acquisition was used. Firstly, a systematic literature search was performed. The electronic databases Medline (PubMed), Web of Science, ScienceDirect and Scopus libraries were used to identify studies reporting on IFCS from 2011 to December 2016. Text terms with appropriate truncations, Boolean operators and relevant indexing terms were used. A set of Medical Subject Headings was used in PubMed and Web of Science.



The reference lists in the articles, reviews and textbooks retrieved were also investigated for additional publications yielding a substantial amount of grey literature such as reports available on websites of governmental institutions. The key words used in the search (in English, French and Spanish) were: 'national nutrition survey'; 'food and nutrition survey'; 'dietary consumption survey'; 'dietary intake'; 'nutrition examination'; 'nutrition survey' and 'dietary intake assessment'. Co-authors from the FAO provided additional information on the surveys available in their databases (FAO/WHO Global Individual Food consumption data Tool (<http://www.fao.org/nutrition/assessment/food-consumption-database/en/>)). These surveys include datasets that have been identified through the Global Dietary Database initiative (<http://www.globaldietarydatabase.org/the-global-dietary-database-measuring-diet-worldwide.html>). Additional terms referring to a country or continent were added to this search query to obtain region-specific information. The selection of continents was based on the seven-continent model excluding Antarctica (no permanent habitation).

Only studies including a national representative sample (or proxy representative) of the population were included in this review. The exclusion criteria used were: (1) age (nutrition surveys in subjects under 18 years only were excluded given their age-specific approach in terms of dietary intake assessment (DIA)); representative surveys including adults and children were included in the inventory tables with the full age range); (2) indirect or ecological measurement of food intake (e.g. FBS or household budget surveys); (3) absence of DIA (e.g. nutritional assessment based on anthropometric or clinical measurements); (4) publications or reports not available in English, French or Spanish and/or not accessible online. It is noteworthy that no exclusions were made based upon the DIA method used as long as it concerned direct intake assessment methods at an individual level (e.g. 24-h dietary recall (24-HDR), food diary, FFQ).

The first step of the search strategy yielded a total of 9687 articles. From these, 8138 articles met at least one of the exclusion criteria during the selection based upon titles. The abstracts of the remaining 1549 articles were reviewed and compared with the inclusion/exclusion criteria, yielding 145 potentially relevant articles. From these articles, a total of 113 articles were selected as relevant according to our inclusion/exclusion criteria after having reviewed the full articles. Single surveys from individual countries were identified based upon these 113 selected articles, leading to a total of thirty-nine countries from six continents that were retained for inclusion in our extraction tables (Fig. 1).

The results of these thirty-nine IFCS are presented according to the eight major aspects listed in the Methods section, clustered by continent (Tables 1–3 and Supplementary Tables S1–S4). It should be noted that for countries in which repeated IFCS have been conducted, only the methods of the last IFCS (with reserve of full report available online) have been included in the tables. IFCS that are still ongoing and for which

no online reports or publications are available yet have not been included in the tables.

Overview of the different study designs and methods used in the national food consumption studies

General survey characteristics

National IFCS systems are available in most of the high-income countries, while such surveys are scarce in low- and middle-income countries (such as Africa, Eastern Europe and several Asian countries). The IFCS were cross-sectional, with only few having a continuing character (Table 1). Nineteen surveys were identified as being conducted erratically (Ethiopia⁽¹²⁾, Nigeria⁽¹³⁾, South Africa⁽¹⁴⁾, Bahrain⁽¹⁵⁾, Belgium⁽¹⁶⁾, Bulgaria⁽¹⁷⁾, Czech Republic⁽¹⁸⁾, Estonia^(19,20), Finland⁽²¹⁾, France⁽²²⁾, Hungary⁽²³⁾, Ireland⁽²⁴⁾, Latvia⁽¹⁰⁾, Poland⁽²⁵⁾, Slovakia⁽¹⁰⁾, Slovenia⁽¹⁰⁾, Brazil⁽²⁶⁾, Chili⁽²⁷⁾, New Zealand⁽²⁸⁾); fifteen on a regular basis (at a fixed frequency; e.g. annually, biennial; India⁽²⁹⁾, Israel^(30,31), Japan⁽³²⁾, South Korea⁽³³⁾, Malaysia⁽³⁴⁾, Philippines⁽³⁵⁾, Austria⁽³⁶⁾, Denmark⁽³⁷⁾, Germany⁽³⁸⁾, Italy^(39,40), The Netherlands⁽⁴¹⁾, Spain⁽⁴²⁾, Sweden⁽⁴³⁾, Canada⁽⁴⁴⁾, Mexico⁽⁴⁵⁾), while five were continuous (ceaselessly from one year to another) surveys over years (China^(46,47), the UK⁽⁴⁸⁾, the USA⁽⁴⁹⁾, Australia⁽⁵⁰⁾, Venezuela⁽⁵¹⁾). Japan was one of the first countries to start collecting IFCS routinely with data collected throughout years since 1946. Other countries conducted IFCS regularly: India, Israel, Japan, South Korea, Malaysia, Philippines, Austria, Denmark, Germany, Italy, The Netherlands, Spain, Sweden, Canada and Mexico. For the USA and China, participants are included in a cohort for tracking over time. Countries which have integrated IFCS in their health survey are: South Africa, Australia, China, Japan, South Korea, Malaysia, Canada, Mexico and the USA. All of the IFCS integrated in health surveys, besides South Africa, have the advantage of being continuous (Australia, the USA and China) or regular (Canada, Japan, South Korea, Malaysia and Mexico), while most of the other IFCS are rather erratic.

Target population, survey design and sampling method

Supplementary Table S1 summarises the study design aspects and methods of the selected surveys. The age of the target populations ranged from <1 year to over 80 years (in surveys that do not include an age <18 years limit). In all surveys, both sexes were included except for the Nigerian IFCS that included solely women. Different sampling designs were used to select study participants with a majority applying a multistage and stratified sampling. The sampling frames used for the selection of sampling units were based either on census data (e.g. the USA, Mexico, Brazil, South Korea and New Zealand), a combination of frames like healthcare registries and labour force data (Canada), strata from counties (China) or other sampling frames, such as enumeration blocks, which are

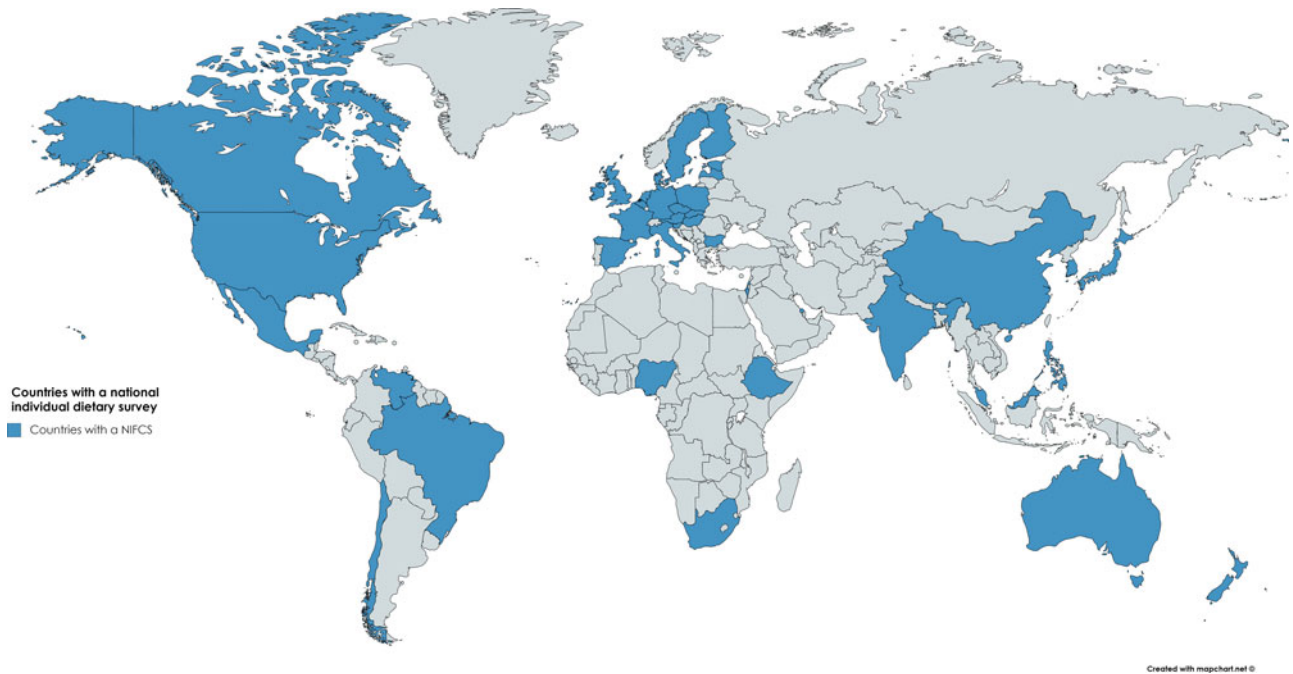


Fig. 1. Mapping of the countries in which at least one national individual food consumption survey has been conducted before 2017 (highlighted in blue). Africa: Nigeria, South Africa, Ethiopia; North and South America: Brazil, Canada, Chile, Mexico, the USA, Venezuela; Asia: Bahrain, China, India, Israel, Japan, South Korea, Malaysia and Philippines; Europe: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, The Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden, the UK; Oceania/Australasia: Australia and New Zealand.

geographical areas artificially created to have several living quarters (Malaysia).

Numbers of participants and participation rates

In Table 1 and in Supplementary Table S1, recruitment aspects of all selected surveys are listed. Sample sizes of single surveys ranged from about 400 (Spain and Slovenia) to over 30 000 (Canada and Brazil). Participation rates were above 90% in Malaysia, Ethiopia and South Africa; between 80.0 and 89.9% in the USA (National Health and Nutrition Examination Survey (NHANES) 2001, 2005), Mexico (National Health and Nutrition Survey 1999), Brazil, China and South Korea; between 70.0 and 79.9% in Canada, the USA (NHANES 2003, 2007 and 2009) and Australia (for the FFQ); and below 70% in Japan, Australia (for 24-HDR) and New Zealand. Overall, participation rates were lowest in European countries (between 23 and 80%, except for Poland and Slovakia where response rates were 96%). The integrated surveys often seem to have higher response rates, a random sampling design and are therefore often more representative for the general population. Although the higher response rates in these integrated surveys may be due to other factors that are out of the scope of this inventory, these numbers are demonstrating the feasibility of integrating an IFCS in other health surveys as the extra respondent burden seems not to reduce the response rate.

Dietary intake assessment methods

Most surveys used 24-HDR as the principal DIA method (Table 3). Multiple recalls for all participants were available in China (three recalls) and in most of the European countries. In some countries, duplicate recalls were available in a subsample only (Canada, South Korea, Australia and New Zealand). Computer-assisted personal interviewing was performed in the USA, Malaysia, Brazil and New Zealand. In the surveys from China and Australia, the 24-HDR was performed with paper and pencil in a face-to-face interview. In South Korea, a face-to-face interview was performed, no interview software was reported, and in Mexico, the method of administration of the 24-HDR was also not reported in the study report. A prospective DIA method was only used in Brazil and Japan (2-d estimated dietary records and 1- or 3-d semi-weighed dietary records, respectively). Finally, Mexico (Mexican Health and Nutrition Survey 2006) and South Africa used only a semi-quantitative FFQ to report on frequencies of intake during the past 7 d. An FFQ (formerly called food propensity questionnaire) was also used in addition to a principal DIA method to identify frequencies of consumption and non-consumers of various food groups in Canada, the USA, Japan, South Korea, Malaysia, Australia and New Zealand (National Nutrition Survey 1997) and several European countries. For particular population groups such as children, the 24-HDR interview is often complemented with a food diary, or food diaries can also be



Table 1. Countries included in the study and general study information (individual food consumption surveys that are still ongoing and for which no online reports or publications are available yet have not been included in the tables)

Continent	Country	Reference	Designation of the survey	Frequency/ recurrence of the survey*	Latest survey	Survey included	Participants (n)	Response rate (%)	Survey integrated in national health survey
Africa	Ethiopia	Ethiopian Public Health Institute ⁽¹²⁾	Ethiopian National Food Consumption Survey	Erratic	2013	June to September 2011	16 592, F and M from 0 year onwards	97	No
	Nigeria	Maziya-Dixon <i>et al.</i> ⁽¹³⁾	Nigeria Food Consumption and Nutrition Survey (NFCNS)	Erratic	2001–2003	October 2000 to June 2001	5325, F, ≥18 years	81.2	No
	South Africa	Shisana O <i>et al.</i> ⁽¹⁴⁾	South African National Health and Nutrition Examination Survey (SANHANES-1)	Erratic	2013	April to November 2012	25 532, F and M from 0 year	92.6	Yes
Asia	Bahrain	Wahab <i>et al.</i> ⁽¹⁵⁾	National Nutrition Survey for adult Bahrainis aged 19 years and above	Erratic	2002	1998–1999	2301, F and M, ≥19 years	NA	No
	China	Chinese Center for Disease Control and Prevention ⁽⁴⁷⁾ ; Zhang <i>et al.</i> ⁽⁴⁶⁾	China Health and Nutrition Survey (CHNS)	Continuous (since 1989)	2011	NR	18 764, F and M, 1–6; 20–45 years	88.0	Yes
	India	Indian Council of Medical Research ⁽²⁹⁾	National Nutrition Monitoring Bureau Technical Report – Diet and Nutritional Status of Rural Population, Prevalence of Hypertension & Diabetes among Adults and Infant & Young Child Feeding Practices – Report of Third Repeat Survey	Regular (since 1972)	2012	NR	11 910 (household), F and M from 0 year onwards	–	No
	Israel	Keinan-Boker <i>et al.</i> ⁽³⁰⁾ ; Ministry of Health of Israel ⁽³¹⁾	National Health and Nutrition Survey (MABAT)	Regular (since 1999, across age ranges)	2009–2012	1999–2001	3246, F and M, 25–64 years	64.1	No
	Japan	National Institute of Health and Nutrition ⁽³²⁾	National Health and Nutrition Survey (J-NNS)	Regular (annually, since 1946)	2011	November 2011	8247, F and M, ≥1 year	62.9	Yes
	South Korea	Kim ⁽³³⁾	Korean National Health and Nutrition Examination Survey (KNHANES)	Regular (triennially from 1998–2005, annually since 2007)	2014	January 2009 to December 2009	9397, F and M, 1–70 years	82.2	Yes
	Malaysia	Institute for Public Health ⁽³⁴⁾	Malaysian Adult Nutrition Survey (MANS)	Regular (since 1986)	2014	October 2002 to December 2003	6886, F and M, 18–59 years	93.6	Yes (National Health and Morbidity Survey)
	Philippines	Food and Nutrition Research Institute ⁽³⁵⁾	National Nutrition Survey	Regular	2013–2014	June 2013 to April 2014	22 176, F and M, >6 months	NR	No

Food consumption surveys : global comparison

Table 1. (Cont.)

Continent	Country	Reference	Designation of the survey	Frequency/ recurrence of the survey*	Latest survey	Survey included	Participants (n)	Response rate (%)	Survey integrated in national health survey
Europe	Austria	Elmadfa <i>et al.</i> ⁽³⁶⁾	Austrian Study On Nutritional Status	Regular (since 1991)	2012	May 2005 to February 2006	2123, F and M, 19–64 years	48	No
	Belgium	Bel <i>et al.</i> ⁽¹⁶⁾	Belgian National Food Consumption Survey	Erratic (2 since 2004)	2014– 2015	February 2004 to February 2005	3245, F and M, 14–105 years	41	No
	Bulgaria	Petrova and Angelova ⁽¹⁷⁾	National survey of dietary intake and nutrition status of the Bulgarian population	Erratic	2004	April 2007 to August 2007	1204, F and M, 16–95 years	78	No
	Czech Republic	Ruprich <i>et al.</i> ⁽¹⁸⁾	SISP04	Erratic	2003– 2004	November 2003 to November 2004	1751, F and M, 16–64 years	54	No
	Denmark	Pedersen <i>et al.</i> ⁽³⁷⁾	Danish Dietary Habits	Regular	2011– 2013	April 2011 to August 2013	7253, F and M, 4–75 years	54.4	No
	Estonia	Pomerleau <i>et al.</i> ⁽²⁰⁾ ; Pudule <i>et al.</i> ⁽¹⁹⁾	National Dietary Survey 1997	Erratic	1997	July 1997 to August 1997	1866, F and M, 19–65 years	67	No
	Finland	Reinivuo <i>et al.</i> ⁽²¹⁾	FINDIET 2012	Erratic	2012	January 2012 to April 2012	1708, F and M, 25–74 years	57	No
	France	Dubuisson <i>et al.</i> ⁽²²⁾	Individual National Food Consumption Study (INCA 2)	Erratic	2014	December 2005 to April 2007	4079, F and M, 3–79 years	60	No
	Germany	Heuer <i>et al.</i> ⁽³⁸⁾	National Nutrition Survey II	Regular (Since 1972)	2005– 2007	November 2005 to January 2007	13 926, F and M, 14–80 years	42	No
	Hungary	Szeitz-Szabó <i>et al.</i> ⁽²³⁾	Dietary Survey in Hungary	Erratic	2009	February 2009 to June 2009	4992, F and M, 0–101 years	80	No
	Ireland	Harrington <i>et al.</i> ⁽²⁴⁾	North/South Ireland Food Consumption Survey	Erratic	2011	October 1997 to October 1999	1379, F and M, 20–65 years	63	No
	Italy	Leclercq <i>et al.</i> ⁽³⁹⁾ ; Sette <i>et al.</i> ⁽⁴⁰⁾	The national survey on food consumption in Italy	Regular	2005– 2006	October 2005 to December 2006	3323, F and M, 0.1–98 years	33	No
	Latvia	Merten <i>et al.</i> ⁽¹⁰⁾	European Food Safety Authority_TEST	Erratic	2008	June 2008 to November 2008	2070, F and M, 7–66 years	56	No
	The Netherlands	Rossum <i>et al.</i> ⁽⁴¹⁾	Dutch National Food Consumption Survey Core Survey	Regular (since 1987)	2007– 2010	March 2007 to April 2010	3819, F and M, 7–69 years	69.4	No
	Poland	Sekula <i>et al.</i> ⁽²⁵⁾	National Food and Nutrition Institute in Poland-FAO	Erratic	2000	September 2000 to November 2000	4134, F and M, 1–96 years	96	No
Slovakia	Merten <i>et al.</i> ⁽¹⁰⁾	Slovakian National Dietary Survey	Erratic	2008	January 2008 to December 2008	2761, F and M, 17–68 years	96	NR	



	Slovenia	Merten <i>et al.</i> ⁽¹⁰⁾	Slovenian Target Research Programme-2008	Erratic	2007–2008	September 2007 to April 2008	410, F and M, 18–65 years	52	NR
	Spain	Ortega <i>et al.</i> ⁽⁴²⁾	Spanish Agency of Food Security and Nutrition	Regular	2009	January 2009 to September 2009	418, F and M, 18–60 years	28	No
	Sweden	Becker and Pearson ⁽⁴³⁾	National Food Agency of Sweden	Regular	2010–2011	January 1997 to January 1998	1210, F and M, 17–79 years	60	NR
	UK	Bates <i>et al.</i> ⁽⁴⁸⁾	National Diet and Nutrition Survey	Continuous	2011–2012	April 2008 to March 2011	6828, F and M, ≥19 years	56	No
North and South America	Brazil	Sichieri <i>et al.</i> ⁽²⁶⁾	Brazilian Individual Dietary Survey (IDS 2008–2009)	Erratic	2008–2009	May 2008 to May 2009	34 032, F and M, ≥10 years	NR	No
	Canada	Statistics Canada ⁽⁴⁴⁾	Canadian Community Health Survey - Nutrition	Regular	2015	January 2004 to January 2005	35 107, F and M, >1 year	76.5	Yes
	Chili	Hugo <i>et al.</i> ⁽²⁷⁾	National Survey of Food Consumption	Erratic	2010–2011	November 2010 to January 2011	4920, F and M, ≥2 years	85.50	No
	Mexico	Barquera <i>et al.</i> ⁽⁴⁵⁾	Mexican Health and Nutrition Survey	Regular	2011–2012	October 2005 to May 2006	48 304 households F and M, 6–49 years	82.4	Yes
	The USA	Centers for Disease Control and Prevention ⁽⁴⁹⁾	National Health and Nutrition Examination Survey	Continuous	2015–2016	January 2009 to December 2010	10 537, F and M from <1 year	79.4	Yes
	Venezuela	Ministerio del Poder Popular de Planificación ⁽⁵¹⁾	National Survey of Food Consumption	Continuous	2015	March–June 2013	10 455, F and M, ≥2 years	NR	No
Oceania	Australia	Australian Bureau of Statistics ⁽⁵⁰⁾	National Nutrition and Physical Activity Survey	Erratic (before 2011) and Continuous (since then)	2015	May 2011 to June 2012	12 153, F and M, ≥2 years	77 (of households)	Yes
	New Zealand	University of Otago and Ministry of Health ⁽²⁸⁾	New Zealand Adult Nutrition Survey	Erratic	2008–2009	October 2008 to October 2009	4721, F and M, ≥15 years	61.0	No

F, female; M, male; NS, not specified; NA, not applicable; NR, not reported.
 * Repeatability of the surveys was categorised according to the following three definitions:

- (1) Erratic, characterised by lack of consistency, regularity or uniformity (e.g. when the survey has only been conducted once);
- (2) Regular, recurring/repeated at fixed, uniform or normal intervals, arranged in or constituting a definite pattern (e.g. with regular funding every x years);
- (3) Continuous, uninterrupted in time; without cessation (e.g. continuous funding available for uninterrupted running of the survey).

Food consumption surveys : global comparison

Table 2. Dietary intake data collection and other dietary assessments of national nutrition surveys per continent

Continent	Country	Cardinal dietary method	Number of recalls/ records*	Additional dietary questionnaires	Administration method	Quantification method	Interview aids/Software
Africa	Ethiopia	24-HDR	7	NR	Face-to-face interview, paper pencil	Household measures, food substitutes (flour, dough, water, lentils), pictures book	CSPro
	Nigeria	24-HDR	1	Food availability and affordability, food consumed away from home, food-related coping strategies	Face-to-face interview, paper pencil	Household measures, thickness sticks, rulers	Food instruction booklet with types of foods and quantities (adopted from USDA)
	South Africa	Dietary diversity	1	FFQ	Face-to-face interview, paper pencil	NA	NR
Asia	Bahrain	24-HDR	NR	FFQ	Face-to-face interview, paper pencil	Household measures	Dankost 2000 database
	China	24-HDR	3	Food market survey	Face-to-face interview, paper pencil	Pictures book, food models	NR
	India	24-HDR	1	Infant and young child feeding practices	Face-to-face interview, paper pencil	NR	NR
	Israel	24-HDR	2	NR	Face-to-face interview, paper pencil	Local Food Quantities Guide, household measures (cup, tablespoon, teaspoon)	BINAT system
	Japan	Dietary record	1–3	FFQ	Face-to-face interview, paper pencil	Scale	NR
	South Korea	24-HDR	1 (per season)	NR	Face-to-face interview, paper pencil	Pictures book, food models	NR
	Malaysia	24-HDR	1	NR	Face-to-face interview, paper pencil	Pictures book, household measures	Nutritionist Pro, Nutrition Analysis Software (for data entry)
	Philippines	24-HDR	2	FFQ, feeding practices, micronutrient supplementation, usage of dietary, supplements	Face-to-face interview, paper pencil	NR	NR
Europe	Austria	24-HDR	1	NR	Post	Household measures	Nutritional software (based on the Federal Food Code 3-01)
	Belgium	24-HDR	2	FFQ	Face-to-face interview	Pictures book, household measures, food portion	GloboDiet
	Bulgaria	24-HDR	2	FFQ	Face-to-face interview	Pictures book, household measures, package labels	Nutricalc



	Czech Republic	24-HDR	2	FFQ	Face-to-face interview	Pictures book, household measures, ruler	Paradox for Windows
	Denmark	Dietary record	7	NR	Face-to-face interview	Pictures book, household measures	GIES, DTU Food Institute database
	Estonia	24-HDR	1	FFQ	Face-to-face interview	Pictures book, household measures	Finnish Micro-Nutrica Nutritional Analysis programme
	Finland	48-h dietary recall	1	FFQ	Face-to-face interview	Pictures book, household measures, package, dimensions	Finessi
	France	Dietary record	7	NR	Face-to-face interview	Pictures book, household measures, packaging dimension	Microsoft Office Access
	Germany	24-HDR	2	Dietary history	Telephone	Pictures book, household measures	GloboDiet
	Hungary	Dietary record	3	NR	Face-to-face interview	NR	NutriCompEtrend
	Ireland	Dietary record	7	FFQ	Face-to-face interview	Weighing, pictures book, household measures, packaging dimension	WISP-DES
	Italy	Dietary record	3	NR	Face-to-face interview	Pictures book, household measures, packaging	INRAN-DIARIO 3-1
	Latvia	24-HDR	2	FFQ	Face-to-face interview	Pictures book, household measures	PGAIS
	The Netherlands	24-HDR	2	FFQ	Telephone	Pictures book, household measures	GloboDiet
	Poland	24-HDR	1	NR	Face-to-face interview	Pictures book, household measures, packaging information	Dieta FAO
	Slovakia	24-HDR	1	NR	Face-to-face interview	NR	Alimenta 4-3
	Slovenia	24-HDR	1	FFQ	Face-to-face interview	Pictures book, household measures	Blaise 4-7
	Spain	24-HDR	2	FFQ	Face-to-face interview	Pictures book, household measures	DIAL software
	Sweden	Dietary record	4	NR	Face-to-face interview	Pictures book, household measures	MATs version 4-03
	UK	Dietary record	4	FFQ	Face-to-face interview	Household measures, packaging information, weighing, dimension	Intake 2
North and South America	Brazil	Dietary record	2	Food security	Face-to-face interview, paper pencil	Pictures book, household measures	CAPI (not specified)
	Canada	24-HDR	2	Consumption of vitamin and mineral supplements	Face-to-face interview, telephone, paper pencil	Pictures book, food model, household measures, scales, dimension, labelling information	CAI software, developed by Statistics Canada (adopted from AMPM, USDA)
	Chili	24-HDR	2	FFQ	Face-to-face interview, paper pencil	NR	NR
	Mexico	Semi-quantitative FFQ, including 101 foods	NR	NR	NR	NR	NR



Table 2. (Cont.)

Continent	Country	Cardinal dietary method	Number of recalls/records*	Additional dietary questionnaires	Administration method	Quantification method	Interview aids/Software
	The USA	24-HDR	1	Dietary supplements, consumer behaviour, food security, antacids use	Face-to-face interview, telephone, paper pencil	Food models for photos and household measures	CAI software, developed by USDA; Automated Multiple-Pass Method (AMPM)
	Venezuela	24-HDR	NR	FFQ	Face-to-face interview, local software	Pictures book, household measures	Local software (NR)
Oceania	Australia	24-HDR	2	FFQ, food habits, food security	Face-to-face interview, paper pencil	Pictures book, household measures, rulers, wedge diagram, meat cuts with fat trimming, standard portions	Automated Multiple-Pass Method (AMPM) developed by USDA and adapted by CAPI software, LINZ24© (analogous to AMPM, USDA)
	New Zealand	24-HDR	2	FFQ, food habits, dietary supplements, food security	Face-to-face interview, paper pencil	Pictures book, food shape aids, labelling information	CAPI software, LINZ24© (analogous to AMPM, USDA)

NS, not specified; NA, not applicable; NR, not reported; 24-HDR, 24-h dietary recall; Dietary record, synonym to Food record; CAPI, computer-assisted personal interviewing; CAI, computer-assisted interviewing; AMPM, Automated Multiple-Pass Method; CSP, Census and Survey Processing System; BINAT, Israeli Nutrient Database.
* If non specified, possibly 1 assumed.

used as stand-alone method. This is the case in most European countries and allows food consumption that occurred when the children were in the presence of care givers who differ from the adult being interviewed (e.g. care givers of kindergarten) to be captured^(52,53).

Additional assessments and measurements

Almost all IFCS collected additional information in addition to the dietary intake data. The most common extra parameters included in the IFCS were anthropometrics (measured or estimated), physical activity questions/measurements and socio-demographical information (Supplementary Table 3). Anthropometrical data were always collected through measurements performed by trained researchers in the IFCS integrated in health surveys, while in other dietary surveys, these were often estimated (respondent recall/report).

Fieldwork characteristics and data controls

In Table 2 and Supplementary Table S1, the fieldwork aspects of the nutrition surveys are presented. Interviews were conducted either face-to-face or by telephone. Places other than the homes of the participants for administrating the DIA were examination centres (e.g. South Korea and several European countries and mobile examination centres in the USA). The time-span of the fieldwork was at least 1 year (all seasons) in almost all European countries, Canada, the USA, Brazil, South Korea (Korean NHANES 2008 and onwards), Malaysia, Australia and New Zealand. In the African countries running an IFCS, only few seasons/months were included in the fieldwork period.

Food linking and statistical analysis

Supplementary Table S4 summarises features related to data analyses of the dietary intake data. Surveys using multiple measures of intake allow for correcting of within-person variability. Most surveys used the Nusser method⁽⁵⁴⁾ (using Software for Intake Distribution Estimation SIDE or C-SIDE) developed at the Iowa State University to calculate distributions of usual intake (Canada, the USA NHANES 2003, Brazil, South Korea and New Zealand and few European countries). For the USA, from NHANES 2005 and onwards, the NCI method developed by the National Cancer Institute was used (<https://epi.grants.cancer.gov/diet/usualintakes/method.html>). Finally, in the Australian survey, an equation developed by the US National Academy of Science was used to adjust for within-person variance⁽⁵⁵⁾. Misreporting of energy intake was assessed using either the Goldberg method⁽⁵⁶⁾ (the USA, Malaysia, Australia and most European countries) or the equations by Black and Cole⁽⁵⁷⁾ (Canada). Whether the Goldberg method was applied at the individual or group level was not always specified. Two surveys indicated that no calculation of misreporting was performed (South Korea and New Zealand), while several surveys did not report whether misreporting was analysed and if any misreporting adjustments were done.



Table 3. National surveys embedded into broader health surveys

Country	Survey	Designation of the general health survey	Organism/ coordinating institution	Health and lifestyle measurements	Additional comments	Advantages	Disadvantages
South Africa	South African National Health and Nutrition Examination Survey (SANHANES-1)	SANHANES-1	Human Sciences Research Council and the Medical Research Council	Blood lipids, physical examination, pulse rate, cardiovascular fitness	This is the first survey (2013). Only a FFQ is used as dietary intake assessment method	Integration in health examination survey allows clinical evaluation (using nutritional biomarkers) of the effect of fortification policies and of the food-based dietary guidelines implemented	
Australia	National Nutrition and Physical Activity Survey (NNPAS)	Australian Health Survey (AHS)	Australian Bureau of Statistics	Physical examination (BP, self-assessed health, conditions) Lifestyle survey (alcohol consumption, medication, smoking, physical activity)	AHS started in 1977–1978; NNPAS started in 1995; both surveys were combined since 2011–2013	Personal results from the clinical examination are used as incentive for the participants in addition to incentive. The fact that participants participate in both surveys at the same time reduces incentive costs. Integration in health survey contributes to evaluating healthcare policies, guidelines and public health programmes	The high number of measurements and mainly the collection of blood and urine samples create extra burden and possible discomfort for the respondent; also the pedometer (attached to waistband) used for measuring physical activity in children may create discomfort
China	China Health and Nutrition Survey (CHNS)	CHNS	National Institute of Nutrition and Food Safety from the China Center for Disease Control and Prevention	Physical examination: BP, skinfold thickness, conditions (goitre, eye diseases, handicap, reproductive health for women), ever-married survey, community survey, energy expenditure	Both surveys were initiated together since 1991	Integration in health survey contributes to evaluating healthcare policies, guidelines and public health programmes	
Japan	National Health and Nutrition Survey (J-NNS)	J-NNS	National Institute of Health and Nutrition	Physical examination (BP, number of steps per day, use of medication, physical activity); Lifestyle survey (smoking, alcohol, dental health, resting, physical activity)	J-NNS started since 1946 and both health and nutrition components were initially integrated		Insufficient data in given literature

Food consumption surveys : global comparison



Table 3. (Cont.)

Country	Survey	Designation of the general health survey	Organism/ coordinating institution	Health and lifestyle measurements	Additional comments	Advantages	Disadvantages
South Korea	Korean National Health and Nutrition Examination Survey (KNHANES)	KNHANES	Ministry of Food And Drug Safety	Health examination (hypertension, diabetes, dyslipidaemia, hepatitis, liver function, chronic kidney disease, anaemia, heavy metal, chronic obstructive pulmonary disease, dental caries, periodontal disease, visual acuity, eye disease, hearing, ear, nose and throat disease, tuberculosis, osteoarthritis, osteoporosis, muscular strength, thyroid disease), Lifestyle survey (smoking, alcohol, weight control, vaccination, mental health, oral health, healthcare utilisation, medical conditions)	The National Health and Health Behaviour Survey started in 1971. The National Nutrition Survey started since 1969. Both surveys were combined since 1998. The sample represents the total non-institutionalised civilian population of Korea	It is a survey of major importance to public health in Korea, because of the breadth and depth of its data. The KNHANES has evolved to meet the health data needs of the nation. Its data are used to establish, develop, monitor and evaluate national health programmes and policies	Sample size too small due to financial and operational constraints-issues with survey design and operations. The KNHANES is designed as a cross-sectional study, but the longitudinal follow-up is limited to linkages of survey participants with National Health Insurance data and National Cancer Registry data. It has been examined, but the effort to follow-up with the respondents was abandoned due to financial constraints and operational problems
Malaysia	Malaysian Adult Nutrition Survey (MANS)	National Health and Morbidity; Survey (NHMS)	Ministry of Health	Medical examination (diabetes, hypertension, dyslipidaemia, mental health, home injury, healthcare demand), Lifestyle (smoking, physical activity, alcohol consumption)	The NHMS was conducted since 1986. The MANS was established since 2004 and integrated to NHMS. The South East Asian Nutrition Survey (SEANUTS) is a four-country multistage cluster design study and also delivers important nutrition and health information for Malaysia	The participants were representative for the target population. The SEANUTS provides data that will be very relevant for assessing the effect of present health and nutrition. Insights into growth parameters in combination with nutritional status and dietary habits provide relevant information for food companies to develop new products or to fine-tune the existing ones. The SEANUTS will benefit the target population in the countries	The study took about 6 months longer than initially foreseen-children study (SEANUTS). The main reason for this was the underestimation of the time needed for data cleaning, questionnaire evaluation, statistical evaluation and finally the preparation of the reports



Canada	Canadian Community Health Survey Nutrition (CCHS)	CCHS	Statistics Canada	Medical examination (general health, chronic conditions, handicap), Lifestyle (smoking, physical activity, alcohol consumption)	The Canadian Nutrition Survey started since 1970–1972 prior to the Canadian Health Survey started in 1978–1979, and both have been combined. Includes indigenous people's health and women's health are included	The survey can be used as a reference to guide nutrition-related programmes and policies. It will be of particular benefit to provincial ministries of health, researchers and graduate students, policy makers and analysts, public health professionals, epidemiologists, dietitians, the food industry and the health media	
Mexico	Mexican Health and Nutrition Survey (ENSANUT)	ENSANUT	National Institute of Public Health	Physical examination (anaemia, diabetes, hypertension, reproductive health, mental health, vaccination), Lifestyle (smoking, alcohol)	National health surveys have been conducted since 1986, but the dietary component was integrated since 2006	–	Tables not in English
The USA	National Health and Nutrition Examination Survey (Continuous NHANES)	Continuous NHANES	National Center for Health Statistics from the Centers for Disease Control and Prevention	Physical examination (audiometry, human papillomavirus, oral health, hypertension, heart, sexually transmitted diseases). Lifestyle (e.g. smoking, alcohol)	National health surveys were collected since 1950s. The first NHANES started in 1971 as a combination both health and nutrition components	Estimates of consumption of specific foods and food groups are important for evaluating the progress in meeting key objectives in national public health initiatives	Under-reporting/ over-reporting data are not accurate. A limited knowledge base exists with regard to the appropriate methodology for obtaining valid and reliable information about dietary supplement use. Sample size was not big enough

BP, blood pressure.

Recruitment and training of field staff

In Supplementary Table S2, recruitment and training of the interviewers and field staff in the nutrition surveys are described. In twenty-three IFCS, the interviewers were nutritionists or dietitians. In some countries, interviews were performed by trained interviewers (sometimes in addition to the nutritionists) who are familiar with local food customs (New Zealand) or professional interviewers working on a variety of surveys (Canada). For interviewers in the USA, a high school diploma was considered to be the minimum education requirement, as this is necessary for government jobs. However, also dietitians/nutritionists were available to perform the IFCS in the USA. Training was provided on a variety of topics such as interviewing and probing skills (Canada, the USA, Brazil, China, South Korea, Malaysia, Australia and New Zealand), training on contacting participants and software training. The duration of these training sessions ranged from 3 d (China) to 3 weeks (India). The average duration of reported training programmes for interviewers was approximately 7 d.

Characteristics of individual food consumption survey integrated in National Health Surveillance Systems

In the past decades, several IFCS have been integrated in a broader health surveillance system with South Africa the most recent (since 2013). In total, nine countries have incorporated their national IFCS into continuous NHANES (see Fig. 2; Table 3): Canada, Mexico, the USA, China, Japan, South Korea, Malaysia, South Africa and Australia. South Africa included their IFCS in their South African NHANES, though the survey data only allow a rough estimate of the dietary intake among this population as a less detailed and closed FFQ has been used as primary DIA method. The dietary assessment methods used in these integrated surveys varied from the use of multiple 24-HDR (the USA) to less detailed semi-quantitative methods such as FFQ (in South Africa). Most of the integrated surveys are face-to-face and often carried out at home. It should be noted that even for IFCS surveys not part of a larger health interview or health examination survey questionnaires on health and physical activity were often included, as shown in the overview in Supplementary Table S3.

Critical appraisal and recommendations

The present inventory is the first of its kind to present the wide range of methodological aspects associated with national IFCS across all continents. The present inventory comprises of IFCS performed in thirty-nine countries from six continents: Africa, Asia, Australasia, Europe, North-America and South-America. National IFCS systems are available in most of the high-income countries, while still scarce in low- and middle-income countries, such as several African and Asian countries.

Computer-assisted interview software is frequently used in national nutrition surveys because it allows structured and standardised collection of dietary intake data. The present overview shows that several countries use the US Department of Agriculture-based computer-assisted interview software and food classification. The leading role of this department is not surprising given its long history that goes back to 1892⁽⁵⁸⁾.

While the use of DIA software from another country can be appropriate, the same is not true when it comes to using food composition data from another country. Many national or regional food composition tables or databases contain incomplete, outdated and unreliable data. For this reason, nutrient intakes are often assessed by borrowing data from US Department of Agriculture data or from neighbouring countries⁽⁵⁹⁾.

Although dietitians or nutritionists were recruited for performing the interviews in most of the national IFCS (e.g. China, Japan, South Korea, Malaysia and Australia); in other countries, interviews were performed by trained interviewers, who were familiar with local food customs although not necessarily dietitians or nutritionists (e.g. New Zealand and several European countries), or professional interviewers working on a variety of surveys (Canada). For interviewers in the USA, a high school diploma was considered to be the minimum education requirement, as this is necessary for government jobs. All surveys rely either on professional interviewers involved in a variety of surveys or survey staff with a given minimal educational qualification, complemented with specific software and interview training. The reason why other specialisations different from dietitian/nutritionist (e.g. nurse) may be required in the IFCS integrated in health surveys for conducting interviews may be because these IFCS are part of the national health surveillance systems that include a large battery of health and lifestyle modules to be investigated in addition to the nutrition module (e.g. anthropometrical and blood pressure measurements requiring a nurse or clinician).

It is noteworthy that some national health surveys also include a nutrition module that most of the time includes an FFQ, though the dietary information obtained through these modules is rather limited and focuses on particular indicators, such as the WHO health indicators. A particular example is Singapore where every 6 years, a health interview survey is conducted that is integrated in the national IFCS. Although the 24-HDR method was used in the previous Singapore health interview surveys, presently they only use an FFQ as primary DIA method.

This inventory demonstrates the increasing integration of IFCS in national health surveillance systems and *vice-versa*, and this not only in high-income countries but also in continents including lower middle-income countries such as Africa, Asia and South America (Table 3). The level of detail and the extent of different health and lifestyle domains included in these surveys differs importantly from survey to survey with a trend towards more detailed questionnaires and DIA methods used in high-income countries compared with less detailed methods in surveys ran in low- or middle-income countries,

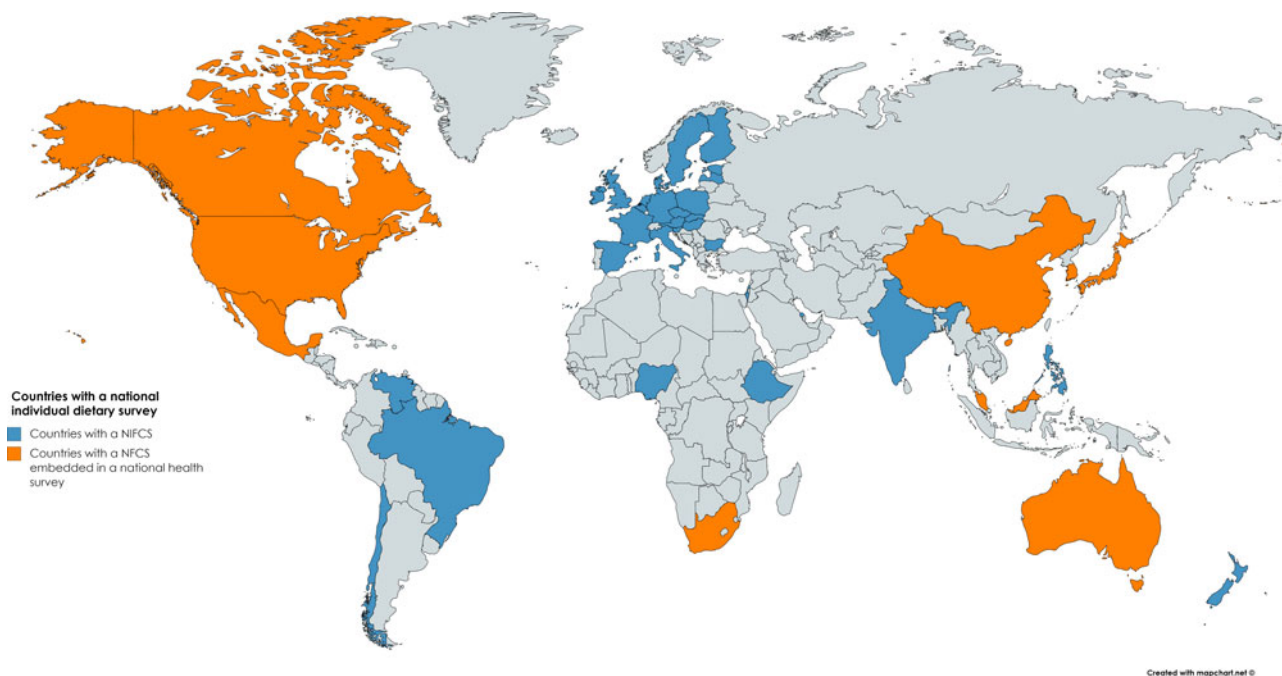


Fig. 2. Mapping of the countries in which at least one national individual food consumption survey has been conducted before 2017 (highlighted in blue/orange), indicating those that were integrated in a national health survey in orange (written in bold italic in the legend). Africa: Nigeria, South Africa, Ethiopia; North and South America: Brazil, *Canada*, *Chili*, *Mexico*, the *USA*, *Venezuela*; Asia: Bahrain, *China*, India, Israel, *Japan*, *South Korea*, *Malaysia* and Philippines; Europe: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, The Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden, the UK; Oceania/Australasia: *Australia* and New Zealand.

although often covering a broad scope of health and life-style topics (collected with less detail).

The NHANES of the USA was one of the first surveys to embed an IFCS in a health examination survey. It demonstrated the added value of this integrated approach through its large publication record reporting on diet-related disease outcomes⁽⁶⁰⁾. In the 1960s, the NHANES began to assess the health status of individuals from the age 6 months through to 74 years, including measures of hypertension, elevated serum cholesterol and overweight. Individual food consumption was added as a survey component in the 1970s. The NHANES and related IFCS conducted by US Department of Agriculture were integrated in 2002, and at that time the dietary reports from the integrated survey became known as What We Eat in America. During the four decades in which individual food consumption has been tracked in nationally representative cross-sectional surveys of the population, there have been improvements in the data collection methods and protocols used to estimate individual food consumption. These improvements included for instance the collection of more than 1 d of consumption on at least a subsample of the population and questions about tap water consumption and water softening, dietary supplement use, etc. The quality of data has improved, but of course some bias and measurement errors still exist given that the estimates rely on self-reported data. The present NHANES survey relies on the gold standard for dietary measures, two or more

24-HDR per person and allows the assessment of usual dietary intakes, including food and nutrient intakes but also contaminants and bio-active components. The NHANES also collects information on race/ethnicity on the basis of self-reported categories as follows: non-Hispanic whites, non-Hispanic African Americans and Mexican Americans. Health examinations are performed in the NHANES Medical Examination Center⁽⁶¹⁾. It is noteworthy that despite the higher respondent burden implied by these integrated surveys (which often include several detailed health modules and physical examinations in addition to the dietary assessment module), the response rate is quite high in comparison with many other non-integrated IFCS. This could indicate that the response rate does not only depend on the respondent burden, demonstrating the feasibility of such integrated approaches in high-income countries. Some middle-income countries such as Mexico, Malaysia and South Africa also confirmed the feasibility of this integrated approach showing high response rates, although using less detailed or less ideal methods for DIA (only 1×24-HDR or FFQ). The feasibility and cost-efficiency of the integration of national IFCS in existing health surveys should be further investigated.

Given that quantitative IFCS are expensive and difficult to implement in low-income countries, questionnaire methods have been developed to assess the dietary diversity of the diet as a simple proxy to measure



micronutrient adequacy in women's and children's diets at the individual level^(62–65). Tufts University, in collaboration with FAO, are in the process of developing and pilot testing a new DIA software for use in low-income countries, considering the logistical and financial constraints that limit the feasibility of using the same DIA methods as those used in the high-income countries (INDDEX, <http://inddex.nutrition.tufts.edu/>). Considering the high prevalence of technology illiteracy in the low-income settings, this newly developed software will require administered interviews. FAO is also developing, together with WHO, a comprehensive international database of individual quantitative IFCS (<http://www.fao.org/nutrition/assessment/food-consumption-database/en/>). A prototype has been published. While this tool is being finalised, FBS represent the easiest and the most widespread source of standardised data that permit international comparisons over time.

This review presents an inventory of methodological aspects related to the performance of national IFCS in the different continents worldwide. Although substantial efforts have been made to undertake a comprehensive overview, it is inevitable that some surveys may not be captured. It is worth noting that, to avoid omission of any surveys in continents where surveys are not necessarily published in public literature or reports, the studies included in our inventory were compared with those identified in the frame of the FAO review aforementioned. Of the nine countries on which FAO had focused, only one nationwide survey had been identified that was not identified in our search. We consider that the two-step approach using both available literature and expert consultation was the best method available to create the comprehensive overview presented.

Conclusion

This review shows that IFCS have been implemented in most high-income countries, although routine IFCS are still lacking in several countries and are even completely absent in most of the low- and middle-income countries, particularly in African and Asian countries. The methods used for DIA in national nutrition surveys are relatively similar across continents with the 24-HDR method as the predominant assessment method worldwide. However, caution is still warranted when comparing results from IFCS between countries due to important differences in levels of detail or other methodological aspects, such as different food classification systems used and differences in conversion factors used for calculating nutrients.

This inventory will help to identify the gaps and needs and for prioritising resource allocations. In addition, it could serve as a basis to advocate for national IFCS to be incorporated into NHANES in order to create more research opportunities for investigating diet–disease relationships and a frame to plan and evaluate the effect of diet-related (e.g. fortification) policies and nutrition recommendations. The nine countries that integrated their IFCS within their NHANES can serve as proof-of-principle for other countries, considering their

strengths and limitations. Such integration of national IFCS in national health surveillance systems would avoid fragmentation of resources and could as such be a cost-efficient opportunity for countries where IFCS are still lacking or executed only sporadically because of lacking resources.

Supplementary material

The supplementary material for this article can be found at <https://doi.org/10.1017/S0029665117001161>.

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Authorship

I. H., F. B. Z. and M. J. G. launched the idea to investigate cross-continental comparisons of national food consumption surveys with particular focus on the possibilities for integration in National Health Surveys. I. H. conducted the systematic review as main reviewer and drafted the manuscript. E. K. A. was responsible for the data extraction of the selected literature in the tables and assisted in the literature searches. A. M. has performed consistency checks in the tables and manuscript. C. L., P. A. and A. B. contributed to extra studies to be included in the tables thanks to an extra search conducted in the frame of a project focusing on additional individual food consumption surveys in low- and lower middle-income countries. All authors contributed to the writing of the manuscript and the interpretation of the results. All the authors have read and approved the final version of this paper.

References

1. Food and Agriculture Organization (2017) FAOSTAT database, food balance sheets. Available at <http://www.fao.org/faostat/en/#data/FBS>.
2. Del Gobbo LC, Khatibzadeh S, Imamura F *et al.* (2015) Assessing global dietary habits: a comparison of national estimates from the FAO and the Global Dietary Database. *Am J Clin Nutr* **101**, 1038–1046.
3. Claro RM, Jaime PC, Lock K *et al.* (2010) Discrepancies among ecological, household, and individual data on fruits and vegetables consumption in Brazil. *Cad Saude Publ* **26**, 2168–2176.
4. Serra-Majem L, MacLean D, Ribas L *et al.* (2003) Comparative analysis of nutrition data from national, household, and individual levels: results from a WHO-CINDI collaborative project in Canada, Finland, Poland, and Spain. *J Epidemiol Commun Health* **57**, 74–80.
5. Engle-Stone R, Brown KH (2015) Comparison of a household consumption and expenditures survey with nationally representative food frequency questionnaire and 24-hour dietary recall data for assessing consumption of fortifiable foods by women and young children in Cameroon. *Food Nutr Bull* **36**, 211–230.
6. Pisa PT, Landais E, Margetts B *et al.* (2014) Inventory on the dietary assessment tools available and needed in Africa: a prerequisite for setting up a common methodological research infrastructure for nutritional surveillance, research and prevention of diet-related non-communicable diseases. *Crit Rev Food Sci Nutr*, 1–25.
7. Micha R, Khatibzadeh S, Shi P *et al.* (2015) Global, regional and national consumption of major food groups in 1990 and 2010: a systematic analysis including 266 country-specific nutrition surveys worldwide. *BMJ Open* **5** (9).
8. De Keyser W, Bracke T, McNaughton SA *et al.* (2015) Cross-continental comparison of national food consumption survey methods – a narrative review. *Nutrients* **7**, 3587–3620.
9. Huybrechts I, Casagrande C, Nicolas G *et al.* (2011) Inventory of experiences from national/regional dietary monitoring surveys using EPIC-Soft. *Eur J Clin Nutr* **65**, Suppl. 1, S16–S28.
10. Merten C, Ferrari P, Bakker M *et al.* (2011) Methodological characteristics of the national dietary surveys carried out in the European Union as included in the European Food Safety Authority Comprehensive European Food Consumption Database. *Food Additives Contaminants A, Chem, Anal, Control, Exposure Risk Assess* **28**, 975–995.
11. Blanquer M, Garcia-Alvarez A, Ribas-Barba L *et al.* (2009) How to find information on national food and nutrient consumption surveys across Europe: systematic literature review and questionnaires to selected country experts are both good strategies. *Br J Nutr* **101**, Suppl. 2, S37–S50.
12. Ethiopian Public Health Institute (2013) *Ethiopia National Food Consumption Survey*. Addis Ababa, Ethiopia: Ethiopian Public Health Institute.
13. Maziya-Dixon B, Akinyele I, Oguntona E *et al.* (2004) *Nigeria Food Consumption and Nutrition Survey 2001–2003 Summary*. Ibadan, Nigeria: International Institute of Tropical Agriculture.
14. Shisana OLD, Rehle T, Simbayi L *et al.* (2013) *South African National Health and Nutrition Examination Survey*. Cape Town: HSRC Press.
15. Wahab A, Gharib N, Al Sairafi M *et al.* (2002) National Nutrition Survey for adult Bahrainis aged 19 years and above. Bahrain: Ministry of Health.
16. Bel S, Van den Abeele S, Lebacqz T *et al.* (2016) Protocol of the Belgian food consumption survey 2014: objectives, design and methods. *Arch. Public Health* **74**, 1–11.
17. Petrova S and Angelova K (2006) Food-based dietary guidelines for Bulgarian adults – scientific background for development and formulation. *Adv Bulg Sci* **4**, 19–33.
18. Ruprich J, Dofkova M, Rehurkova I *et al.* (2006) Individual food consumption – the national study SISP04. Prague: Institute of Public Health.
19. Pudule I, Grinberga D, Kadziauskiene K *et al.* (1999) Patterns of smoking in the Baltic Republics. *J Epidemiol Commun Health* **53**, 277–282.
20. Pomerleau J, McKee M, Robertson A *et al.* (1999) Nutrition and lifestyle in the Baltic republics. European Centre on Health of Societies in Transition & World Health Organization Regional Office for Europe. PHP Departmental Publication No. 32. London: School of Hygiene and Tropical Medicine.
21. Reinivuo H, Hirvonen T, Ovaskainen ML *et al.* (2010) Dietary survey methodology of FINDIET 2007 with a risk assessment perspective. *Public Health Nutr* **13**, 915–919.
22. Dubuisson C, Lioret S, Touvier M *et al.* (2010) Trends in food and nutritional intakes of French adults from 1999 to 2007: results from the INCA surveys. *Br J Nutr* **103**, 1035–1048.
23. Szeitz-Szabó M, Bíró L, Bíró G *et al.* (2011) Dietary survey in Hungary, 2009. Part I. Macronutrients, alcohol, caffeine. *Fibre Acta Alimentaria* **40**, 142–152.
24. Harrington KE, Robson PJ, Kiely M *et al.* (2001) The North/South Ireland Food Consumption Survey: survey design and methodology. *Public Health Nutr* **4**, 1037–1042.
25. Sekula W, Nelson M, Figurska K *et al.* (2005) Comparison between household budget survey and 24-hour recall data in a nationally representative sample of Polish households. *Public Health Nutr* **8**, 430–439.
26. Sichieri R, Pereira R, Martins A *et al.* (2008) Rationale, design, and analysis of combined Brazilian household budget survey and food intake individual data. *BMC Public Health* **8**, 89.
27. Hugo A, Patricia B, Marcelo P. (2010) Encuesta Nacional De Consumo Alimentario. Santiago: University of Chile.
28. University of Otago and Ministry of Health (2011) *A Focus on Nutrition Key Findings of the 2008/09 New Zealand Adult Nutrition Survey*. Wellington: Ministry of Health.
29. Indian Council of Medical Research (2012) Diet and Nutritional Status of Rural Population, Prevalence of Hypertension & Diabetes among Adults and Infant & Young Child Feeding Practices; Report of Third Repeat Survey. Hyderabad, India: Indian Council of Medical Research.
30. Keinan-Boker L, Noyman N, Chinich A *et al.* (2005) Overweight and obesity prevalence in Israel: findings of the first national health and nutrition survey (MABAT). *Isr Med Assoc* **7**, 219–223.
31. Ministry of Health of Israel (2017) Nutrition Surveys (MABAT). Available at <http://www.health.gov.il/English/Ministry Units/ICDC/mabat/Pages/default.aspx>.
32. National Institute of Health and Nutrition (2011) Outline of the National Health and Nutrition Survey Japan. Available at http://www0.nih.go.jp/eiken/english/research/project_nhns.html.
33. Kim Y (2014) The Korea National Health and Nutrition Examination Survey: current status and challenges. *Epidemiol Health* **36**, e2014002.



34. Institute for Public Health (2014) National Health and Morbidity Survey 2014: Malaysian Adult Nutrition Survey. Kuala Lumpur: Institute for Public Health.
35. Food and Nutrition Research Institute (2017). 8th National Nutrition Survey. Available at <http://www.fnri.dost.gov.ph/index.php/nutrition-statistic/19-nutrition-statistic/118-8th-national-nutrition-survey>.
36. Elmadfa I, Freisling H, Nowak V *et al.* (2009) Austrian Nutrition Report 2008 English Summary. Vienna, Austria: Institute of Nutritional Sciences, University of Vienna.
37. Pedersen N, Christensen T, Matthiessen J *et al.* (2015) Danskernes kostvaner 2011–2013 Hovedresultater [Danish Dietary Habits 2011–2013 Main results]. Soborg, Denmark: DTU Fødevareinstituttet
38. Heuer T, Krems C, Moon K *et al.* (2015) Food consumption of adults in Germany: results of the German National Nutrition Survey II based on diet history interviews. *Br J Nutr* **113**, 1603–1614.
39. Leclercq C, Arcella D, Piccinelli R *et al.* (2009) The Italian National Food Consumption Survey INRAN-SCAI 2005–06: main results in terms of food consumption. *Public Health Nutr* **12**, 2504–2532.
40. Sette S, Le Donne C, Piccinelli R *et al.* (2013) The third National Food Consumption Survey, INRAN-SCAI 2005–06: major dietary sources of nutrients in Italy. *Int J Food Sci Nutr* **64**, 1014–1021.
41. Rossum CTMv, Franssen HP, Verkaik-Kloosterman J *et al.* (2011) Dutch National Food Consumption Survey 2007–2010 Diet of children and adults aged 7 to 69 years. Bilthoven: National Institute for Public Health and the Environment.
42. Ortega RM, Lopez-Sobaler AM, Ballesteros JM *et al.* (2011) Estimation of salt intake by 24 h urinary sodium excretion in a representative sample of Spanish adults. *Br J Nutr* **105**, 787–794.
43. Becker W & Pearson M (2002) Kostvanor och na` ringsintag I Sverige. Metod-och resultatanalys. [Dietary habits and nutritional intake In Sweden. Method and performance analysis]. pp. 1–201. Uppsala: National Food Administration.
44. Statistics Canada (2017) Canadian dietary survey project.. Available at <http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5049>.
45. Barquera S, Hernandez-Barrera L, Campos-Nonato I *et al.* (2009) Energy and nutrient consumption in adults: analysis of the Mexican National Health and Nutrition Survey 2006. *Salud Publica Mexico* **51**, Suppl. 4, S562–S573.
46. Zhang B, Zhai FY, Du SF *et al.* (2014) The China Health and Nutrition Survey, 1989–2011. *Obesity Rev: Off J Int Assoc Study Obesity* **15**, Suppl. 1, 2–7.
47. Chinese Center for Disease Control and Prevention (2017) China Health and Nutrition Survey. Available at <http://www.cpc.unc.edu/projects/china/about>.
48. Bates B, Lennox A, Prentice A *et al.* (2014) *National Diet and Nutrition Survey Results from Years 1, 2, 3 and 4 (combined) of the Rolling Programme (2008/2009–2011/2012)*. London: Public Health England.
49. Centers for Disease Control and Prevention (2017) National Health and Nutrition Examination Survey. Available at <http://www.cdc.gov/nchs/nhanes/>
50. Australian Bureau of Statistics (2017) National Nutrition Survey. Available at <http://www.abs.gov.au/AUSSTATS/abs@.nsf/0/01F2086AD5CDBF65CA256BD000272375?OpenDocument>.
51. Ministerio del Poder Popular de Planificación (2013) Encuesta Nacional de Consumo de Alimentos. Available at http://www.ine.gov.ve/index.php?option=com_content&view=category&id=114&Itemid=38
52. Freisling H, Ocke MC, Casagrande C *et al.* (2015) Comparison of two food record-based dietary assessment methods for a pan-European food consumption survey among infants, toddlers, and children using data quality indicators. *Eur J Nutr* **54**, 437–445.
53. Ocke M, Brants H, Dofkova M *et al.* (2015) Feasibility of dietary assessment methods, other tools and procedures for a pan-European food consumption survey among infants, toddlers and children. *Eur J Nutr* **54**, 721–732.
54. Nusser SM, Carriquiry AL, Jensen HH *et al.* (1990) *A Transformation Approach to Estimating Usual Intake Distributions*. Iowa State University Digital Repository, CARD Working Papers. Paper 95. Available at http://lib.dr.iastate.edu/card_workingpapers/95.
55. Mackerras D, Rutishauser I (2005) 24-hour national dietary survey data: how do we interpret them most effectively? *Public Health Nutr* **8**, 657–665.
56. Goldberg GR, Black AE, Jebb SA *et al.* (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-reporting. *Eur J Clin Nutr* **45**, 569–581.
57. Black AE, Cole TJ (2001) Biased over- or under-reporting is characteristic of individuals whether over time or by different assessment methods. *J Am Diet Assoc.* **101**, 70–80.
58. Ahuja JK, Moshfegh AJ, Holden JM *et al.* (2013) USDA food and nutrient databases provide the infrastructure for food and nutrition research, policy, and practice. *J Nutr* **143**, 241S–249S.
59. Food and Agriculture Organization (2016) Food Composition Challenges Rome, Italy. Food Composition Challenges. Available at <http://www.fao.org/infoods/infoods/food-composition-challenges> (accessed on 21 May 2013).
60. Institute of Medicine (US) Committee on Strategies to Reduce Sodium Intake (2010) Appendix E, Background on the National Health and Nutrition Examination Surveys and Data Analysis Methods. In *Strategies to Reduce Sodium Intake in the United States*. pp. 409–416 [JE Henney, CL Taylor and CS Boon, editors]. Washington, DC: National Academies Press.
61. National Center for Health Statistics (2009) Health, United States, 2008 with special feature on the health of young adults United States. DHHS Publication No. 2009-1232. Hyattsville, MD: National Center for Health Statistics.
62. Hoddinott J, Yisehac Y (2002) *Dietary Diversity as a Food Security Indicator. Food and Nutrition Technical Assistance Project*. Washington, DC: Academy for Educational Development.
63. Working Group on Infant and Young Child Feeding Indicators (2006) Developing and Validating Simple Indicators of Dietary Quality and Energy Intake of Infants and Young Children in Developing Countries: Summary of Findings from Analysis of 10 Data Sets. Food and Nutrition Technical Assistance Project. Washington, DC, USA: FHI 360.
64. Arimond M, Wiesmann D, Becquey E *et al.* (2010) Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. *J Nutr* **140**, 2059S–2069S.
65. Arimond M, Ballard T, Deitchler M *et al.* (2016) *Minimum Dietary Diversity for Women: A Guide for Measurement*. Rome: FAO.

Annex 1. Overview of the Inventory Framework, including eight aspect categories and fifty indicator fields (Tx indicates the table number in which the indicator is included with x = number)

		Fieldwork characteristics and data controls			
T1	General items	T2		T4	Recruitment and training of interviewers
T1	Continent	T2	Place of DIA administration (place of interview)	T4	Recruitment criteria interviewers (type/background interviewers)
T1	Country	T2	Language of interview materials	T4	Number of interviewers
T1	Designation of the survey	T2	Language of interview	T4	Training material/training topics
T1	Reference			T4	Training duration
T1	Coordinating institute	T3-T5	Dietary intake and other assessments	T4	Presence of nutritionists/dietitians
T1	Frequency/recurrence of survey	T3	Method (cardinal dietary assessment method)		
T1	Latest survey	T3	Number of recalls/ records (n)	T6	Food linking and analysis
T1	Survey included in the inventory	T3	Administration method	T6	Food classification system
T1	Survey integrated in broader national health survey	T3	Portion size estimation (quantification method)	T6	Food composition databases
T2	Target population, survey design and sampling	T3	Interview aids/software	T6	Statistical procedures/ adjustment (software)
T2	Sex of participants	T5	Additional questionnaires/ measurements	T6	Methods for calculating under- or over-reporters
T2	Age (years) range	T5	Anthropometry	T7	National surveys embedded into broader health surveys
T2	Sampling method and design	T5	Mode of measurement/ assessment	T7	Survey
T2	Sampling frame/type	T5	Biological samples	T7	Designation of the general health survey
T2	Stratification scheme	T3	Laboratory analysis	T7	Organism/coordinating institute
T2	Survey period		Additional dietary questionnaires	T7	Health measurements
T2	Recruitment of participants			T7	Additional comments (e.g. starting date integration of food consumption survey)
T2	Invitation type (channel)				
T2	Incentives				
T2	Number of participants (n)				
T2	Participation rate (%)				

DIA, dietary intake assessment.