



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

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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

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ABSTRACT

Objective: To carry out an inventory on the availability, challenges, and needs of dietary assessment (DA) methods in Africa as a pre-requisite to provide evidence, and set directions (strategies) for implementing common dietary methods and support web-research infrastructure across countries. **Methods:** The inventory was performed within the framework of the "Africa's Study on Physical Activity and Dietary Assessment Methods" (AS-PADAM) project. It involves international institutional and African networks. An inventory questionnaire was developed and disseminated through the networks. Eighteen countries responded to the dietary inventory questionnaire. **Results:** Various DA tools were reported in Africa; 24-Hour Dietary Recall and Food Frequency Questionnaire were the most commonly used tools. Few tools were validated and tested for reliability. Face-to-face interview was the common method of

KEYWORDS

Inventory; dietary assessment; tools; Africa; AS-PADAM

administration. No computerized software or other new (web) technologies were reported. No tools were standardized across countries. *Conclusions:* The lack of comparable DA methods across represented countries is a major obstacle to implement comprehensive and joint nutrition-related programmes for surveillance, programme evaluation, research, and prevention. There is a need to develop new or adapt existing DA methods across countries by employing related research infrastructure that has been validated and standardized in other settings, with the view to standardizing methods for wider use.

Introduction

Africa is currently experiencing a major health transition, attributable mainly to rapid urbanization and accompanied by the emergence of Non-Communicable Diseases (NCDs) and the Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome(AIDS) pandemic, while under-nutrition and other infectious diseases are still highly prevalent (Vorster, 2002; Boutayeb, 2006; Popkin, 2009; Delisle et al., 2011; Vorster et al., 2011; Delisle et al., 2012; Pisa et al., 2012; Popkin et al., 2012; Steyn et al., 2012). This transition is also associated with rapid changes in dietary and physical activity patterns in populations across Africa (Kruger et al., 2002; Vorster, 2002, 2011; Aounallah-Skhiri et al., 2011). Although most NCDs have been reported to be preventable through modifiable lifestyle factors, i.e. appropriate diets and physical activity (World Health Organization (WHO), 2004, 2013; Lim et al., 2012), in sub-Saharan Africa, the prevalence of NCDs is increasing exponentially, and are expected to account for three-quarters of as many deaths as caused by communicable, maternal, perinatal, and nutritional diseases by 2020 and to exceed these as the most common cause of death by 2030 (World Health Organization (WHO), 2013).

Little is known about nutrition and physical activity as determinants for NCDs, including cancer, in Africa. One of the main drawbacks in implementing research to diet and/or physical activity-related NCDs is the lack of reliable dietary and physical activity methodologies. Furthermore, reliable and standardized tools are needed for measuring, monitoring, and comparing the different stages of transition across countries and investigating their association with diseases in order to inform policies. Lack of reliable and comprehensive evidence on dietary intakes is a major constraint for guiding action and assessing trends in dietary patterns (Micha et al., 2012). The Dietary Exposure (DEX) assessment group at the International Agency for Research on Cancer (IARC), an integrated part of the World Health Organization, has been a part of and has a long-standing experience in the development, standardization, validation, and implementation of dietary methods and analyses of dietary exposures to international epidemiological and monitoring settings relevant for cancer and other NCD research and their prevention in Europe (Slimani et al., 1999, 2002, 2007, 2011; Al-Delaimy et al., 2005; de Boer et al., 2011; Crispim et al., 2011a, 2011b, 2012, 2013; Huybrechts et al., 2011b). Through existing and newly initiated international and national partnerships (some that are existing and others still under development), this group (DEX) intends to support and address the major methodological and infrastructural challenges facing low- and middle-income countries (LMIC), including those in Africa, and to support the implementation of a global nutritional surveillance system within the broader WHO action plans on the control and prevention of NCDs (World Health Organization (WHO), 2008). In 2011, with this objective

in mind and building on its previous experience, DEX established Africa's Study on Physical Activity and Dietary Assessment Methods (AS-PADAM) project with several partners at national ("African Network") and international ("International Institutional Network") levels. This paper aims to report an inventory on the availability, challenges, and needs of dietary assessment (DA) methods as a pre-requisite to develop strategies and approaches for the implementation of common DA methodologies, and to support e-research infrastructures across African countries for research, monitoring surveillance, and prevention on diet-related NCDs. Ultimately, this initiative should provide decision makers, stakeholders, and scientists, at national, regional, and international levels, with more standardized dietary data sets being comparable across countries. In this paper, only the inventory on the DA methods and related issues is reported.

Methods

The inventory was conducted through two complementary networks established within the AS-PADAM project: the International Institutional Network and the African Network. This inventory considered the main gaps and the existing needs in Africa with respect to DA methods. The African Network included African collaborators and partners. This network currently includes 23 countries; comprising and being represented mainly by invited academics, organizations, and research groups with relevant experience in the areas of nutrition and physical activity research in African settings. This network was created mainly by the following procedures: (i) inviting different African scientists with known expertise in the areas of dietary and physical activity method research, (ii) inviting different African partners/researchers through the African Nutrition Leadership Programme (ANLP), (iii) using relevant search engines such as PubMed to identify and invite relevant people currently working and those who have previously worked in this area of research in Africa, and (iv) inviting partners through other international institutional networks involved in the project (e.g. World Public Health Nutrition Association (WPHNA)). Their specific tasks in the inventory included completing a questionnaire inquiring on availability, quality and, challenges of DA methods/devices in their countries and distributing it to other relevant partners, as appropriate.

Of the 23 African countries that initially accepted to be part of this initiative, 18 responded to the dietary inventory questionnaires and are grouped by region as follows: (1) *North Africa*: Algeria, Egypt, Morocco, and Tunisia; (2) *West Africa*: Benin, Burkina Faso, Cameroon, Ghana, Nigeria, and Senegal; (3) *Southern Africa*: Malawi, Mozambique, Namibia, South Africa, and Zimbabwe; and (4) *East Africa*: Kenya, Sudan, and Uganda.

At this stage of the project, the International Institutional Network had specific tasks to assist in and comment on the

design and content of the dietary inventory questionnaire developed by DEX and to interpret the intermediate outcomes. This network comprises international institutions and associations that have experience in the field of DA methods and/or experience in developing countries or African settings, i.e. the ANLP, WPHNA, Food and Agriculture Organization (FAO), the Institute of Research for Development (IRD) (France), the Centre of Excellence for Nutrition (CEN) in Africa (South Africa), African Nutrition Society (ANS), The University of Montreal, Transition Nutritionnelle team (TRANSNUT), Canada, and Alberta Health Services, Canada. All partners and institutions involved in the inventory received a detailed project proposal outlining the short, medium, and long-term objective of the project before they formally agreed to take part in this initiative.

A comprehensive ad hoc inventory questionnaire (see Supplemental file) on DA methods was developed and pre-tested within the International Institutional Network before its wide circulation to the African Network for completion. The quality was further improved by taking into account the remarks and suggestions from selected experts in the African Network who evaluated the questionnaire. Its final version was then disseminated to the entire African Network. A thesaurus (see Supplemental file) was included to define important terms used in the questionnaires to ensure a harmonized use of terminology among respondents. The questionnaire included open and closed questions and was structured into three sections that aimed to provide detailed information on the following:

1. "General information on the local situation," including major public health problems and challenges that nutrition research is facing.
2. "Dietary assessment methods" currently being used in the countries of interest (the DA methods investigated were: food record/diary, dietary recalls, food frequency questionnaire, dietary history, direct observation, duplicated diets, and biological assessments (biomarkers)).
3. "Research studies and/or monitoring surveys" that reported results of dietary assessment.

The questionnaire was developed and disseminated in French and English. It was sent to the International and African networks by electronic mail. Completed questionnaires were received and checked for completeness and comprehensiveness. Data were extracted into Excel databases and tables were created to summarize all findings. Summary tables were sent back to all participants and institutions to re-check, review for completeness and accuracy, and to provide missing information. Since this inventory does not pretend to be ultimately exhaustive, it provides only a general indication of the current status on DA methods in African countries as reported by the respondents.

Results

Table 1 summarizes general information on the DA methods, public health nutrition problems, and research needs in different African regions as perceived and self-reported by the respondents and thus does not intend to be fully exhaustive. The main challenges affecting nutrition research reported were the lack of financial support, the lack of expertise (skills), and

the lack of infrastructure. Food Frequency Questionnaires (FFQ) and 24-Hour Dietary Recalls (24-HDR) were reported to be the most frequently used DA methods in the four regions. All 24-HDR reported, as well as all FFQs, were paper- and interview-based methods (except Ghana where FFQs were both telephone and face-to-face interviews).

Dietary assessment methods, food composition tables (FCTs), and food-based dietary guidelines (FBDGs)

Tables 2–5 provide details of the DA methods, FCTs, and FBDGs used in each region. In summary, various DA tools are available, with FFQs and 24-HDRs reported to be the most predominantly used; no tools are standardized across countries; all questionnaires were paper- and pencil-based; no nationally or regionally designed computerized tools nor web-based technologies; all tools were administered face-to-face by trained interviewers; the main reported barrier to self-administration was the low level of literacy; all interviewers were trained. Most of the interviews were conducted at home, but sometimes in care centers or at school. The most common way to estimate portion sizes was household measures, while the main challenge for estimating portion size was communal food consumption in a shared bowl at household level. Most of the tools have been tested for feasibility but few have been validated (relative validity using a more precise method, or objective validity using biomarkers) or tested for reproducibility/reliability.

All countries except Algeria reported a FCT, specific for their country or borrowed and/or adapted from one or more other countries. Only 4 out of the 18 countries reported having their own FBDGs. Details specific to a particular region are described below.

North Africa: Algeria, Egypt, Morocco, and Tunisia (Table 2)

Food Frequency Questionnaires were reported in all the countries and were applied to epidemiology. The reported FFQs were mainly used to assess usual intakes of nutrient or food groups. In total, six different FFQs were reported: one quantitative, three semi-quantitative, and two qualitative. All FFQs were structured by food groups. A large variation in time was reported to complete a single interview (5–30 minutes) and the reference time frame ranged between one week and one year. The number of food items varied between 8 and 268. Most foods included were based on previous dietary surveys. Only Tunisia and Morocco included recipes and dietary supplements. Three out of the six reported FFQs were validated (Tunisia: objective validation using biomarkers, and relative validation using a more precise tool; Morocco: relative validation using a more precise tool) and tested for reliability (El Ati et al., 2004).

24-Hour Dietary Recalls was used in all countries except Algeria and applied to epidemiology, monitoring, and nutrition interventions. All reported 24-HDR were used to assess usual nutrient intakes. 24-HDR from Egypt and Morocco were structured by meal occasions and that from Tunisia by food groups. Duration of interview completion ranged from 10 to 30 minutes. Portion size estimation was conducted in all countries

Table 1. Summary of reported dietary assessment methods, public health problems, and research needs as perceived and self-reported by the respondents in different African regions.

Region	EAST (N = 3)	WEST (N = 6)	NORTH (N = 4)	SOUTH (N = 5)
Countries	Kenya, Sudan, Uganda	Benin, Burkina Faso, Cameroon, Ghana, Nigeria, Senegal	Algeria, Egypt, Morocco, Tunisia	South Africa, Zimbabwe, Mozambique, Namibia, Malawi
Methods				
Food Frequency Questionnaire (N = 22)	Qualitative (N = 2) Quantitative (N = 2) All paper- and interview-based (except Ghana with both telephone and face-to-face interviewing)	Qualitative (N = 4) Semi-quantitative (N = 2) Quantitative (N = 1)	Qualitative (N = 2) Semi-quantitative (N = 3) Quantitative (N = 1)	Qualitative (N = 1) Semi-quantitative (N = 1) Quantitative (N = 3)
24-Hours Dietary Recall (N = 23)	N = 2	N = 9	N = 5	N = 7
Food/Dietary Records (N = 4)	All paper- and interview-based N = 1	N = 2	N = 1	N = 0
	All paper-based and used as proxy for sub-populations, e.g. children. While in Tunisia and Ghana, respondent were trained to record their food intake, in Benin and Burkina, food intake was recorded by an interviewer.			
Major public health problems				
Micronutrient deficiencies				
Vitamin A deficiency	✓:[Uga; Sud]	✓:[Ben; Bur; Nig]	✓:[Mor]	✓:[RSA; Zim; Moz; Nam; Mal]
Vitamin B12 deficiency	✓:[Uga]	NR	NR	✓:[RSA; Zim; Nam; Mal]
Iron deficiency	✓:[Uga]	✓:[Ben; Bur; Cam; Gha; Nig; Sen]	✓:[Egy; Mor; Tun]	✓:[RSA; Zim; Moz; Nam; Mal]
Zinc deficiency	✓:[Uga]	✓:[Nig]	NR	✓:[RSA; Zim; Moz; Nam; Mal]
Calcium deficiency	✓:[Uga]	NR	NR	NR
Iodine deficiency	✓:[Uga; Sud]	✓:[Nig; Sen]	✓:[Mor]	✓:[RSA; Zim; Moz; Nam; Mal]
Folate deficiency	NR	NR	✓:[Mor]	NR
Nutritional status				
Childhood under-nutrition	✓:[Ken; Sud; Uga]	✓:[Ben; Bur; Nig]	✓:[Egy; Mor]	✓:[RSA; Zim; Moz; Nam; Mal]
Anemia	✓:[Ken; Sud; Uga]	✓:[Ben; Bur; Cam; Gha; Nig; Sen]	✓:[Egy; Mor; Tun]	✓:[RSA; Zim; Moz; Nam; Mal]
Overweight/obesity	✓:[Ken; Uga]	✓:[Ben; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor; Tun]	✓:[RSA; Zim; Nam]
Non-Communicable Diseases				
Cancer	✓:[Ken; Uga]	✓:[Ben; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor; Tun]	✓:[RSA; Zim; Nam]
Cardiovascular diseases	✓:[Ken]	✓:[Ben; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor; Tun]	✓:[RSA; Nam]
Diabetes	NR	✓:[Ben; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor; Tun]	✓:[RSA; Zim; Nam]
Hypertension	NR	NR	✓:[Alg; Egy; Mor; Tun]	✓:[RSA; Zim; Nam]
Challenges and needs for research				
Financial support	✓:[Ken; Sud; Uga]	✓:[Ben; Bur; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor; Tun]	✓:[RSA; Zim; Moz; Nam; Mal]
Expertise	✓:[Ken; Sud; Uga]	✓:[Ben; Bur; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor]	✓:[Zim; Moz; Nam; Mal]
Infrastructure	✓:[Ken; Sud; Uga]	✓:[Ben; Cam; Gha; Nig]	NR [Egy]	✓:[Zim; Moz; Nam; Mal]
Religious and cultural obstacles	NR [Ken; Uga] ✓:[Sud]	✓:[Cam; Gha; Nig]	NR [Alg; Egy; Mor; Tun]	NR [RSA; Zim; Moz; Nam; Mal]
Political factors	✓:[Ken; Sud; Uga]	✓:[Cam; Nig]	NR [Mor; Tun] ✓:[Egy]	NR [RSA; Zim; Moz; Nam; Mal]
Other (need for adapted tools for specific populations)	✓:[Ken; Sud]	✓:[Ben; Cam; Gha; Nig; Sen]	✓:[Alg; Egy; Mor]	✓:[Zim; Moz; Nam]
Major findings across regions	Various tools are available in Africa, with the 24-HDR and FFQ being the most dominant; no software or other technologies are used; no tools are standardized across countries, although some tools are used across countries; lack of nutrition and cancer research and support infrastructures.			

Ken: Kenya; Sud: Sudan; Uga: Uganda; Ben: Benin; Bur: Burkina Faso; Cam: Cameroon; Gha: Ghana; Nig: Nigeria; Sen: Senegal; Alg: Algeria; Egy: Egypt; Mor: Morocco; Tun: Tunisia; RSA: Republic of South Africa; Zim: Zimbabwe; Moz: Mozambique; Nam: Namibia; Mal: Malawi; NR: Not Reported as a problem;
✓:A need exists/challenge exists.



Table 2. Summary of dietary assessment methods, food composition tables and food-based dietary guidelines by regions: North Africa.

METHODS	Indicators	Countries			Morocco
		Egypt	Algeria	Tunisia	
Food Frequency Questionnaire (N = 6)	Type	N = 1 Qualitative	N = 1 Semi-quantitative	N = 1 Semi-quantitative	N = 3 (a) Qualitative (b) Quantitative (c) Semi-quantitative
Domain of application Interviews	Epidemiology Interviewers are highly trained; mostly interviews are conducted at home (but sometimes in care center or at school); the main reported barrier to administration is the low level of literacy of the respondents, except in Tunisia, where no barrier were reported.	Non dieticians nor nutritionists	Dieticians or nutritionists	Dieticians or nutritionists	Epidemiology (a) Dieticians or nutritionists (b) Non dieticians nor nutritionists (c) Non dieticians nor nutritionists
Interviewer					Epidemiology (a) Dieticians or nutritionists (b) Non dieticians nor nutritionists (c) Non dieticians nor nutritionists
Duration	10 minutes	15 minutes	15 minutes	30 minutes	(a) 15 minutes (b) 5 minutes (c) 20–25 minutes
Language	Questionnaire in French but interview in Arabic	Arabic		French and Arabic (Tunisian dialect)	(a) and (b) Questionnaire in French but interview in Arabic (Moroccan dialect) (c) Arabic (Moroccan dialect)
Structure Food list	Food groups All food lists reported to be appropriate for target populations	Food groups	Food groups	Food groups	Food groups
Number of food items	19	100–110	100–110	235	(a) 31 (b) 8 (c) 268
Recipes	Not included	Included	Included	Included	(a) and (c) Not included (b) Included (c) Not included
Dietary supplements	Not included	Not included	Not included	Not included	(a) Not included, (b) and (c) included
Data/source/methods used to compose food list	Usually main food groups described in literature	Previous dietary surveys; 24-HDR	Previous dietary surveys; 24-HDR	Previous dietary surveys, dietary records	(a) and (b) Previous dietary surveys (c) Other
Reference period	Past week	Past month	Number of times per day, week, or month	Past month	(a) and (c) Previous year (b) Past week
Frequency categories	Number of times per week to number of times per day	Number of times per day, week, or month	From <1 time/month to 4 and + times/day	From <1 time/month to 4 and + times/day	(a) Number of times per day or per week, or month (b) No pre-defined categories, number of times per day or per week (c) 8 categories from rarely to 4 times/day
Portion size estimation	N/A	In grams or liters as open questions – actual cups, plates, etc.	For each item, the interviewer showed a reference item portion size (median of the item intake) to participants who indicated if they consumed less, equal, or more than the showed portion. The lowest and the bigger portions represent the first and the third tertiles of the item intake	For each item, the interviewer showed a reference item portion size (median of the item intake) to participants who indicated if they consumed less, equal, or more than the showed portion. The lowest and the bigger portions represent the first and the third tertiles of the item intake	(a) N/A (b) Different standard portions – part of picture book and photos (c) Standard portion sizes
Validation	Not performed	Not performed	Not performed	Not performed	(a) Not performed (b) and (c) (c) ✓
Reproducibility	Not performed	Not performed	Not performed	Not performed	(b) ✓ Test-retest (c) ✓

(continued)



Table 2. (Continued)

	Countries	Algeria	Egypt	Tunisia	Morocco
24-Hour Dietary Recall ($N = 5$)	Description	NR	$N = 1$ All age groups	$N = 1$ Children (<5 years)	$N = 3$ (a) Women (15–49 years) and children (<5 years) (b) Women (15–49 years) (c) Adults (> 18 years)
Domain of application	Interviews	N/A Interviewers are highly trained; administration is the low level of literacy of the respondents.	Surveys Dieticians or nutritionists	Epidemiology (but sometimes in care center or at school); the main reported barrier to (a) Dieticians or nutritionists (b) and (c) Non-dieticians nor nutritionists	(a) Dieticians or nutritionists (b) and (c) Non-dieticians nor nutritionists (c) NR
Interviewer		N/A	30 minutes	10 minutes	(a) 30 minutes (b) 30 minutes (c) Questionnaire in Arabic and French but interview in Arabic (Moroccan dialect)
Duration		N/A	Arabic	French and Arabic (Tunisian dialect)	(b) Questionnaire in French but interview in Arabic (Moroccan dialect (c) Arabic (Moroccan dialect)
Language		N/A			(a) Recalls done every day of the week and not all the year (b) Recalls not done every day of the week and not all the year (c) Recalls done every day of the week
Other		N/A	Recalls done every day of the week and all the year	By foods By meal occasions Household measures	(a), (b), and (c) By meal occasions (a) No visual aids used (b) Visual aids and complete picture book, photo, household measures, known weights (c) No visual aids-household measures and units
Structure	Portion size estimation	N/A N/A			(a) Don't know (b) Empirical approaches using arbitrary cut-off (c) Not performed (a) Don't know (b) and (c) Not performed
Validation		N/A	✓Empirical approaches (using Goldberg cut-offs)	Not performed	N/A
Reproducibility		N/A	Not performed	Not performed	N/A
Food Records ($N = 1$)	Domain of application	N/A Description	N/A N/A	Epidemiology $N = 1$ 3 days food record; Respondents trained to record; Records collected all the year round	N/A
	Structure	N/A N/A	Meal occasions	Meal occasions	N/A
	Portion size estimation		Standardized scales and weighing not done/used – only visual estimations using picture books, bread shapes, and household	Standardized scales and weighing not done/used – only visual estimations using picture books, bread shapes, and household	N/A
Validation		N/A N/A		Not performed	N/A
Reproducibility		N/A		Not performed	N/A



Food Composition Tables	Availability	✓FCTs of foods consumed in Morocco		
		✓Table de composition des aliments Tunisiens	412; 5 Printed and CD-ROM*	412; 5 Printed and CD-ROM*
	Number of food items; recipes	N/A	254; 0 Printed and CD-ROM	254; 0 Printed and CD-ROM
	Format (printed, disk, CD-ROM, online)	N/A		
	Languages	N/A	Arabic, French, English	Arabic, French, English
	Dietary supplements included	N/A	Not included	Not included
	Indigenous foods included	N/A	Included	Included
	Frequency of update	N/A	Not updated	Recent 2013
Food-Based Dietary Guidelines				
		None of the countries have their own FBDGs		

NR: Not reported; N/A: Not applicable; FCTs: food composition tables; FBDGs: food-based dietary guidelines.

✓Available/procedure performed.

*Moroccan FCT is to be released in 2014.

Table 3. Summary of dietary assessment methods, food composition tables and food-based dietary guidelines by regions: West Africa.

METHODS	Countries	Benin	Burkina Faso	Cameroon	Ghana	Nigeria	Senegal
Food Frequency Questionnaire (<i>N</i> = 7)	Type	<i>N</i> = 2 (a) Qualitative* (b) Qualitative (a) Epidemiology (b) Research	<i>N</i> = 1 Qualitative*	<i>N</i> = 1 Quantitative	<i>N</i> = 1 Semi-quantitative	<i>N</i> = 2 (a) Semi-quantitative (b) Qualitative (a) and (b) Epidemiology, interventions, monitoring and surveillance	<i>N</i> = 1 Qualitative
Interviews	Domain of application						
Interviewer							
Duration							
Language							
Structure							
Food list	Number of food items	Food lists reported to be appropriate for target populations according to study aim	13	76	30	(a) 70 (b) 67	37
Recipes		(a) Not included (b) Included	Not included	Included	Not included	(a) and (b) Not included	Not included
Dietary supplements	Data/Source/Methods used to compose food list	(a) and (b) Not included (a) and (b) Previous dietary surveys; 24-HDR	Not included Previous dietary surveys; 24-HDR and 2 day food diaries	Not included Previous dietary surveys; 24-HDR	Previous dietary surveys; 24-HDR	(a) and (b) Not included (a) and (b) Previous dietary surveys; 24-HDR	Not included Previous dietary surveys
Reference period		(a) Past week (b) Past month (a) From 0 to several times per week (b) From 0 several times per day	Past week	Previous 12 months	Past week	(a) Past week (b) Past month	Past week
Frequency categories		(a) From 0 to several times per week	From 0 to several times per week	NR	NR	(a) No days per week (b) Never, Sometimes (1/2/month), Often (1–2 days/week), Frequently (4–7 days/week)	From 0 to 1 and + times/day
Portion size estimation		N/A	N/A	Household measures and food models	Different standard portions; household handy measures—Different standard portions; household handy measures	(a) In grams or litres as open questions; Different standard portions—No visual aids used(b) N/A	N/A
Validation		✓(a) and (b) Relative validation (a) Not performed(b) Performed	✓Relative validation Not performed	Don't know Don't know	Don't know ✓	(a) and (b) Don't know	Not performed Not performed
Reproducibility							



24-Hour Dietary Recall (<i>N</i> = 9)	Description	<i>N</i> = 2 (a) Adults* (b) Variable according to study	<i>N</i> = 3(a) Adults* (b) Women and children(c) Women and children	<i>N</i> = 1 Children (24–72 months)	<i>N</i> = 1 Women, children, men	<i>N</i> = 1 Women, children, men
Domain of application	(a) Epidemiology; (b) Epidemiology; Interventions	(b) and (c) Epidemiology (cross sectional)	Epidemiology; Interventions	Nutrition monitoring; Clinical research	Epidemiology; Interventions: monitoring and surveillance	Epidemiology adult men children (5–17 years) (a) Epidemiology (cross sectional) (b) Epidemiology
Interviewer	Interviewers are highly trained; Mostly interviews are conducted at home (but sometimes in care center or at school); The main reported barrier to administration is the low level of literacy of the respondents (a) Dieticians or nutritionists (b) and (c) Non dieticians nor nutritionists	Non dieticians nor nutritionists	Non dieticians nor nutritionists	Dieticians or nutritionists	Non dieticians nor nutritionists	(a) Non dieticians nor nutritionists (b) Dieticians or nutritionists
Duration	(a) 60 minutes;(b) 30 minutes (a) and (b) French and several local dialects	(b) and (c) 60–90 minutes (b) French (c) French and other local dialects	NR	15–20 minutes Local languages	45–60 minutes English and local languages	(a) 30–45 minutes (b) 15–30 minutes (a) English(b) Local language (Wolof)
Language						
Other	(a) Recalls done every day of the week and but not all year (b) Recalls done every day of the week and all year	(b) and (c) Recalls done every day of the week and not all year	Recalls done every day of the week and not done all year	Recalls done every day of the week and all year	Recalls not done every day of the week and but done all year	(a) and (b) Recalls not done every day of the week and not all year
Structure	(a) and (b) By meal occasions (a) Previously calibrated local household measures and visual aids;(b) Visual aids- Households measures, bread shapes	(b) and (c) By meal occasions (b) Household measures (c) Household measures, play dough replicates, photos, weight, volumes, bread shapes	Meals and snacks	Household measures made by the mothers	Multiple pass method	(a) and (b) By meal occasions (a) Visual aids - Ruler, Pictures of household measures, Rulers, using handy measures which have already been estimated
Portion size estimation				Visual aids - Pictures of household measures, Rulers, using handy measures which have already been estimated	By meal occasions	Visual aids - Complete picture book, Ruler, Pictures of household measures, Bread shapes (a) Visual aids - Prices, photo of food portion size, household measures (a) and (b) Not performed
Validation	(a) Not performed (b) ✓Relative validation	(a) and (c) Not performed (b) ✓Relative validation (a) ✓[(<i>b</i>)][(b)] and (c)	Don't know	✓Relative validation	Don't know	(a) and (b) Not performed
Reproducibility	✓(a) and (b)	Not performed	Don't know	✓	Don't know	(a) and (b) Not performed

(continued)



Table 3. (Continued)

	Counties	Benin	Burkina Faso	Cameroon	Ghana	Nigeria	Senegal
Food Records (2)	Domain of application	Epidemiology (cross sectional)	N/A	Epidemiology and clinical research	N/A	N/A	N/A
Description		N = 1Investigators stay in for a day and record; Respondents not trained to record; Records not collected all year round	N/A	N = 1Respondents trained to record; Records not collected all year round	N/A	N/A	N/A
Structure	Meal occasions	N/A	N/A	Not pre-defined Pictures of household measures	N/A	N/A	N/A
Portion size estimation	Through weighing	N/A	N/A	✓ Relative validation	N/A	N/A	N/A
Validation	Don't know	N/A	N/A	Not performed	N/Am	N/A	N/A
Reproducibility	Not performed	✓ N = 2	✓ N = 2	✓ FCTs for Southern Cameroon	✓ Food Research Institute-Council for Scientific and Industrial Research	✓ N = 2	✓ N = 2
Availability	✓ Mainly Malian FCT*	(a) Malian FCT* (b) West Africa FCT from FAO				(a) Composition of selected foods from west Africa (b) Nutrient Composition of selected foods eaten in Nigeria	(a) WorldFood 2 (b) West Africa FCTS
Food Composition Tables	Number of food items; recipes	268; 186	(a) 268; 186(b) 472;0	172;2	329;0	(a) 311;0 (b) 472;0	
Format (printed, disk, CD-ROM, online)	Printed		(a) and (b) Online and printed	Printed		(b) 262; 32 Printed	
Languages	English, French and Bambara		(a) English, French and Bambara (b) English and French	English	English and French	(a) English (b) English and French	
Dietary supplements included	Not included		Not included	Included	Not included	Not included	
Indigenous foods included	Included		Included	Included	Included	Included	
Frequency of update	Updated, but frequency		Updated, but frequency	Not updated, but frequency NR	Not updated	Updated, but frequency NR	
Food-Based Dietary Guidelines			NR	NR	Only Nigeria reported use of their own FBDGs	Rarely	

NR: not reported; N/A: not applicable; FCTs: food composition tables; FBDGs: food-based dietary guidelines.

*Available/procedure performed.

*Same tool used in different countries.

Table 4. Summary of dietary assessment methods, food composition tables and food-based dietary guidelines by regions: Southern Africa.

Methods	Countries		Malawi	Mozambique	South Africa	Zimbabwe	Namibia
	Indicators						
Food Frequency Questionnaire ($N = 5$)	Type	$N = 1$ Semi-quantitative	$N = 1$ Qualitative	$N = 2$ (a) Quantitative (b) Quantitative	$N = 1$ Quantitative	NR	NR
Domain of application	Epidemiology	Epidemiology	(a) and (b) Epidemiology	(a) and (b) Epidemiology	Epidemiology	N/A	N/A
Interviews	Interviewers are highly trained; Mostly interviews are conducted at home (but sometimes in care center or at school); The main reported barrier to administration is the low level of literacy of the respondents						
Interviewer	Dieticians or nutritionists	Non dieticians nor nutritionists	(a) Non dieticians nor nutritionists (b) Dieticians or nutritionists	(a) Non dieticians nor nutritionists (b) Dieticians or nutritionists	Dieticians or nutritionists	N/A	N/A
Duration	10 minutes	About 10 minutes	(a) 40–60 minutes (b) 45 minutes	(a) 40–60 minutes (b) Written in English but administered in local languages	15–20 minutes	English and local languages (i.e. Shona)	N/A
Language	English	Portuguese	(a) Local languages (b) Written in English but administered in local languages	(a) English and local languages (i.e. Shona)	English and local languages (i.e. Shona)	English and local languages (i.e. Shona)	N/A
Structure	Food groups	Food groups	(a) and (b) Food groups	Food groups	Food groups	N/A	N/A
Food list	Food list reported to be appropriate for target populations 25–35	43	(a) > 300 (b) 214	> 100	Not included	N/A	N/A
Number of food items	Not included	Not included	(a) and (b) Included	Not included	Not included	N/A	N/A
Recipes	Not included	Included	(a) and (b) Included				
Dietary supplements	Previous dietary surveys; 24-HDR, diet histories/derived from food composition tables						
Data/Source/Methods used to compose food list	Past month	Past week	(a) Past month and 6 months (b) Past week	Past year			
Reference period			(a) Per day, week, month and seldom (b) Times/week and times/day	From never to 4–5 times/day			
Frequency categories	From never to daily	From never to 7 times/week	(a) and (b) Standard portion size; Household measures; Complete picture book; Pictures of household measures; Ruler; Bread shapes; Pictures for spreadable fat on bread; Food models, tins (and packaged examples) of often eaten processed foods	Standard portion size; Complete picture book; Pictures for spreadable fat on bread			
Portion size estimation	Different standard portion size options; In grams or litres as open question-pictures of household measures	Portion sizes not estimated (method not used to calculate food quantities or energy intakes)					
Validation	Not performed	Not performed	(a) ✓ Relative and objective validation (b) Not performed	Don't know	N/A		
Reproducibility Description	Not performed $N = 1$ Children (<5 years)	Not performed $N = 2$ (a) Girls (15–18 years) (b) Mother-child pairs	(a) ✓(a) and (b) $N = 2$ (a) All sub-groups in SA population (b) Children (0–2; 2–5 years), primary school children and women	Don't know $N = 1$ Adults (35–70 years)	$N = 1$ Children (6–59 months) and mothers		
24-Hour Dietary Recall ($N = 7$)							
Domain of application	Epidemiology and clinical	(a) Epidemiology (b) Surveillance	(a) Epidemiology and surveillance (b) Monitoring and surveillance	Epidemiology	Epidemiology		
Interviews	Interviewers are highly trained; Mostly interviews are conducted at home (but sometimes in care center or at school); The main reported barrier to administration is the low level of literacy of the respondents						
Interviewer	Dieticians or nutritionists	(a) Dieticians or nutritionists (b) Non dieticians nor nutritionists	(a) Non dieticians nor nutritionists	Dieticians or nutritionists	Dieticians or nutritionists		
Duration	30 minutes	Local language (Chichewa)	(a) 20 minutes (b) Not known (a) Portuguese (b) Portuguese and local languages	(a) 30–50 minutes (b) 30 minutes (a) and (b) English and local languages	20 minutes English and local languages (i.e. Shona)	15 minutes English and local languages	
Language							

(continued)



Table 4. (Continued)

Countries	Malawi	Mozambique	South Africa	Zimbabwe	Namibia
Other	Recalls not done every day of the week and not all year No pre-defined structure	(a) and (b) Recalls not done every day of the week and not all year (a) No pre-defined structure (b) Multiple pass method	(a) and (b) Recalls not done every day of the week and but all year (a) and (b) Per meal, food eaten, preparation method/what was added, amount	Recalls done every day of the week and but not all year No pre-defined structure	Recalls not done every day of the week and not all year not all year No pre-defined structure
Structure					
Portion size estimation	Local food models; common (standardized) household measures	(a) Visual aids-food photographs and household utensils- Complete picture book (b) Visual aids - direct weighing, determining volume equivalent using bakers with marked volume, using play dough model and measuring water volume displacement, photographs, dimensions	(a) Visual aids - Part picture book; Ruler; Bread shapes; Pictures for spreadable fat on bread- different sizes of spoons, food models; cups, glasses; three-dimensional sponge models; empty containers of frequently consumed foods; participant uses dry oats to identify the amount that resembles the amount of food eaten, empty tins	Visual aids - complete picture book; Pictures of household measurements; Pictures for spreadable fat on bread	Local food models; common (standardized) household measures
Validation	Not performed	Not performed	Not performed (b) Don't know	(a) ✓Relative and objective validation (b) Don't know	Don't know
Reproducibility			Not performed (b) Don't know	(a) ✓ (b) Don't know	Don't know
Food Records (N = 0)	Domain of application Description Structure Portion size estimation Validation Reproducibility Availability	N/A N/A N/A N/A N/A N/A ✓Use of multiple FCTs	N/A N/A N/A N/A N/A N/A ✓N = 2 ✓FCTs for Mozambique. Version 2 (b) Tabela de composicao de alimentos	N/A N/A N/A N/A N/A N/A ✓South African Food Composition Database*	N/A N/A N/A N/A N/A N/A ✓South African Food Composition Database*
Food Composition Tables	Number of food items; recipes		1472:14 1472:413	1472:420	1472:420
	Format (printed, disk, CD-ROM, online)				
	Languages Dietary supplements included Indigenous foods included Frequency of update	English Not included Included Rarely	(a) Online (b) Printed (a) English (b) Portuguese (a) and (b) Not included (a) Included (b) Not included (a) and (b) Not updated	Printed, online and software English Included Included Constantly updated, but frequency of release NR	Printed English Included Included Not updated NR
Food-Based Dietary Guidelines					

NR: not reported; N/A: not applicable; FCTs: food composition tables; FBDGs: food-based dietary guidelines.

✓Available/procedure performed;

*Same tool used in different countries.

Table 5. Summary of dietary assessment methods, food composition tables and food-based dietary guidelines by regions: East Africa.

Methods	Countries		Kenya	Sudan
	Indicators			
Food Frequency Questionnaire ($N = 4$)	Type	$N = 2$ (a) Qualitative (b) Quantitative	$N = 1$ Qualitative	$N = 1$ Quantitative
	Domain of application	(a) Interventions (b) Monitoring	Epidemiology; Clinical research; Interventions	Monitoring; Research
Interviews	Interviewer	Interviewers are highly trained; Mostly interviews are conducted at home (but sometimes in care center or at school); The main reported barrier to administration is the low level of literacy of the respondents and access to some regions (transport problems)	Non dieticians or nutritionists	Dieticians or nutritionists
	Duration	(a) Dieticians or nutritionists (b) Non dieticians nor nutritionists (a) 60 minutes (b) 3 hours	20–30 minutes	30–45 minutes
Language	English, Ateso, Ngakarimojong, Luganda, Lughara, Luo, Runyankole-Rukiga, and Runyoro-Rutoro	Arabic and English	English and Kiswahili	Arabic and English
Structure Food list	Food groups	Food groups (a) Food list reported to be appropriate for target populations (b) Food list reported not be appropriate for target populations (a) 245 (b) 52	Food groups Food list reported to be appropriate for target populations	Food groups Food list reported to be appropriate for target populations
	Recipes	(a) Included (b) Not included (a) and (b) Not included (a) and (b) Previous dietary survey; 24-HDR, diet histories/ derived from FFQs	Fluctuates with researcher/area. Mainly includes common household foods Not included	>16 Included
Dietary supplements	Data/Source/Methods used to compose food list	Not included Previous surveys; 24-HDR, other sources such as FAO guidelines on Dietary Diversity Score	Previous surveys; 24-HDR, other sources such as FAO guidelines on Dietary Diversity Score	Included Previous surveys; 24-HDR
Reference period	Frequency categories	(a) and (b) Past week (a) From 0 to 6 and more times/day (b) NR	Usually 3 or 7 days recall From daily to 1 time/week	Past month NR
Portion size estimation		(a) Different standard portion size options; In grams or litres as open questions - Pictures of household measurements; Ruler; Pictures for spreadable fat on bread (b) No visual aids - In grams or litres as open questions; Price estimate	N/A	Household measures
Validation	Reproducibility	(a) and (b) Don't know (a) Not performed (b) Don't know	Not performed Not performed	Don't know Don't know
24-Hour Dietary Recall ($N = 2$)	Description	$N = 1$ Gibson and Ferguson method (Kenya: all population subgroups (children <5 years); Uganda: adults, women of reproductive age and children (6–59 months))	$N = 1$ All age groups	Monitoring Interventions
	Domain of application	Interviewers are highly trained; Mostly interviews are conducted at home (but sometimes in care center or at school); The main reported barrier to administration is the low level of literacy of the respondents and transport to access areas with bad terrain	Non dieticians nor nutritionists	Dieticians or nutritionists
	Interviewer	2–3.5 hours	60 minutes	30–45 minutes
	Duration	English, Luganda and Runyakitata	English and local languages	Arabic and English
	Language	Recalls done every day of the week and all year	Recalls not done every day of the week and not all year	Recalls done every day of the week and not all year
	Other			

(continued)

Table 5. (Continued)

	Countries	Uganda	Kenya	Sudan
Food Records (N = 1)	Structure Portion size estimation Validation Reproducibility Domain of application Description	Multiple pass method Visual aids - Complete picture book; Pictures of household measures; Pictures for spreadable fat on bread; Food replicas Don't know ✓ N/A N/A	Multiple pass method Not always used. Except in small scale studies Don't know Don't know N/A N/A	By meal occasions Household measures Don't know Don't know NR N = 15 days food record; Respondents trained to record; Records not collected all year round By food items Household measures Don't know Don't know (a) Tanzania FCTs (b) USDA FCTs
Food Composition Tables	Structure Portion size estimation Validation Reproducibility Availability	N/A N/A N/A N/A ✓ N = 3 (a) Tanzania FCTs (b) Harvest Plus composition table for Uganda (c) Kenya Wild food species (d) 400:250 (e) 72/494 (f) 157,0 (g) Disk (h) Online (i) Disk (j) English (k) (b) and (c) English (l) (a), (b) and (c) Not included (m) Indigenous foods included (n) Frequency of update	N/A N/A N/A N/A ✓ National FCTs and the Planning of Satisfactory Diets 350:20 Printed (a) Disk (b) Online (a) and (b) English (a) Not included (b) Included (a) and (b) Included (a) Updated once (b) Constantly updated	(a) 400:250 (b) 8,463 food items (a) Disk (b) Online (a) and (b) English (a) Not included (b) Included (a) and (b) Included (a) Updated once (b) Constantly updated
Food-Based Dietary Guidelines			None of the countries have their own FBDGs	

NR: not reported; N/A: not applicable; FCTs: food composition tables; FBDGs: Food-based dietary guidelines.

✓ Available/Procedure performed.

*Same tool used in different countries.

Table 6. Overview of monitoring surveys with food or nutrient intake data from 2002 onwards.*

Countries	Survey	Year	Target population	Sample size	Dietary methods used	Level	References
Egypt	Diet, nutrition and Prevention of Chronic Non-Communicable Diseases Demographic and Health Survey	2003-2004	Adolescents (12–18 years)	6000	Dietary history	National	Ismail (2005). Diet, nutrition and Prevention of Chronic Non-Communicable Diseases
		2005	Women and children	22,807 households, 12,131 children (<5 years), 10,990 girls (10–19 years), 19,565 women (including 11,988 mothers)	24-HDR and FFQ	National	El-Zanaty, Fatma and Ann Way. 2006. Egypt Demographic and Health Survey 2005. Cairo, Egypt: Ministry of Health and Population, National Population Council El-Zanaty and Associates, and ORC Macro
	Demographic and Health Survey	2008	Women and children	Main Survey: 19,968 households, 7632 preschool children (<5 years), 17,383 adolescents (10–19 years), 16,527 ever-married women (15–49 years)	24-HDR and FFQ	National	El-Zanaty, Fatma and Ann Way. 2009. Egypt Demographic and Health Survey 2008. Cairo, Egypt: Ministry of Health, El-Zanaty and Associates, and Macro International
	Food consumption pattern among children under five in selected villages in Upper Egypt	2009-2010	Children (<5 years)	2418 children (1179 males and 1139 females)	24-HDR and FFQ	Local	National Nutrition Institute and UNICEF
Tunisia	Enquête Nationale sur le Budget, la Consommation et le Niveau de Vie des Ménages, Volet Alimentaire	2005	All age groups	6500 households	Food Record	National	Institut National de la Statistique (2008). Enquête Nationale sur le Budget, la Consommation et le Niveau de Vie des Ménages 2005. Ministère du Développement et de la Coopération Internationale. Vol 2: Alimentation, 127p. [in arabic]. Available: http://www.ins.nattn/indexfr.php
	Children Vitamin A status	2006	School-aged children (5–7 years)	7407 children	FFQ	Regional	El Ati J, Kaâbachi N, Fekih M, et al., Statut en vitamine A de l'enfant Tunisien. Ed 2007, Tunis: INNTA/UNICEF/ Laboratoire de Biochimie de la Rabta, 2007, 102p. [in french]. Available: http://www.institutdenutrition.rn.tn/images/rapport_vitA.pdf
	Enquête Nationale sur le Budget, la Consommation et le Niveau de Vie des Ménages, Volet Alimentaire	2010	All age groups	6500 households	Food Record	National	Institut National de la Statistique (2013). Enquête Nationale sur le Budget, la Consommation et le Niveau de Vie des Ménages 2010. Ministère du Développement et de la Coopération Internationale. Volet Alimentation. Available

(continued)

Table 6. (Continued)

Countries	Survey	Year	Target population	Sample size	Dietary methods used	Level	References
Cameroon	Comprehensive Food Security and Vulnerability Analysis	2011	All	6300 households	Food Record	National	on line: http://www.ins.nattn/indexfr.php Programme alimentaire mondial. Analyse globale de la sécurité alimentaire et de la vulnérabilité au Cameroun. Rome: PAM, 2011.
Ghana	Ghana Demographic and Health Survey	2003	Women and men	5691 women and 5015 men - 6251 households	Vitamin a rich foods consumed 7 days preceding the survey	National	Ghana Statistical Service (GSS), Noguchi Memorial Institute for Medical Research (NIMMR), and ORC Macro. 2004. Ghana Demographic and Health Survey 2003. Calverton, Maryland: GSS, NIMMR, and ORC Macro
Ghana	Ghana Demographic and Health Survey	2008	Women and men	11,778 households, 4916 women and 4566 men	Fruit and vegetables rich in Vitamin A consumed 24 hours before the survey	National	Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF Macro. 2009. Ghana Demographic and Health Survey 2008. Accra, Ghana: GSS, GHS, and ICF Macro
Nigeria	National Food Consumption and Nutrition Survey (NFCNS)	2001–2003	Women and their children (< 5 years)	6480 households (5325 mothers, a sub-population of 1080 of pregnant women)	24-HDR	National	B. Maziya-Dixon, I.O. Akinyeye, E.B. Oguntola, S. Nokoe, R.A. Sanusi, and E. Harris. Nigeria Food Consumption and Nutrition Survey 2001–2003 Summary. International Institute of Tropical Agriculture (IITA). 2004, pages 1–67
Nigeria	Nigerian Demographic and Health Survey	2008	Women and men	33,385 women and 15,486 men	Types of food consumed by mothers with children <3 during the day and night preceding the interview	National	National Population Commission (NPC) (Nigeria) and ICF Macro. 2009. Nigeria Demographic and Health Survey 2008. Abuja, Nigeria: National Population Commission and ICF Macro
Malawi	National Micronutrient Survey	2009	Children (<5 years), women (15–49 years) and men (20–55 years)	166 children, 234 women and 173 men	Fortification Rapid Assessment Tool (FRAT) that includes simplified 24-HDR and FFQ	National	Malawi Government (2011). A report for the national micronutrient survey 2009. Lilongwe, Malawi.
Mozambique	Mozambique Demographic and Health Survey	2003	Children (<3 years)	>5000	A) food consumption (yes/no) of food and complementary food groups during past 24 hours. B) food consumption during past 7 days (number of days in which a food group was consumed)	National	Instituto Nacional de Estatística, Ministério da Saúde, and ORC Macro (2005). Moçambique Inquérito Demográfico e de Saúde 2003. http://www.measuredhs.com/pubs/pdf/FRT61/FRT61.pdf



WHO Stepwise/ Mozambique	2005	Adults (25–64 years)	3323	Frequency and daily portion of fruit and vegetable consumed in a typical week	National	Padrião P et al. Low fruit and vegetable consumption in Mozambique: results from a WHO STEPwise approach to chronic disease risk factor surveillance. <i>Br J Nutr.</i> 2012 Feb;107(3):428–35. doi: 10.1017/S0007114511003023. Epub 2011 Jul 15. AND also see: http://www.who.int/chp/steps/mozambique/en/index.html
Mozambique Demographic and Health Survey	2011	Children (2 years)	>4000	Food consumption (yes/no) of food groups during past 24 h	National	Ministério da Saúde, Instituto Nacional de Estatística, and ICF International (2013). <i>Moçambique Inquérito Demográfico e de Saúde 2011.</i> Calverton, Maryland: Ministério da Saúde, Instituto Nacional de Estatística, ICF International. http://www.measuredhs.com/pubs/pdf/FR266/FR266.pdf
South Africa 1st National Youth Risk Behaviour Surveys	2002	Youths	10,699	Frequency and consumption of various food types during the past 7 days	National	Reddy SP, Panday S, Swart D, Jinabhai CC, Amosun SL, James S, Monyeki RD, Stevens G, Morejje N, Kambaran NS, Omardien RG, Van den Borne HW. Umhenthe Uhlaba Usamila – The South African Youth Risk Behaviour Survey 2002, Cape Town: South African Medical Research Council, 2003
Demographic and Health Survey	2003	Households (children and adults)	7756 households	Nutrient Index (N-Index) that consists of a short 30 item food frequency questionnaire reflecting specified micronutrients and 7 questions concerning fat intake (Senekal and Steyn, 1997)	National	Department of Health, Medical Research Council, OrcMacro. 2007. <i>South Africa Demographic and Health Survey 2003.</i> Pretoria: Department of Health
2nd National Youth Risk Behaviour Surveys	2008	Youths	10,270 youths	Frequency and consumption of various food types during the past 7 days	National	Reddy SP, James S, Sewpaul R, Koopman F, Funani NI, Sifunda S, Josie J, Masuka P, Kambaran NS, Omardien RG. Umhenthe Uhlaba Usamila – The South African Youth Risk Behaviour Survey 2008. Cape Town: South African Medical Research Council, 2010
South African Social Attitudes Study (SASAS)	2009	Adults	3286 adults (for nutrition module)	Recall of all foods and drinks consumed the previous day	National	Labadarios D, Steyn NP, Nel J. How diverse is the diet of adult (continued)

Table 6. (Continued)

Countries	Survey	Year	Target population	Sample size	Dietary methods used	Level	References
South African National Health and Nutrition Examination Survey (SANHANES)	South African National Health and Nutrition Examination Survey (SANHANES)	2012	Children and adults	8168 households	(calculation of dietary diversity scores) Recall of all foods and drinks consumed the previous day (calculation of dietary diversity scores)	National	South Africans? Nutrition Journal 2011;10:33 Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dholayay A, Reddy P, Parker W, Hoosain E, Naidoo P, Hongoro C, Mchiza Z, Steyn NP, Dwane N, Makoe M, Matuleke T, Ramlogan S, Zungu N, Evans MG, Jacobs L, Faber M, and SANHANES-1 Team. South African National Health and Nutrition Examination Survey (SANHANES-1). Cape Town: HSRC Press, 2013.
Zimbabwe	Zimbabwe Non-communicable disease risk factor survey http://www.who.int/chp/steps/	2005	Adults (≥ 25 years)	3081 (75% females)	FFQ and fortification rapid assessment tool	Regional (Midlands, Mashonaland Central and Matabeleland South)	Women (15–49 years) and men (15–54 years)
					Zimbabwe Demographic and Health Survey	2005	
Namibia	Namibia demographic health survey	2006/2007	Children (6–59 months), adults (15–49 years)	5457 children and 8803 women	24-HDR and household food frequency	Regional	
Uganda	Household Consumption and Expenditures Survey Uganda Food Consumption Survey	2005–2006	All	7421 households	Food frequency	National	http://www.gaininhealth.org/reports/2008-uganda-food-consumption-survey
	Comprehensive Food Security and Vulnerability Analysis	2008	Children (<5 years) and women (15–49 years)	957 households, 957 women (15–49 years), 437 women with children (6–23 months) and 510 women with children (24–59 months)	Food frequency	National	www.ubos.org
				7271 households			
				6800 households	Food frequency	National	www.ubos.org

Uganda National Housing Survey Household Consumption and Expenditures Survey	2010-2011	All	Children (<5 years) and women (15–49 years)	6775 households	FFQ 7-day recall	National	http://catalog.ihsn.org/index.php/catalog/2119/download/36380
Uganda Demographic and Health Survey	2011		Children (<5 years), women (15–49 years) and men	9033 households, 8674 women and 2350 children	24-HDR	National	http://www.measuredhs.com/publications/publication-pr-18-preliminary-reports.cfm
Kenya Demographic Health Survey	2003		Children (<5 years)	5906 children	Qualitative FFQ	National	Central Bureau of Statistics (CBS) [Kenya], Ministry of Health (MOH) [Kenya] and ORC Macro, 2004. Kenya Demographic and Health Survey 2003: Calverton, Maryland, USA: CBS, MOH and ORC Macro
8th National iodine survey	2003/2004		School-age children	2114 children	FFQ	National	Mwaniki, D., Nyandieka, L. N., Muniu, F. M. et al 2006: Iodine Nutrition Situation in Kenya and Trends in the Control of Iodine Deficiency. Final Draft. KEMRI, UNICEF, MOH, UON. Kenya 2006
Kenya Demographic Health Survey	2008		Children (<5 years)	5470 children	Qualitative FFQ	National	Kenya National Bureau of Statistics (KNBS) and ICF Macro. 2010. Kenya Demographic and Health Survey 2008–09. Calverton, Maryland: KNBS and ICF Macro. Final report yet to be released
National Micronutrient survey	2011		Children (6–59 months and 5–14 years) and women (15–59 years) All age groups	2960 households	24-HDR and FFQ	National	
Sudan Food and Nutrition Security Assessment in Sudan	2009			Households	recall over the last 7 days	National	Food and Nutrition Security Assessment in Sudan. Analysis of 2009 National Baseline Household Survey (NBHS). Southern Sudan Centre for Census, Statistics and Evaluation Central Bureau of Statistics. http://img.static.reliefweb.int/report/sudan/food-and-nutrition-security-assessment-sudan-analysis-2009-national-baseline-household

* Only the survey including dietary intake at the individual level was taken into account, therefore data such as food balance sheets and household budget surveys were excluded.
 24-HDR: 24-Hour Dietary Recall; FFQ: Food Frequency Questionnaire.

except from Tunisia, Algeria, and from one reported in Morocco. Two out of the four reported 24-HDRs were validated (Egypt and Morocco: both validated by empirical methods using the Goldberg cut-offs) and none were tested for reliability. Dietary records reported in Tunisia were only applied to epidemiology and to semi-quantitative FFQ validation studies. Respondents were trained to record and the dietary record was structured by meal occasions. Standardized scales and weighing were not used. Only visual estimations using picture books, bread shapes, and household measures were used.

West Africa: Benin, Burkina Faso, Cameroon, Ghana, Nigeria, and Senegal (Table 3)

Food Frequency Questionnaires were used in all countries and mostly applied to epidemiology, monitoring, and surveillance. FFQs were mainly used to assess food habits and to estimate usual nutrient intakes. In total, seven FFQs were reported: one quantitative, two semi-quantitative, and four qualitative. All FFQs but one were structured by food groups but wide variations in time to complete a single interview (15–60 minutes) were also reported. The reference time frame reported varied from two days to one month. The number of food items also varies between 13 and 76 and dietary supplements. Only one FFQ in Benin included recipes. Most of the foods included were based on previous dietary surveys. Only in Benin and Burkina Faso, the FFQs were validated (relative validation) and only in Ghana and Benin the FFQs were tested for reliability.

24-Hour Dietary Recalls was reported in all the countries and mainly applied to epidemiology, monitoring and intervention studies. Almost all recalls were structured by meal occasions, and the duration of completion ranged from 15 to 90 minutes. Three out of the nine reported recalls were validated and tested for reliability (Benin, Burkina Faso, and Ghana, all relatively validated). Two different dietary records were reported (one for both Benin and Burkina Faso and the other in Ghana). The major domain of application reported was in observational studies in Burkina Faso and Benin. While in Ghana, respondents were trained to record dietary data. The records in Burkina Faso and Benin were structured by meal occasions but the one in Ghana was not structured. In both records food was weighed. In Ghana, in addition to weight, individuals also used pictures of household measures to estimate portion sizes. The dietary record used in Ghana was validated (relative validation) but none of the records were tested for reliability.

In Benin, Ghana, and Nigeria, interviews were conducted by dieticians or nutritionists.

Southern Africa: Malawi, Mozambique, Namibia, South Africa, and Zimbabwe (Table 4)

Food Frequency Questionnaires were reported in all countries except from Namibia and mainly applied to epidemiology. In total, five FFQs were reported: three quantitative, one semi-quantitative, and one qualitative. All FFQs were structured by food groups and a large variation in time to complete a single interview (10–60 minutes) was reported. The reference time frame ranged from one week to one year. Only one FFQ, from

South Africa, was validated using biomarkers, which was urinary nitrogen and relatively against 24-HDR and tested for reliability. The number of food items varied between 25 and over 300. Most of the foods included were based on previous dietary surveys. Only Zimbabwe and South Africa's food lists included recipes.

24-Hour Dietary Recalls was also reported in all the countries and mainly applied to epidemiology, surveillance and monitoring, clinical research, and validation studies. All recalls included portion size estimation. Duration of completing of interviews ranged from 15 to 50 minutes. Visual aids, such as pictures of portion size and actual household utensils, were used for portion size estimation in all countries except from Namibia. Only one 24-HDR from South Africa was validated using a biomarker, which was urinary nitrogen and tested for reliability.

Interviews in Malawi, Namibia, Mozambique, and Zimbabwe were conducted by dieticians or nutritionists.

East Africa: Kenya, Sudan, and Uganda (Table 5)

Food Frequency Questionnaires were reported in all the three countries and mostly applied to epidemiology, intervention, and monitoring. In total, four FFQs were reported: two quantitative, and two qualitative. All FFQs were structured by food groups and a large variation in time to complete a single interview (20 minutes–3 hours) was reported. Most of the foods included were based on previous dietary surveys. The reference time frame ranged from three days to one month. The FFQ reported for Kenya was not validated or tested for reliability. The qualitative FFQ reported for Uganda was only tested for reliability. Recipes were included for two of the FFQs. Only Sudan's FFQ included dietary supplements. Previous dietary surveys were the main methods used to select the most appropriate food list.

The Gibson and Ferguson 24-HDR (Gibson and Ferguson, 1999) was used in Kenya and Uganda. All the 24-HDR reported mainly applied to monitoring and intervention studies. Duration of completing an interview ranged from 30 minutes to 3.5 hours. In Uganda, portion sizes were estimated using visual aids, such as pictures, while in Sudan portion size were estimated using household measures. In Uganda, the 24-HDR was tested for reliability. None of the reported tools were tested for validity.

Only Sudan reported the use of dietary record, which was structured by food items. The respondents were trained to record foods and used household measures to quantify them.

Monitoring surveys

Table 6 gives an overview of monitoring surveys conducted in the countries represented in the AS-PADAM project with food or nutrient intake data collected at the individual level from 2002 to 2013. For all surveys, children and women were the main target population, and 24-HDR and FFQ were the main DA tools used. Most surveys reported were conducted at national level.

Discussion

The main findings of this inventory of DA methods in Africa were that these tools were mainly used in epidemiology and monitoring (nutrition surveillance) and the most available DA tools were the 24-HDR and FFQ. However, few of these tools have been validated and/or tested for reproducibility. Indeed, of the DA tools reported in this inventory, only 12 (six FFQ; five 24-HDRs; and one food record) out of a total of 49 tools assessing intakes at an individual level were validated either by objective (use of biomarkers) or relative measurements (against a more precise method) (Sharma et al., 1996; Macintyre et al., 2001a, 2001b, 2001c; El Ati et al., 2004; Aounallah-Skhiri et al., 2011; Korkalo et al., 2013; Landais et al., 2014). In addition, all tools reported have been administered face-to-face, except one FFQ administrated through telephone in Ghana; and none of these were computerized questionnaires or using other new (web) technologies. However, although the aim of the project was to achieve a good overall representativeness of the DA methods and local situations in the four main African regions, this inventory was by no means fully exhaustive. Therefore, other DA tools used in African countries were not reported in the present inventory (because of a lack of local capacity to collaborate on this project or a lack of response to our request for participation).

Also, it is worth noting that other tools, out of the scope of the present inventory, are used across Africa to investigate specific aspects of the diet, such as sodium intake, dietary diversity, and food security (Torheim et al., 2003; Charlton et al., 2008; Leyna et al., 2008; Senekal et al., 2009; Dary and Jariseta, 2012). For example, an FAO Dietary Diversity Score (DDS) tool kit has been developed to assess dietary diversity at household and individual levels in resource-limited countries (Food and Agriculture Organization (FAO), 2010). DDS tool is a qualitative method that has been validated to evaluate macro- and micro-nutrient adequacy of diets of individuals (diet quality) (Arimond et al., 2010), and household food accessibility (food security). The DDS questionnaire involves a recall of food consumed over the previous 24 hours at either household or individual level. The tool can be used in baseline and impact assessment in nutrition and food security programmes, national surveys and surveillance systems, monitoring and evaluation of programmes and policies, emergency, and routine food security analyses, etc. DDS can be translated into local languages and adapted to use in local contexts. The tool has already been adapted in numerous countries, such as Mozambique–Portuguese, Malawi–Chichewa, Kenya–Kiswahili, Mali–Bambara, and Tajikistan–Taji.

Another kind of dietary survey, although not a strictly speaking DA method, widely conducted in African countries is the Household Budget Surveys (HBS). HBS provide data on food availability at household level, which can be used to compute a proxy of actual individual food consumption. Their major limitation is that they do not allow to capture information on the distribution of foods between individuals, wastes, or food eaten out-of-home (Webster-Gandy et al., 2012).

This inventory also showed that to date no initiatives in Africa have been taken to standardize dietary methodologies across countries for monitoring surveys or other international nutritional projects, although several national or regional monitoring surveys were conducted in all regions over the last

10 years. The lack of comparable tools for capturing information on the heterogeneous diets existing across African populations and the need for more support for these methods and the associated research infrastructure were unanimously reported as being the major gap and a priority by the participating partners.

Dietary assessment methods usually present difficulties for interviewers and respondents, and misreporting errors are common (Ngo et al., 2009). Indeed, diet is one of the most challenging exposures to assess that is particularly prone to errors coming from different sources (interviewers, study subjects, study design and logistics, and dietary tools used). For short-(one day and one week) or long-term (one month and one year) recall dietary methods, the errors can result from interviewer bias and need of study subjects to perform difficult cognitive tasks and to be literate. This source of error also includes respondent's ability to recall the type of food, the frequency of consumption, and the estimate of the portion size of foods consumed over a reference period of time (Ngo et al., 2009), making the interviewing process a real challenge, particularly in settings lacking resources and skills. For these methods, portion size estimation was reported as one of the main challenges influencing misreporting (both under and over reporting), although most methods reported to use different models (i.e. visual aids, pictures books, household measures, etc.) to help respondents to recall sizes accurately. Specific cultural practices in African countries, including sharing food bowls, are additional challenges to address for a proper estimate of individual dietary intakes (Hudson, 1995). Since all tools reported are paper- and interview-based, training of interviewers remains the most pivotal role in obtaining high quality and reliable data. Interviewers were reported to come from multi-disciplinary fields. Almost half of the countries reported using trained nutritionists and dieticians. However, different situations exist in Africa concerning the availability of trained dieticians and nutritionists, which challenge the transfer of knowledge and training of field workers. All countries reported that they were satisfied with the level and intensity of training of interviewers. However, whether this training effectively reduced bias could not be deduced from the questionnaires. Therefore, the transfer of knowledge, provisions of standard operating systems, and highly standardized training on dietary methods and practices will be a major aspect to be addressed in any future joint initiatives in Africa.

Although reliable food composition tables are essential for deriving individual nutrient intakes from food intake (Thompson and Byers, 1994; Rutishauser, 2005; Ngo et al., 2009), this area is another major limitation to nutrition research and prevention of NCDs in Africa, which will have to be addressed through broader initiatives. Indeed, most countries reported not having their own FCTs and adopting those from other proxy/neighboring countries or using FAO food composition tables (Food and Agriculture Organization (FAO) and US Department of Health, E.a.W., 1968; Food and Agriculture Organization (FAO), 2012). Countries having their own FCTs rarely updated them because of a lack of resources and expertise on this complex methodological area. Although the topic of FCT was not explored in-depth and was beyond the scope of this inventory, it is well covered by long-standing initiatives led by other networks (e.g. FAO and INFOODS). With an increasing influx of new foods into most African markets and

countries, the FCTs need to be updated more regularly so as to have or incorporate most foods available in a market with an increasing availability of processed local and imported foods. While indigenous foods were reported in most of the FCTs used, dietary supplements were reported only in South African and Ghanaian FCTs.

No computerized questionnaires or other new (web) technologies were reported to assess dietary intakes in Africa, although there is a lot of potential in the near future to adopt this approach, since there is an increase in access to the web and a wide use of cell phones. The application of information, communication, and computer technologies (ICCT) in dietary assessment offers several potential advantages, including improvement in data quality, consistency, accuracy, and completeness (Ngo et al., 2009; Illner et al., 2012). ICCTs are cost effective in the long term as they reduce interviewer and respondent burden, ultimately increasing compliance and validity (Kroeze et al., 2006). Furthermore, they reduce costs of training (Ngo et al., 2009; Illner et al., 2012) and save time in data coding and calculations since data are immediately stored (Lagerros et al., 2006; Evers and Carol, 2007). ICCTs enhance the interview process by simplifying it, making it less time-consuming, thus increasing the respondent's motivation (Ngo et al., 2009; Illner et al., 2012). There is a need to explore new or adapt already existing applications of ICCTs to improve dietary assessment in Africa.

Across Europe, two standardized computer-assisted DA methods are available to assess diets at individual level: the Young Adolescents Nutrition Assessment on Computer (YANA-C) (Vereecken et al., 2008) and GloboDiet software¹ (Slimani et al., 2011). These tools include both self- and interviewer-administered computerized methods. The YANA-C is a community self-administered computerized 24-HDR (Vereecken et al., 2005, 2008, 2009, 2010) developed for self-monitoring of foods intake by children and adolescents aged 11 years and older. This tool was well received by most adolescents from 10 different European countries (Vereecken et al., 2008), and it was also time-efficient (Vereecken et al., 2005). However, its weaknesses include requirements for computer skills, internet access, and nutrition knowledge (Vereecken et al., 2005, 2008).

The interviewer-administered GloboDiet software is a computer-assisted 24-HDR that permits a very detailed description and quantification of foods, recipes, and supplements consumed in the course of the preceding day (Slimani et al., 1999, 2002, 2011; de Boer et al., 2011). This programme, developed by the IARC has been validated in international epidemiological and monitoring settings in Europe (e.g. calibration, validation, or dietary monitoring surveys) (Slimani et al., 1999, 2002, 2011; Al-Delaimy et al., 2005; Crispim et al., 2011a, 2011b, 2012, 2013; Huybrechts et al., 2011a). Probing questions and entering consumed foods in chronological order aid the respondent's memory. Quantification of consumed foods is supported by the GloboDiet picture book that comprises colored photographs of foods in different portion sizes. The software provides an automatic coding of food items and recipe ingredients as well as estimation of nutrient intake (Voss et al., 1998; Slimani et al., 2002, 2011; de Boer et al., 2011).

In spite of these features, computerized interviewer-based 24-HDR are still relatively expensive to develop and use as the

main instrument large cohorts, especially when the aim is to accurately estimate individuals' usual intakes, and multiple measurements are required (Schatzkin et al., 2009; Crispim et al., 2011a; Touvier et al., 2011; Illner et al., 2012).

Although several monitoring and demographic health surveys were reported in the last 10 years in all four African regions using 24-HDR, FFQ, and dietary scores, the lack of standardized tools to assess intakes at individual levels across countries makes the collected data not comparable across countries and regions and creates challenges for setting up of common cost-effective nutritional strategies in Africa. Considering the different cultures and populations across Africa, valid and standardized DA tools could provide a better understanding of ethnic differences in disease incidence, and ultimately lead to harmonized policies or health prevention programmes. In addition, these tools can improve the way epidemiological transitions are monitored in Africa and enable better evaluation of public health intervention strategies designed to decelerate this transition (Pisa et al., 2011; Vorster et al., 2011).

The major public health nutrition challenges in Africa require increasingly coping with both under- and over-nutrition situations (Mendez et al., 2005; Asfaw, 2007; Delisle, 2008). This double burden, largely driven by the nutrition transition, is characterized by a trend of moving from traditional "prudent" diets to more western "industrialized" diets high in fat, energy, salt, and alcohol (Vorster, 2002; Popkin, 2009, 2012; Pisa et al., 2011, 2012). This transition further extends to an increase in physical inactivity patterns, and has been attributed to be the main cause in the emergence of NCDs in Africa for years (Popkin, 2003). The form and speed or rate of acceleration of this phenomenon varies across different African countries and sub-populations (e.g. children vs. adults) as industrialization, urbanization, and economic development also vary across countries (Steyn et al., 2012). Monitoring this transition has become the most challenging exercise for Africa (Crush et al., 2011; Delisle et al., 2011). For reasons mentioned above, the interviewer-administered software seems more feasible to adapt as common methodology across African settings and study populations (different age groups, gender, socioeconomic status, and languages) as compared with self-administered computerized tools.

In spite of strong micronutrient fortification programmes in Africa, micronutrient malnutrition (hidden hunger), and notably anemia, was reported as a major concern in all regions. Various types of childhood under-nutrition, such as stunting, were reported as major concerns in most countries in all regions. It should be noted that communicable diseases, including HIV/AIDS, tuberculosis, and malaria, still remain a major challenge (World Health Organization (WHO), 2006) and a need to balance between addressing emerging NCDs and current infectious diseases should be established. The main reported challenges affecting nutrition research included a lack of expertise (skills), infrastructure, financial support, cultural factors, religious obstacles, and unstable political environments. In terms of needs and priorities to improve nutrition research training (i.e. transfer of skills), funding and methodological infrastructure were reported as the most important priorities. Identifying the barriers and challenges plus assessing the opportunities available to steer the nutrition transition in a more positive direction is important (Pisa et al., 2011; Vorster et al., 2011).

This initiative is the first to our knowledge, to conduct an inventory on different DA methods being used at continental level. The strengths of this inventory include also selecting a total of 18 countries representing the four main African regions (Northern, Southern, Eastern, and Western), thus allowing us to draw general conclusions from the findings. In addition, experts from Africa and other international networks with experience on DA methodologies were included in this initiative so as to limit or reduce the risk of this exercise to miss important aspects related to dietary assessment in Africa.

This inventory had some limitations that are recognized. Not all African countries were included and some DA tools were definitely missed (e.g. among the six countries that were contacted but did not send back their questionnaires, there were DA studies). Moreover, the inventory was conducted in English and French, which could have excluded Lusophone African countries. Thus, bias could exist potentially due to the selection methodologies set for this study. Although this inventory did not intend to pretend to provide an exhaustive coverage of the specific and local situations, it was designed to provide a data-based broad evaluation of the current situation in Africa pertaining to dietary methodologies and other related issues and provide conclusions and recommendations that could be easily extrapolated and generalized to other countries not represented in this inventory.

Conclusions

A need to improve and build the research infrastructure for DA methods based on either developing new or adapting existing international dietary methodologies/devices that have been validated and standardized in international settings should be a priority in Africa. These new or adapted tools should further be culturally sensitive and acceptable in African countries to facilitate cross-country comparisons and generalizations of research findings and to implement international action plans and policies. Currently one of the major challenges in nutrition and health research programmes in Africa is the lack of high quality, validated, and standardized tools, making it difficult to monitor the different phases and speed of nutrition transition across countries. The outcomes of this inventory should ease the identification and prioritization of international (new) methodologies and related web-infrastructure needed to support nutritional research in Africa. Developing such a tool would improve the quality of future Pan-African research that could incorporate dietary exposure assessments in their multi-disciplinary research and monitoring activities in a cost-effective way. More critically, without these tools, Africa cannot reliably monitor progress on policies aimed at improving diet (nutrition)-related health challenges.

Scientific evidence coming from the use of such international tools could be used to develop harmonized prevention guidelines for NCDs, including lifestyle cancers (e.g. breast cancer) in Africa, and design more targeted guidelines (with national and international stakeholders) in relation to diet and other lifestyle environmental factors. In addition, and in a next step, such international tools could be used to establish a global nutritional surveillance system across Africa. Indeed, building on its long-standing experience on international dietary methodologies and

their successful implementations in different settings, IARC as a WHO research institute, intends to play an active role and support broader initiatives, programmes, and action plans to combat NCDs in close collaboration with WHO-HQ and other UN, regional, and national health organizations (World Health Organization (WHO), 2008), including Africa.

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References

- Al-Delaimy, W. K., Ferrari, P., Slimani, N., Pala, V., Johansson, I., Nilsson, S., Mattisson, I., Wirth, E., Galasso, R., Palli, D., Vineis, P., Tumino, R., Dorronsoro, M., Pera, G., Ocke, M. C., Bueno-de-Mesquita, H. B., Overvad, K., Chirlaque, M., Trichopoulou, A., Naska, A., Tjonneland, A., Olsen, A., Lund, E., Alsaker, E. H., Barricarte, A., Kesse, E., Boutron-Ruault, M. C., Clavel-Chapelon, F., Key, T. J., Spencer, E., Birmingham, S., Welch, A. A., Sanchez-Perez, M. J., Nagel, G., Linseisen, J., Quiros, J. R., Peeters, P. H., van Gils, C. H., Boeing, H., van Kappel, A. L., Steghens, J. P. and Riboli, E. (2005). Plasma carotenoids as biomarkers of intake of fruits and vegetables: Individual-level correlations in the European Prospective Investigation into Cancer and Nutrition (EPIC). *Eur. J. Clin. Nutr.* **59**:1387–1396.
- Aounallah-Skhiri, H., Traissac, P., El, A. J., Eymard-Duverney, S., Landais, E., Achour, N., Delpeuch, F., Ben, R. H. and Maire, B. (2011). Nutrition transition among adolescents of a south-Mediterranean country: Dietary patterns, association with socio-economic factors, overweight and blood pressure. A cross-sectional study in Tunisia. *Nutr. J.* **10**:38, 1–17.
- Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M. C., Deitchler, M., Fanou-Fogny, N., Joseph, M. L., Kennedy, G., Martin-Prevel, Y. and Torheim, L. E. (2010). Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. *J. Nutr.* **140**:2059S–2069S.
- Asfaw, A. (2007). Micronutrient deficiency and the prevalence of mothers' overweight/obesity in Egypt. *Econ. Hum. Biol.* **5**:471–483.
- Boutayeb, A. (2006). The double burden of communicable and non-communicable diseases in developing countries. *Trans. R. Soc. Trop. Med. Hyg.* **100**:191–199.
- Charlton, K. E., Steyn, K., Levitt, N. S., Jonathan, D., Zulu, J. V. and Nel, J. H. (2008). Development and validation of a short questionnaire to assess sodium intake. *Public Health Nutr.* **11**:83–94.
- Crispim, S. P., de Vries, J. H., Geelen, A., Souverein, O. W., Hulshof, P. J., Lafay, L., Rousseau, A. S., Lillegaard, I. T., Andersen, L. F., Huybrechts, I., De, K. W., Ruprich, J., Dofkova, M., Ocke, M. C., de, B. E., Slimani, N. and van't, V. P. (2011a). Two non-consecutive 24-h recalls using EPIC-Soft software are sufficiently valid for comparing protein and potassium intake between five European centres—results from the European Food Consumption Validation (EFCOVAL) study. *Br. J. Nutr.* **105**:447–458.
- Crispim, S. P., Geelen, A., Siebelink, E., Huybrechts, I., Lillegaard, I. T., Margaritis, I., Rehurkova, I., Slimani, N., Ocke, M. C., de, B. E., van't, V. P. and de Vries, J. H. (2012). Design aspects of 24-h recall assessments may affect the estimates of protein and potassium intake in dietary surveys. *Public Health Nutr.* **15**:1196–1200.
- Crispim, S. P., Geelen, A., Souverein, O. W., Hulshof, P. J., Ruprich, J., Dofkova, M., Huybrechts, I., De, K. W., Lillegaard, I. T., Andersen, L. F., Lafay, L., Rousseau, A. S., Ocke, M. C., Slimani, N., van't, V. P. and de Vries, J. H. (2011b). Biomarker-based evaluation of two 24-h recalls for comparing usual fish, fruit and vegetable intakes across European centers in the EFCOVAL Study. *Eur. J. Clin. Nutr.* **65**(Suppl 1):S38–S47.

- Crispim, S. P., Nicolas, G., Casagrande, C., Knaze, V., Illner, A. K., Huybrechts, I. and Slimani, N. (2013). Quality assurance of the international computerised 24-h dietary recall method (EPIC-Soft). *Br. J. Nutr.* **111**(3):506–515.
- Crush, J., Frayne, B. and McLachlan, M. (2011). Rapid Urbanization and the Nutrition Transition in Southern African. Queen's University and AFSUN, Cape Town, South Africa.
- Dary, O. and Jariseta, Z. R. (2012). Validation of dietary applications of Household Consumption and Expenditures Surveys (HCES) against a 24-hour recall method in Uganda. *Food Nutr. Bull.* **33**:S190–S198.
- de Boer, E. J., Slimani, N., van't Veer, P., Boeing, H., Feinberg, M., Leclercq, C., Trolle, E., Amiano, P., Andersen, L. F., Freisling, H., Geelen, A., Harttig, U., Huybrechts, I., Kaic-Rak, A., Lafay, L., Lillegaard, I. T., Ruprich, J., de Vries, J. H. and Ocke, M. C. (2011). The European Food Consumption Validation Project: Conclusions and recommendations. *Eur. J. Clin. Nutr.* **65**(Suppl 1):S102–S107.
- Delisle, H., Agueh, V. and Fayomi, B. (2011). Partnership research on nutrition transition and chronic diseases in West Africa – trends, outcomes and impacts. *BMC. Int. Health Hum. Rights.* **11**(Suppl 2):S10–S11.
- Delisle, H., Ntandou-Bouzitou, G., Agueh, V., Sodjinou, R. and Fayomi, B. (2012). Urbanisation, nutrition transition and cardiometabolic risk: The Benin study. *Br. J. Nutr.* **107**(10):1534–1544.
- Delisle, H. (2008). The double burden of malnutrition in mothers and the intergenerational impact. *Annal. N.Y. Acad. Sci.* **1136**:172–184.
- El Ati, J., Le Bihan, D., Haddad, S., Eymard-Duvernay, S., Cherif, S., Holdsworth, M., Traissac, P., Ben Rayana, C. and Delpeuch, F. (2004). Food frequency questionnaire for Tunisian dietary intakes: Development, reproducibility and validity. *Arab J. Food Nutr.* **5**:10–30.
- Evers, W. and Carol, B. (2007). An internet-based assessment tool for food choices and physical activity behaviors. *J. Nutr. Educ. Behav.* **39**:105–106.
- Food and Agriculture Organization (FAO). (2010). Guidelines for Measuring Household and Individual Dietary Diversity: A Simple Tool for Developing and Evaluating Food and Nutrition Security Interventions. FAO, Rome, Italy.
- Food and Agriculture Organization (FAO). (2012). West African Food Composition Table/Table de composition des aliments d'Afrique de l'Ouest. FAO, Rome, Italy.
- Food and Agriculture Organization (FAO) and U.S. Department of Health, E.a.W. (1968). Food Composition Tables for Use in Africa. FAO, Rome, Italy.
- Gibson, R. S. and Ferguson, E. L. (2008). An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries. *HarvestPlus Technical Monograph 8.* **2008**:1–160.
- Hudson, G. J. (1995). Food intake in a west African village. Estimation of food intake from a shared bowl. *Br. J. Nutr.* **73**:551–569.
- Huybrechts, I., Casagrande, C., Nicolas, G., Geelen, A., Crispim, S. P., De, K. W., Freisling, H., De, H. S., De, M. M., Krems, C., Amiano, P., de Boer, E. J., Ocke, M. C., de Vries, J. H. and Slimani, N. (2011a). Inventory of experiences from national/regional dietary monitoring surveys using EPIC-Soft. *Eur. J. Clin. Nutr.* **65**(Suppl 1):S16–S28.
- Huybrechts, I., Geelen, A., de Vries, J. H., Casagrande, C., Nicolas, G., De, K. W., Lillegaard, I. T., Ruprich, J., Lafay, L., Wilson-van den Hooven, EC, Niekerk, E. M., Margaritis, I., Rehurkova, I., Crispim, S. P., Freisling, H., De, H. S. and Slimani, N. (2011b). Respondents' evaluation of the 24-h dietary recall method (EPIC-Soft) in the EFCOVAL Project. *Eur. J. Clin. Nutr.* **65**(Suppl 1):S29–S37.
- Illner, A. K., Freisling, H., Boeing, H., Huybrechts, I., Crispim, S. P. and Slimani, N. (2012). Review and evaluation of innovative technologies for measuring diet in nutritional epidemiology. *Int. J. Epidemiol.* **41**:1187–1203.
- Korkalo, L., Erkkola, M., Fidalgo, L., Nevalainen, J. and Mutanen, M. (2013). Food photographs in portion size estimation among adolescent Mozambican girls. *Public Health Nutr.* **16**:1558–1564.
- Kroeze, W., Werkman, A. and Brug, J. (2006). A systematic review of randomized trials on the effectiveness of computer-tailored education on physical activity and dietary behaviors. *Ann. Behav. Med.* **31**:205–223.
- Kruger, H. S., Venter, C. S., Vorster, H. H. and Margetts, B. M. (2002). Physical inactivity is the major determinant of obesity in black women in the North West Province, South Africa: The THUSA study. Transition and health during urbanisation of South Africa. *Nutrition.* **18**:422–427.
- Lagerros, Y. T., Mucci, L. A., Bellocchio, R., Nyren, O., Balter, O. and Balter, K. A. (2006). Validity and reliability of self-reported total energy expenditure using a novel instrument. *Eur. J. Epidemiol.* **21**:227–236.
- Landais, E., Gartner, A., Bour, A., McCullough, F., Delpeuch, F. and Holdsworth, M. (2014). Reproducibility and relative validity of a brief quantitative food frequency questionnaire for assessing fruit and vegetable intakes in North African women. *J. Human Nutr. Diet.* **27**:152–159.
- Leyna, G. H., Mmbaga, E. J., Mnyika, K. S. and Klepp, K. I. (2008). Validation of the Radimer/Cornell food insecurity measure in rural Kilimanjaro, Tanzania. *Public Health Nutr.* **11**:684–689.
- Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., ir-Rohani, H., Ammann, M., Anderson, H. R., Andrews, K. G., Aryee, M., Atkinson, C., Bacchus, L. J., Bahalim, A. N., Balakrishnan, K., Balmes, J., Barker-Collo, S., Baxter, A., Bell, M. L., Blore, J. D., Blyth, F., Bonner, C., Borges, G., Bourne, R., Boussinesq, M., Brauer, M., Brooks, P., Bruce, N. G., Brunekreef, B., Bryan-Hancock, C., Bucello, C., Buchbinder, R., Bull, F., Burnett, R. T., Byers, T. E., Calabria, B., Carapetis, J., Carnahan, E., Chafe, Z., Charlson, F., Chen, H., Chen, J. S., Cheng, A. T., Child, J. C., Cohen, A., Colson, K. E., Cowie, B. C., Darby, S., Darling, S., Davis, A., Degenhardt, L., Dentener, F., Des, J., Devries, K., Dherani, M., Ding, E. L., Dorsey, E. R., Driscoll, T., Edmond, K., Ali, S. E., Engell, R. E., Erwin, P. J., Fahimi, S., Falder, G., Farzadfar, F., Ferrari, A., Finucane, M. M., Flaxman, S., Fowkes, F. G., Freedman, G., Freeman, M. K., Gakidou, E., Ghosh, S., Giovannucci, E., Gmel, G., Graham, K., Grainger, R., Grant, B., Gunnell, D., Gutierrez, H. R., Hall, W., Hoek, H. W., Hogan, A., Hosgood, H. D., III, Hoy, D., Hu, H., Hubbell, B. J., Hutchings, S. J., Ibeanusi, S. E., Jacklyn, G. L., Jasrasaria, R., Jonas, J. B., Kan, H., Kanis, J. A., Kassebaum, N., Kawakami, N., Khang, Y. H., Khatibzadeh, S., Khoo, J. P., Kok, C., Laden, F., Laloo, R., Lan, Q., Lathlean, T., Leasher, J. L., Leigh, J., Li, Y., Lin, J. K., Lipshultz, S. E., London, S., Lozano, R., Lu, Y., Mak, J., Malekzadeh, R., Mallinger, L., Marcenes, W., March, L., Marks, R., Martin, R., McGale, P., McGrath, J., Mehta, S., Mensah, G. A., Merriman, T. R., Micha, R., Michaud, C., Mishra, V., Mohd, H. K., Mokdad, A. A., Morawska, L., Mozaffarian, D., Murphy, T., Naghavi, M., Neal, B., Nelson, P. K., Nolla, J. M., Norman, R., Olives, C., Omer, S. B., Orchard, J., Osborne, R., Ostro, B., Page, A., Pandey, K. D., Parry, C. D., Passmore, E., Patra, J., Pearce, N., Pelizzari, P. M., Petzold, M., Phillips, M. R., Pope, D., Pope, C. A., III, Powles, J., Rao, M., Razavi, H., Rehfuss, E. A., Rehm, J. T., Ritz, B., Rivara, F. P., Roberts, T., Robinson, C., Rodriguez-Portales, J. A., Romieu, I., Room, R., Rosenfeld, L. C., Roy, A., Rushton, L., Salomon, J. A., Sampson, U., Sanchez-Riera, L., Sanman, E., Sapkota, A., Seedat, S., Shi, P., Shield, K., Shivakoti, R., Singh, G. M., Sleet, D. A., Smith, E., Smith, K. R., Stapelberg, N. J., Steenland, K., Stockl, H., Stovner, L. J., Straif, K., Straney, L., Thurston, G. D., Tran, J. H., Van, D. R., van, D. A., Veerman, J. L., Vijayakumar, L., Weintraub, R., Weissman, M. M., White, R. A., Whiteford, H., Wiersma, S. T., Wilkinson, J. D., Williams, H. C., Williams, W., Wilson, N., Woolf, A. D., Yip, P., Zielinski, J. M., Lopez, A. D., Murray, C. J., Ezzati, M., AlMazroa, M. A. and Memish, Z. A. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet.* **380**:2224–2260.
- Macintyre, U. E., Venter, C. S. and Vorster, H. H. (2001a). A culture-sensitive quantitative food frequency questionnaire used in an African population: 1. Development and reproducibility. *Public Health Nutr.* **4**:53–62.
- Macintyre, U. E., Venter, C. S. and Vorster, H. H. (2001b). A culture-sensitive quantitative food frequency questionnaire used in an African population: 2. Relative validation by 7-day weighted records and biomarkers. *Public Health Nutr.* **4**:63–71.
- Macintyre, U. E., Venter, C. S., Vorster, H. H. and Steyn, H. S. (2001c). A combination of statistical methods for the analysis of the relative validation data of the quantitative food frequency questionnaire used in the THUSA study. Transition, health and urbanisation in South Africa. *Public Health Nutr.* **4**:45–51.
- Mendez, M. A., Monteiro, C. A. and Popkin, B. M. (2005). Overweight exceeds underweight among women in most developing countries. *Am. J. Clin. Nutr.* **81**:714–721.

- Micha, R., Kalantarian, S., Wirojratana, P., Byers, T., Danaei, G., Elmadfa, I., Ding, E., Giovannucci, E., Powles, J., Smith-Warner, S., Ezzati, M. and Mozaffarian, D. (2012). Estimating the global and regional burden of suboptimal nutrition on chronic disease: Methods and inputs to the analysis. *Eur. J. Clin. Nutr.* **66**:119–129.
- Ngo, J., Engelen, A., Molag, M., Roesle, J., Garcia-Segovia, P. and Serra-Majem, L. (2009). A review of the use of information and communication technologies for dietary assessment. *Br. J. Nutr.* **101**(Suppl 2): S102–S112.
- Pisa, P. T., Vorster, H. H. and Nishida, C. (2011). Cardiovascular disease and nutrition: The use of food-based dietary guidelines for prevention in Africa. *S. Afr. Heart J.* **8**:38–47.
- Pisa, P. T., Behanen, R., Vorster, H. H. and Kruger, A. (2012). Social drift of cardiovascular disease risk factors in Africans from the North West Province of South Africa: The PURE study. *Cardiovasc. J. Afr.* **23**:371–388.
- Popkin, B. M. (2009). Global changes in diet and activity patterns as drivers of the nutrition transition. *Nestle. Nutr. Workshop Ser. Pediatr. Program.* **63**:1–10.
- Popkin, B. M., Adair, L. S. and Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutr. Rev.* **70**:3–21.
- Popkin, B. M. (2003). The nutrition transition in the developing world. *Dev. Policy Rev.* **21**:581–597.
- Rutishauser, I. H. (2005). Dietary intake measurements. *Public Health Nutr.* **8**:1100–1107.
- Schatzkin, A., Subar, A. F., Moore, S., Park, Y., Potischman, N., Thompson, F. E., Leitzmann, M., Hollenbeck, A., Morrissey, K. G. and Kipnis, V. (2009). Observational epidemiologic studies of nutrition and cancer: The next generation (with better observation). *Cancer Epidemiol. Biomarkers Prev.* **18**:1026–1032.
- Senekal, M., Steyn, N. P. and Nel, J. (2009). A questionnaire for screening the micronutrient intake of economically active South African adults. *Public Health Nutr.* **12**:2159–2167.
- Sharma, S., Cade, J., Jackson, M., Mbanya, J. C., Chungong, S., Forrester, T., Bennett, F., Wilks, R., Balkau, B. and Cruickshank, J. K. (1996). Development of food frequency questionnaires in three population samples of African origin from Cameroon, Jamaica and Caribbean migrants to the UK. *Eur. J. Clin. Nutr.* **50**:479–486.
- Slimani, N., Casagrande, C., Nicolas, G., Freisling, H., Huybrechts, I., Ocke, M. C., Niekerk, E. M., van, R. C., Bellemans, M., De, M. M., Lafay, L., Krems, C., Amiano, P., Trolle, E., Geelen, A., de Vries, J. H. and de Boer, E. J. (2011). The standardized computerized 24-h dietary recall method EPIC-Soft adapted for pan-European dietary monitoring. *Eur. J. Clin. Nutr.* **65**(Suppl 1):S5–15.
- Slimani, N., Deharveng, G., Charrondiere, R. U., van Kappel, A. L., Ocke, M. C., Welch, A., Lagiou, A., van, L. M., Agudo, A., Pala, V., Brandstetter, B., Andren, C., Stripp, C., Van Staveren, W. A. and Riboli, E. (1999). Structure of the standardized computerized 24-h diet recall interview used as reference method in the 22 centers participating in the EPIC project. European Prospective Investigation into Cancer and Nutrition. *Comput. Methods Programs Biomed.* **58**:251–266.
- Slimani, N., Deharveng, G., Unwin, I., Southgate, D. A., Vignat, J., Skeie, G., Salvini, S., Parpinel, M., Moller, A., Ireland, J., Becker, W., Farran, A., Westenbrink, S., Vasilopoulou, E., Unwin, J., Borgejordet, A., Rohrmann, S., Church, S., Gnagnarella, P., Casagrande, C., van, B. M., Niravong, M., Boutron-Ruault, M. C., Stripp, C., Tjonneland, A., Trichopoulou, A., Georga, K., Nilsson, S., Mattisson, I., Ray, J., Boeing, H., Ocke, M., Peeters, P. H., Jakobsen, P., Amiano, P., Engeset, D., Lund, E., de Magistris, M. S., Sacerdote, C., Welch, A., Bingham, S., Subar, A. F. and Riboli, E. (2007). The EPIC nutrient database project (ENDB): A first attempt to standardize nutrient databases across the 10 European countries participating in the EPIC study. *Eur. J. Clin. Nutr.* **61**:1037–1056.
- Slimani, N., Kaaks, R., Ferrari, P., Casagrande, C., Clavel-Chapelon, F., Lotze, G., Kroke, A., Trichopoulos, D., Trichopoulou, A., Lauria, C., Bellegotti, M., Ocke, M. C., Peeters, P. H., Engeset, D., Lund, E., Agudo, A., Larranaga, N., Mattisson, I., Andren, C., Johansson, I., Davey, G., Welch, A. A., Overvad, K., Tjonneland, A., Van Staveren, W. A., Sartacci, R. and Riboli, E. (2002). European Prospective Investigation into Cancer and Nutrition (EPIC) calibration study: Rationale, design and population characteristics. *Public Health Nutr.* **5**:1125–1145.
- Steyn, N. P., Nel, J. H., Parker, W., Ayah, R. and Mbithe, D. (2012). Urbanisation and the nutrition transition: A comparison of diet and weight status of South African and Kenyan women. *Scand. J. Public Health.* **40**:229–238.
- Thompson, F. E. and Byers, T. (1994). Dietary assessment resource manual. *J. Nutr.* **124**:2245S–2317S.
- Torheim, L. E., Barikmo, I., Parr, C. L., Hatloy, A., Ouattara, F. and Oshaug, A. (2003). Validation of food variety as an indicator of diet quality assessed with a food frequency questionnaire for Western Mali. *Eur. J. Clin. Nutr.* **57**:1283–1291.
- Touvier, M., Kesse-Guyot, E., Mejean, C., Pollet, C., Malon, A., Castetbon, K. and Hercberg, S. (2011). Comparison between an interactive web-based self-administered 24-h dietary record and an interview by a dietitian for large-scale epidemiological studies. *Br. J. Nutr.* **105**:1055–1064.
- Vereecken, C., Dohogne, S., Covents, M. and Maes, L. (2010). How accurate are adolescents in portion-size estimation using the computer tool Young Adolescents' Nutrition Assessment on Computer (YANA-C)? *Br. J. Nutr.* **103**:1844–1850.
- Vereecken, C. A., Covents, M., Haynie, D. and Maes, L. (2009). Feasibility of the young children's nutrition assessment on the web. *J. Am. Diet. Assoc.* **109**:1896–1902.
- Vereecken, C. A., Covents, M., Matthys, C. and Maes, L. (2005). Young adolescents' nutrition assessment on computer (YANA-C). *Eur. J. Clin. Nutr.* **59**:658–667.
- Vereecken, C. A., Covents, M., Sichert-Hellert, W., Alvira, J. M., Le, D. C., De, H. S., De, V. T., Phillip, M. K., Beghin, L., Manios, Y., Hallstrom, L., Poortvliet, E., Matthys, C., Plada, M., Nagy, E. and Moreno, L. A. (2008). Development and evaluation of a self-administered computerized 24-h dietary recall method for adolescents in Europe. *Int. J. Obes. (Lond.)* **32**(Suppl 5):S26–S34.
- Vorster, H. H. (2002). The emergence of cardiovascular disease during urbanisation of Africans. *Public Health Nutr.* **5**:239–243.
- Vorster, H. H., Kruger, A. and Margetts, B. M. (2011). The nutrition transition in Africa: Can it be steered into a more positive direction? *Nutrients.* **3**:429–441.
- Voss, S., Charrondiere, U. R., Slimani, N., Kroke, A., Riboli, E., Wahrendorf, J. and Boeing, H. (1998). EPIC-SOFT a European computer program for 24-hour dietary protocols. *Z. Ernahrungsphysiol.* **37**:227–233.
- Webster-Gandy, J., Madden, A. and Holdsworth, M. (2012). Oxford Handbook of Nutrition and Dietetics. Vol. Oxford handbooks. Oxford: Oxford University Press. Pgs. 33–56.
- World Health Organization (WHO). (2004). Global Strategy on Diet, Physical Activity and Health. WHO, Geneva, Switzerland.
- World Health Organization (WHO). (2006). The African Regional Health Report: The Health of the People. AFRO, Geneva, Switzerland.
- World Health Organization (WHO). (2008). 2008–2013 Action Plan for the Global Strategy for the Prevention and Control of Noncommunicable Diseases. WHO, Geneva, Switzerland.
- World Health Organization (WHO). (2013). Non communicable diseases (fact sheet): An update. Available from http://www.who.int/media_centre/factsheets/fs355/en/. Accessed 11 November 2013.