PERSPECTIVE

Perspective: Essential Study Quality Descriptors for Data from Nutritional Epidemiologic Research

Chen Yang,[1] Mariona Pinart,[5] Patrick Kolsteren,[1] John Van Camp,[1] Nathalie De Cock,[1] Katharina Nimptsch,[5] Tobias Pischon,[5–8] Eamon Laird,[9] Giuditta Perozzi,[10] Raffaella Canali,[10] Axelle Hoge,[11] Marta Stelmach-Mardas,[12,13] Lars Ove Dragsted,[14] Stéphanie Maria Palombi,[14] Irina Dobre,[14] Jildau Bouwman,[15] Peter Clarys,[16] Fabio Minervini,[17] Maria De Angelis,[17] Marco Gobbetti,[18] Jean Tafforeau,[19] Oscar Coltell,[20,21] Dolores Corella,[21,22] Hendrik De Ruyck,[23] Janette Walton,[24] Laura Kehoe,[24] Christophe Matthys,[25] Bernard De Baets,[2] Guy De Tré,[3] Antoon Bronselaer,[3] Angela Rivellese,[26] Rosalba Giacco,[27] Rosario Lombardo,[28] Sofian De Clercq,[29] Niels Hulstaert,[4,30] and Carl Lachat[1]

Departments of [1]Food Safety and Food Quality, [2]Mathematical Modelling, Statistics and Bioinformatic, [3]Telecommunications and Information Processing, and [4]Biochemistry, Ghent University, Ghent, Belgium; [5]Molecular Epidemiology Research Group, Max Delbrück Centre for Molecular Medicine, Berlin, Germany; [6]Charité – Berlin University of Medicine, Berlin, Germany; [7]Max Delbrück Center for Molecular Medicine and Berlin Institute of Health, Berlin, Germany; [8]German Centre for Cardiovascular Research, partner site, Berlin, Germany; [9]Vitamin Research Group, Trinity College Dublin, Dublin, Ireland; [10]Food and Nutrition Research Centre, Rome, Italy; [11]Department of Public Health, University of Liège, Liège, Belgium; [12]Department of Epidemiology, German Institute of Human Nutrition Potsdam-Rehbruecke, Nuthetal, Germany; [13]Department of Pediatric Gastroenterology and Metabolic Diseases, Poznan University of Medical Sciences, Poznan, Poland; [14]Department of Nutrition, Exercise and Sports, University of Copenhagen, Frederiksberg, Denmark; [15]Netherlands Organisation for Applied Scientific Research, Zeist, Netherlands; [16]Vrije Universiteit Brussels, Brussels, Belgium; [17]Department of Soil, Plant and Food Science, University of Bari Aldo Moro, Bari, Italy; [18]Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy; [19]Department of Public Health and Surveillance, Scientific Institute of Public Health, Brussels, Belgium; [20]Department of Computer Languages and Systems, University Jaume I, Castellón, Spain; [21]Department of Preventive Medicine and Public Health, University of Valencia, Valencia, Spain; [22]Biomedical Research Centre in Physiopathology of Obesity and Nutrition, Institute of Health Carlos III, Madrid, Spain; [23]Flanders research institute for agriculture, fisheries and food, Technology and Food Science Unit, Food Safety and Product Innovation, Melle, Belgium; [24]School of Food and Nutritional Sciences, University College Cork, Cork, Ireland; [25]KU Leuven, Clinical and Experimental Endocrinology and University Hospitals Leuven/KU Leuven, Department of Endocrinology, Campus Gasthuisberg, Leuven, Belgium; [26]Department of Clinical Medicine and Surgery, School of Medicine, University Federico II, Naples, Italy; [27]Institute of Food Sciences of National Research Council, Avellino, Italy; [28]The Microsoft Research, University of Trento Centre for Computational and Systems Biology, Trento, Italy; [29]Department of Biochemistry, Ghent University, Faculty of Medicine and Health Sciences, Ghent, Belgium; and [30]VIB-UGent Center for Medical Biotechnology, VIB, Ghent, Belgium

ABSTRACT

Pooled analysis of secondary data increases the power of research and enables scientific discovery in nutritional epidemiology. Information on study characteristics that determine data quality is needed to enable correct reuse and interpretation of data. This study aims to define essential quality characteristics for data from observational studies in nutrition. First, a literature review was performed to get an insight on existing instruments that assess the quality of cohort, case-control, and cross-sectional studies and dietary measurement. Second, 2 face-to-face workshops were organized to determine the study characteristics that affect data quality. Third, consensus on the data descriptors and controlled vocabulary was obtained. From 4884 papers retrieved, 26 relevant instruments, containing 164 characteristics for study design and 93 characteristics for measurements, were selected. The workshop and consensus process resulted in 10 descriptors allocated to "study design" and 22 to "measurement" domains. Data descriptors were organized as an ordinal scale of items to facilitate the identification, storage, and querying of nutrition data. Further integration of an Ontology for Nutrition Studies will facilitate interoperability of data repositories. *Adv Nutr* 2017;8:639–51.

Keywords: data quality, observational study, dietary assessment, nutritional epidemiology, data interoperability

Introduction

Poor diets are among the leading causes of disease and inadequate health worldwide (1). Observational studies are an essential source of information in nutritional epidemiology. They assess the relation between diet and health outcomes (2, 3) and allow for the inference of findings from mechanistic and laboratory studies in free-living populations (4). Observational studies need to be adequately powered for this purpose, which requires substantial funding, resources, participant involvement, and time. Reuse of secondary data can increase

the return on investments from observational studies. Apart from providing additional power, the analysis of secondary data can allow for the assessment of the robustness of findings across study settings, study design, and participants (5). The Global Burden of Disease (1), the Non-Communicable Disease Risk Factor Collaboration (6), and the Global Dietary Database (7) demonstrate how the reanalysis of secondary data can generate new insights into diet, nutrition, and human health.

Sharing research data has gained considerable momentum. Despite this, however, low accessibility (i.e., difficulties in finding appropriate secondary datasets) and validation of data (i.e., challenges in identifying the characteristics of available data sets as well as their collection method) remain key concerns for secondary data analysis in epidemiology (8). A key requirement to enable effective use and machine readability of research data is the use of appropriate data descriptors (9). To date, however, no consensus has been reached on the required metadata for nutritional studies.

Knowledge of data quality is key to interpreting findings of secondary analyses. It enables the performance of uncertainty analysis of risk factors for disease (10) and is of interest for comparing data sets and their contribution to overall findings in pooled analysis (11, 12). Quality tools exist for epidemiologic research (13) but are designed to appraise the quality of the study findings, rather than the study data, and are influenced by the reporting quality of the study or judgement of external assessors. Research data, however, can be (re)used for different research questions. Because secondary data analysis may demand specific data quality, a clear description of data characteristics by data providers is needed.

The present report provides guidelines to facilitate the collection of a uniform set of information (i.e., data descriptors) from nutritional epidemiologic studies. This information would be helpful to describe the quality of available data from observational nutrition studies in the event researchers attempt to pool data and perform secondary analyses.

Perspective articles allow authors to take a position on a topic of current major importance or controversy in the field of nutrition. As such, these articles could include statements based on author opinions or point of view. Opinions expressed in Perspective articles are those of the author and are not attributable to the funder(s) or the sponsor(s) or the publisher, Editor, or Editorial Board of *Advances in Nutrition*. Individuals with different positions of the topic of a Perspective are invited to submit their comments in the form of a Perspectives article or in a Letter to the Editor.

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Supplemental Table 1 is available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://advances.nutrition.org.

Address correspondence to CL (e-mail: carl.lachat@ugent.be).

Abbreviations used: DASH-IN, Data Sharing In Nutrition; ENPADASI, European Nutritional Phenotype Assessment and Data Sharing Initiative; ONS, Ontology for Nutritional Studies.

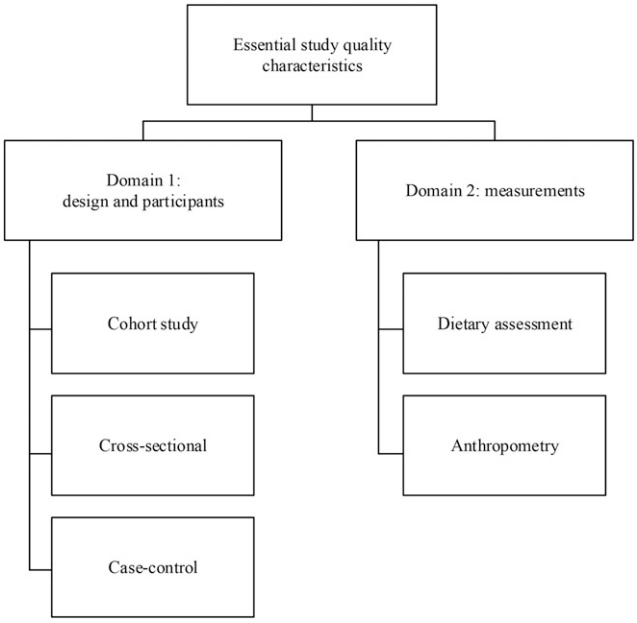

FIGURE 1 The domain-based structure of the essential study quality characteristics.

This study was performed in the context of ENPADASI (European Nutritional Phenotype Assessment and Data Sharing Initiative), a collaborative effort of 16 multidisciplinary consortia from 50 research centers in 9 countries. ENPADASI aims to enable sharing and reuse of existing nutritional data through a nutritional data infrastructure called DASH-IN (Data Sharing In Nutrition) (14).

Methods

This study was organized in 3 consecutive steps. First, a systematic literature review was performed to identify existing tools that assess quality of observational studies. Second, face-to-face and online meetings with the relevant ENPADASI partners were organized to determine the descriptors and their structure. Third, we built consensus on the descriptors. A controlled vocabulary was developed to avoid ambiguity and facilitate understanding of descriptors and wording.

Step 1: literature review

To guide the literature review, a scoping study was conducted to identify available study quality appraisal tools and reviews on the topic. The websites of the Scottish Intercollegiate Guidelines Network initiative (15) and Cochrane Handbook (16) were searched, and a citation analysis of systematic reviews on the topic (13, 17–19) and reporting guidelines (20) were performed. The scoping study confirmed the lack of existing tools for describing the quality characteristics of study data from nutritional epidemiology. Existing instruments and standards in biosciences, such as the "investigation-study-assay" framework (21), provided further input to organize the data quality descriptors into 2 domains: study design and measurements (**Figure 1**). Such modular structure enables combination of descriptors from the 2 domains. Following recommendations for the reporting of observational studies in epidemiology (20) and nutritional epidemiology (22), we focused on the main study designs for observational studies: cross-sectional, case-control, and cohort studies. In this first instance, the measurements domain was limited to dietary assessment and anthropometric status.

The scoping review led to the development of a search syntax (**Supplemental Table 1**) to review available literature systematically. Because nutritional epidemiology uses general epidemiologic methods (23), we searched and reviewed all tools for epidemiologic studies. The consortium discussed the procedures for the data extraction and data extraction templates were before the search and are available on request.

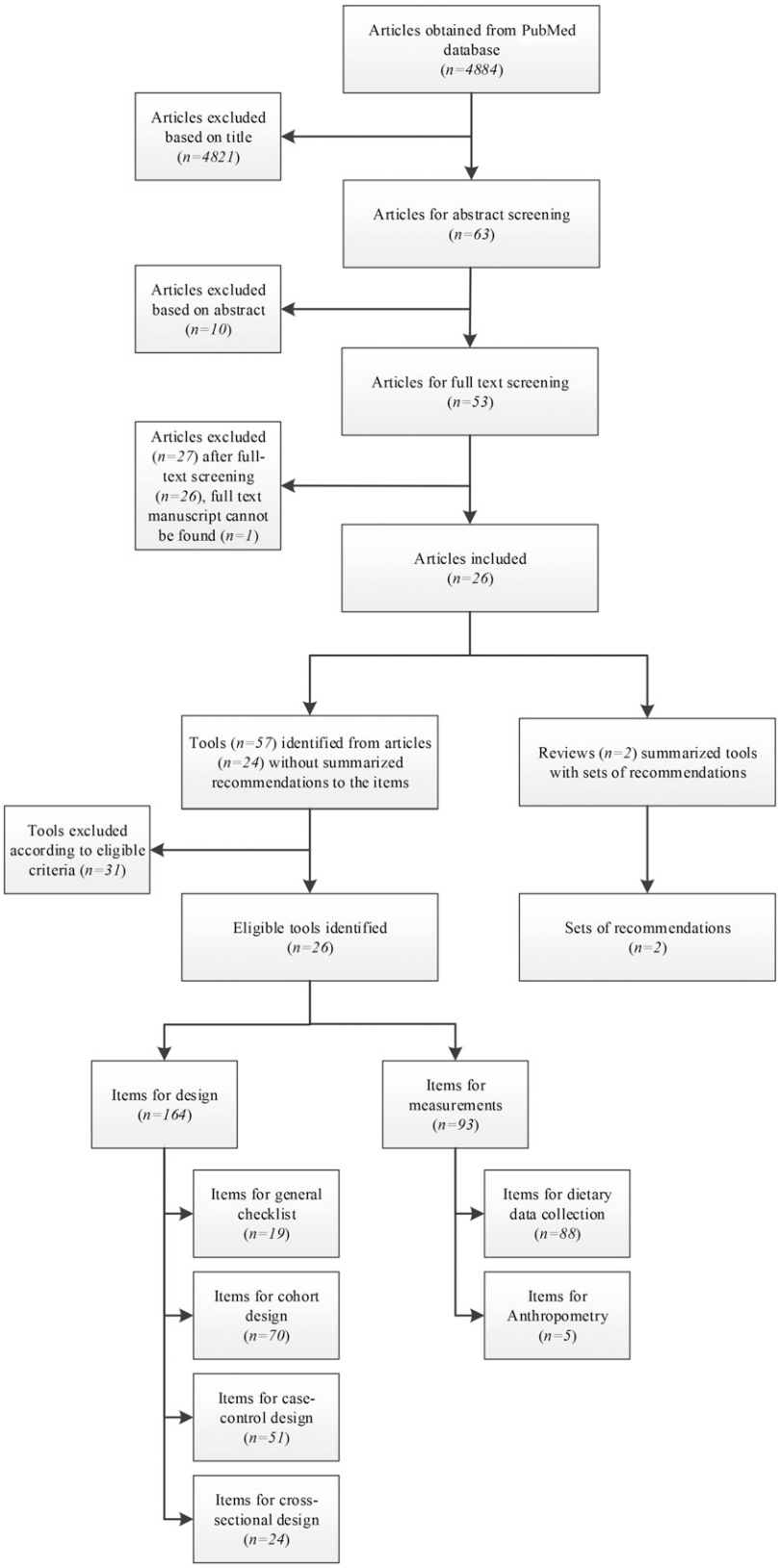

FIGURE 2 Flowchart of study screening and extraction of items for essential study quality characteristics.

MEDLINE (entry: PubMed) was searched twice by MP to retrieve relevant tools. A first search was performed on 1 July 2015, with the limit for publication dates set between 1 January 2000 and 31 December 2015. Because the search syntax did not retrieve some essential tools, a second search was performed on 8 July 2015 using broader search syntax (Supplemental Table 1) with higher sensitivity and extended publication dates from 1 January 1990 to 31 December 2015.

Studies were included if they met the following criteria: studies that developed instruments with items assessing *1*) the methodological quality of ≥1 of the following study designs: cohort and panel studies, case-control

TABLE 1 Eligible study quality appraisal tools identified from the literature review[1]

Tool name (ref)	Study design			Measurement	
	Case-control	Cross-sectional	Cohort	Diet	Anthropometry
1 Newcastle-Ottawa Scale (31)	x	—	x	—	—
2 SIGN (15)	x	—	x	—	—
3 Friedenreich et al. (32)	x	—	—	x	—
4 Margetts et al. (33)	x	—	x	x	—
5 Yang et al. (34)	x	x	x	x	—
6 NNR5 working group (35)	—	x	x	x	x
7 Hoy et al. (36)	—	x	—	—	—
8 Al-Jader et al. (37)	—	—	—	x	—
9 EPHPP (38)	—	—	—	x	—
10 SAQOR (39)	—	—	—	x	—
11 Giannakopoulos et al. (40)	—	—	—	—	x
12 Thompson et al. (41)	—	—	x	x	—
13 Cho and Bero (42)	—	—	—	—	x
14 Carneiro (43)	x	—	—	—	—
15 CASP (44)	x	—	x	—	—
16 NICE (45)	x	—	x	—	—
17 AHRQ (46)	—	x	—	x	—
18 Crombie's items (47)	x	x	x	x	—
19 NCCEH (48)	—	x	—	x	x
20 CEBMa (49)	x	—	x	x	—
21 EAI (50)	x	x	x	x	x
22 NHMRC (51)	x	—	x	—	—
23 Greenhalgh (52)	x	x	x	—	—
24 Greenhalgh and Taylor (53)	—	—	—	x	—
25 Heller et al. (54)	x	—	—	—	—
26 QATSDD (55)	—	—	—	x	—
27 Sanderson et al. (13) (recommendations)	x	x	x	—	—
28 Deeks et al. (18) (recommendations)	x	x	x	—	—
Total	16	10	15	15	5

[1] The "x" means the tool includes quality appraisal item(s) for that design. AHRQ, Agency for Healthcare Research and Quality; CASP, Critical Appraisal Skills Programme; CEBMa, Center for Evidence-Based Management; EAI, epidemiological appraisal instrument; EPHPP, Effective Public Health Practice Project; NCCEH, National Collaborating Centre for Environmental Health; NHMRC, National Health and Medical Research Council; NICE, National Institute for Health and Care Excellence; NNR, Nordic Nutrition Recommendations; QATSDD, Quality Assessment Tool for Studies with Diverse Designs; ref, reference; SAQOR, Systematic Assessment of Quality in Observational Research; SIGN, Scottish Intercollegiate Guidelines Network.

studies, and cross-sectional studies and analyses, transversal studies, and prevalence studies, and *2*) the methodological quality of ≥1 of the measurements done in nutritional epidemiology: diet, food intake or anthropometry. Items were excluded if they assessed *1*) statistical analysis or assessment of study results and *2*) the reporting quality of studies.

Two reviewers screened titles (CL and MP) and abstracts (CY and MP) independently. Before data extraction, the independent reviewers (CL and MP) screened the full text of the selected studies. Reference lists from the included studies were manually searched to identify additional eligible studies. Disagreements were resolved by discussion until consensus was achieved. In case of doubt, we used a conservative approach and included the studies.

A pre-established data extraction form was used to summarize relevant studies, instruments, and quality appraisal items of the included studies.

Step 2: selection and modification of items

On 18 March 2016, a face-to-face meeting with ENPADASI researchers involved in the development of standards and identification of data sets for joint data analysis was organized in Brussels to define essential descriptors. At the inception of the meeting, the guiding principles for item selection and modification were determined. The principles used were *1*) independent nature of the descriptors (i.e., every descriptor must capture a distinct data quality parameter), *2*) conciseness (i.e., the number of descriptors of the tool should be as concise as possible), *3*) objectiveness (i.e., those specifying the data characteristics should be able to provide an objective assessment of how the study was done without value judgment), and *4*) generalizability (i.e., the descriptors can be applied to other nutrition study data systems).

Because the discussions were based on existing items from the literature study, the tool made use of existing knowledge as much as possible. The selection and modification of specific descriptors was conducted in small working groups of 3–5 people that were moderated by the lead researchers of this report (CY, MP, and CL). After the face-to-face meeting, the working groups finalized a draft of the study descriptors through conference calls and e-mail communications.

Step 3: consensus building

A conference call was organized on 10 May 2016 to reach consensus within the working group that participated in the face-to-face meeting on the shortlisted descriptors and labels. Absent researchers were informed about the tool and were encouraged to provide comments electronically.

Final consensus in the ENPADASI consortium was obtained during the annual meeting held on 5 September 2016 in Copenhagen, Denmark. During the first week of August, all attendees received the relevant material for the discussion, which included the draft proposed by the working group with a short description of the objective of the study descriptors. Then, standardized definitions of identified terms in quality descriptors were retrieved from the Medical Subject Headings database of US National Library of Medicine (24) and *A Dictionary of Epidemiology* (Sixth Edition) (25). In case terms were not found, manuscripts were used to describe the terms (26–30).

We achieved consensus on the structure, the scope, and description of the included descriptors and how they should be implemented in the DASH-IN database. Unresolved disagreements were further discussed thereafter through electronic communications or conference calls, or both, until final consensus was reached.

Results

Step 1: literature review

We identified 4884 citations after removal of duplicates from the 2 literature searches, of which 24 studies (containing 26

TABLE 2 Items for quality assessment of study design[1]

No.	Case-control	Cross-sectional	Cohort	Descriptors	Label	Referred definition
1	x	x	x	Response rate	• Response rate: _____	Response rate (25): The number of completed or returned survey instruments (questionnaires, interviews, etc.) divided by the total number of persons who would have been surveyed if all had participated. Usually expressed as a percentage. Nonresponse can have several causes (e.g., death, removal from the survey community, and refusal).
					• Cooperation rate: _____	Cooperation rate (27): The number of participants divided by the number eligible that were ever contacted.
					• Both are unknown	
2	x	x	x	Covariates and confounding factors	• Yes, all identified covariates and confounding factors are assessed • Yes, some of the identified covariates and confounding factors are assessed • No, they are not assessed	Confounding (25): Loosely, the distortion of a measure of the effect of an exposure on an outcome due to the association of the exposure with other factors that influence the occurrence of the outcome. Confounding occurs when all or part of the apparent association between the exposure and outcome is in fact accounted for by other variables that affect the outcome and are not themselves affected by exposure.
3	x	x	x	Confirmed diagnosis[2]	• Yes, method used for confirming diagnosis: _____ • No, a non-validated self-report diagnosis was used	Diagnosis (25): The process of determining the health status and the factors responsible for it; may be applied to an individual, family, group, or society. The term is applied both to the process of determination and to its findings.
4	x	x	x	Percentage of missing data for the main exposure(s)/ outcome	• Exact percentage (exposure): _____ • Exact percentage (outcome): _____	Missing data (25): Lack of some information or incomplete information for some study participants. Usually (but not always) the term refers to data missing in ways deviating from the study design.
5	x	x	x	Pattern of missing data	• Missing (completely) at random	Missing completely at random (25): There are no systematic differences between the missing values and the observed values.

(Continued)

TABLE 2 (*Continued*)

No.	Case-control	Cross-sectional	Cohort	Descriptors	Label	Referred definition
						Missing at random (25): Any systematic difference between the missing values and the observed values can be explained by differences in observed data.
					• Missing, not at random	Missing, not at random (25): Even after the observed data are taken into account, systematic differences remain between the missing values and the observed values.
					• Unknown	
6	—	x	x	Random selection	• Yes • No	Selection bias (25): Bias in the estimated association or effect of an exposure on an outcome that arises from the procedures used to select individuals into the study or the analysis. When the selection involves conditioning on a factor that is affected by the exposure or a cause of the exposure, and also affected by the outcome or a cause of the outcome, selection bias can arise even in the absence of a causal effect of exposure on outcome.
7	x (if applicable)	x	x (if applicable)	Representative sample	• Yes: representative sample for the study population • No, a nonrepresentative sample was taken	Representative sample (25): A sample that to a large extent resembles a population of interest.
8	x	—	x	Incidence	• Yes, cases reported as incident cases • No, cases not reported as incident cases	Incidence (25): The number of instances of illness commencing, or of persons falling ill, during a given period in a specified population. More generally, the number of new health-related events in a defined population within a specified period of time. It may be measured as a frequency count, a rate, or a proportion.
9	x	—	—	Controls	• Controls are from the same population as cases • Controls are from similar population as cases • Controls are from another population or national controls	Controls (25): Subjects with whom a comparison is made. In a case-control study, controls are often defined as noncases or by other postexposure events, making them especially susceptible to selection bias. Selection of appropriate controls is crucial to the validity of epidemiologic and clinical studies.

(Continued)

TABLE 2 (*Continued*)

No.	Case-control	Cross-sectional	Cohort	Descriptors	Label	Referred definition
10	—	—	x	Lost to follow-up	• <5% • 5–20% • >20% • Unknown	Lost to follow-up (24, 25): Study subjects in cohort studies whose outcomes are unknown (e.g., because they could not or did not wish to attend follow-up visits).

[1] The "x" means the tool includes quality appraisal item(s) for that design.
[2] For a data set with >1 outcome, it is better to provide an answer for each of the outcomes.

tools) were finally selected for inclusion and data extraction (**Figure 2**). Recommendations from 2 relevant systematic reviews were also considered (13, 18). Although both systematic reviews have much broader scopes compared with the present study, their recommendations were considered key to guide the selection of descriptors.

From the 26 selected tools and 2 sets of recommendations, 16, 10, and 15 contained relevant items for design of case-control, cross-sectional, and cohort studies, respectively, and 15 and 5 tools contained items to assess quality of measuring food intake and anthropometry, respectively (**Table 1**).

Step 2: selection and modification of descriptors

All of the 18 invited ENPADASI partners participated in the face-to-face meeting. During the workshop, 164 items derived from the 26 eligible tools were considered for assessment of the study design and 93 items for measurement assessment. After discussion, the working groups proposed a draft tool with 10 quality descriptors for study design and 22 quality descriptors for nutritional measurements (16 for dietary intake and 6 for anthropometry).

Step 3: consensus building

There were 35 attendees at the ENPADASI consortium meeting. The meeting participants agreed to organize the descriptors as an ordinal scale without an overall score. Meanwhile, controlled vocabularies were added to most of the descriptors in **Tables 2–4** to ensure a common understanding and correct interpretation for each of them.

Table 2 contains the 10 descriptors related to study design. Among the 10 descriptors, 6 descriptors are applicable for all the 3 included study designs. For the remainder, the descriptor "random selection" applies to cohort and cross-sectional study designs. The descriptor for "incidence" applies to case-control and cohort study designs. The descriptors for "controls" and "loss to follow-up" were identified for case-control and cohort study designs, respectively. Among the 6 general descriptors, descriptor "representative sample" might not be applicable for case-control studies or cohort studies in some cases. Three types of information should be provided: *1*) exact response and cooperation rate, *2*) diagnosis method, and *3*) missing data rate.

Table 3 summarizes the 16 quality descriptors for dietary assessment by the most popular data collection instruments (i.e., dietary record, 24-h recall, FFQ and screener, and dietary history). These descriptors include 2 items for recall method (descriptor "type of administration" and "the time of diet records"), 5 for data collection instruments (descriptor "origin of the questionnaire," "content validity of questionnaire assessed," "reference of the validation," "validated elements" and "type of validation"), 4 for representativeness of days (descriptor "representativeness of seasons," "representativeness of the week/weekend days," "number of days of the recall/measurement per individual," and "selection of recall/measurement days selected"), and 5 for the food quantification method (descriptor "quantification of portion sizes," "description of food intake data," "geographically specific food composition data," "matching consumed food to referred food composition data." and "customized food quantification method based on characters of population groups"). To date, traditional methods are combined with digital technologies, such as *1*) dietary assessment through personal digital assistant technologies, mobile phone–based technologies, camera and tape recorder–based technologies developed from dietary record, *2*) interactive computer-based technologies, web-based developed from 24-h dietary recall, and *3*) interactive computer- and web-based technologies developed from the FFQ (56). The data quality descriptors can be equally used for these combined methods.

Table 4 summarizes 6 descriptors for anthropometry measurement, which focused on training of assessors, weight, height, waist circumference, BMI status (categories), and whole-body adiposity.

Discussion

Here, we propose essential quality descriptors for study data from nutritional epidemiology. Unlike existing quality assessment tools for studies, the present set of quality descriptors provides essential items to be added as metadata of nutrition research data. Apart from having a different scope, the present set of descriptors has several differences compared with existing tools.

First, existing quality appraisal tools assign quality scores to studies. Unlike these tools, the present set of descriptors describes essential quality aspects of the study without ranking or scoring studies and their data. Because data quality requirements depend on the purpose of the research, an absolute assessment of study quality was considered unrealistic. As such, data quality might be judged acceptable for one specific purpose but not for another. Instead of assessing absolute quality, the present tool ensures that studies are adequately characterized with descriptors relevant for assessing

TABLE 3 Items for measurement of diet and food intake[1]

No.	Dietary record	24-h recall	FFQ and screener	Dietary history	Descriptors	Label	Referred definition
1	x	x	x	x	Type of administration	• Proxy administered • Self-administered and not verified by interviewer • Self-administered and checked by interviewer • Interview administered • Interview administered using automated multiple-pass method	Automated multiple-pass method (26): Computerized method for collecting interviewer-administered 24-h dietary recalls either in person or by telephone.
2	x	x	x	x	Origin of the questionnaire	• Self-developed questionnaires • Use of standardized questionnaire • Adopted other questionnaires	Questionnaires (25): A predetermined set of questions used to collect data—clinical data, social status, occupational group, etc. This term is often applied to a self-completed survey instrument, as contrasted with an interview schedule.
3 (if 2 = self-developed questionnaires)	x	x	x	x	Content validity of questionnaire assessed	• No • Yes, in another population • Yes, in a comparable population in terms of both age and dietary habits	Content validity (25): The extent to which the measurement incorporates the domain of the phenomenon under study. For example, a measurement of functional health status should embrace activities of daily living (occupational, family, and social functioning, etc.).
4 (if 3 = yes)	x	x	x	x	Reference of the validation[2]	• No validation was conducted • Comparison with subjective dietary assessment methods (e.g., FFQ, 24-h recall, or short term dietary record) • Comparison with long-term weighted dietary record (>7 d) • Comparison with objective methods (e.g., biomarker of dietary intake)	Biomarker (25): A substance, structure, or process that can be measured in biological specimens or media and may be associated with health outcomes or biological effects. A cellular, biochemical, or molecular indicator of exposure; of biological, subclinical, or clinical effects; or of possible susceptibility. A biological indicator of internal dose, biologically effective dose, early biological response, altered structure, or altered function.
5 (if 3 = yes)	x	x	x	x	Validated element(s)	• Properties of the whole questionnaire (e.g., interrater reliability, etc.) • Frequency options appropriate to identify between-person variations • Food items lead to underestimated target nutrients intake (for FFQ only) • Others	—

(Continued)

TABLE 3 (*Continued*)

No.	Dietary record	24-h recall	FFQ and screener	Dietary history	Descriptors	Label	Referred definition
6 (if 3 = yes)	x	x	x	x	Type of validation	• Concurrent validity or precision only • Concurrent validity and precision	—
7	x	x	x	x	Representativeness of seasons	• All seasons • Not all seasons	Seasons (24): Divisions of the year according to some regularly recurrent phenomena usually astronomical or climatic.
8	x	x	x	x	Quantification of portion sizes	• Not quantified • Standard portion sizes without aids • Standard portion sizes with aids such as pictures, models, standard household measure, utensils, etc. • Portion sizes are assessed digitally but not verified by trained staff • Portion sizes are assessed digitally and verified by trained staff (or packaging)	Portion size (24): The amount of a particular food one chooses to eat at a single meal.
9 (If 8 ≠ not quantified)	x	x	x	x	Description of food intake data	• Food intake is directly expressed into units of weights or volume (for weighed food record) • Food intake is converted from estimated portion sizes into units of weights or volume • Portion sizes are not converted	Portion size (24): The amount of a particular food one chooses to eat at a single meal.
10 (If 8 ≠ not quantified)	x	x	x	x	Geographically specific food composition data	• Yes • No	Geographically specific food composition data (28): In a single country there may be a wide diversity of soil and climatic conditions, resulting in significant variance in food composition. Variations in food marketing and food preparation within different parts of a country—or between countries in the case of a multicountry database—may also produce notable variance. For these reasons, geographically specific data may be presented in the database as a supplement to nationwide and/or region-wide averages.
11 (If 8 ≠ not quantified)	x	x	x	x	Matching consumed food to referred food composition data	• __% food items with exact matching • __% food items matched to means of ≥3 food items in the table	Food matching links food consumption data with food composition data and affects the quality of the dietary assessment

(Continued)

TABLE 3 (*Continued*)

No.	Dietary record	24-h recall	FFQ and screener	Dietary history	Descriptors	Label	Referred definition
						• __% food items matched to same food items in the table with similar moisture content • __% matched to a different food	and accuracy of findings. High-quality matching is desirable but is often not achievable due to lack of food composition data or information on food consumed. Exact match (29): If food description reported in 24-h recall matched exactly with the description in food consumption data.
12	x	x	—	x	Representativeness of the week/weekend days	• Only weekend days • Only weekdays • Both • n/a	—
13	x	x	—	x	Number of days of the recall/measurement per individual	• 1 d • 2–7 d • >7 d	—
14	x	x	—	x	Selection of recall/measurement days selected	• Convenience selection • Consecutive days • Nonconsecutive, nonrandom days • Randomly over the week	—
15	x	—	x	x	The time of diet records	• Not during eating occasions or immediately after • Immediately after eating occasion • During eating occasion	Diet records (24): Records of nutrient intake over a specific period of time, usually kept by the patient.
16	—	—	x	x	Customized food quantification method based on characters of population groups	• The method was tailored to the characteristics of the population assessed • The method was not specifically tailored to the characteristics of the population assessed • Unknown	Population groups (24): Individuals classified according to their sex, racial origin, religion, common place of living, financial or social status, or some other cultural or behavioral attribute.

[1] The "x" means the item is applicable for that design. n/a, not available.
[2] If applicable, tick multiple options to describe the combination of methods.

data quality by the user of the data. In doing so, researchers extracting data from nutrition data research infrastructure can determine quality parameters and boundaries relative to their specific research interest. By requesting data providers to describe data quality, we avoid quality assessment from external assessors. No predefined quality scores are provided because this could trigger data providers to indicate a better quality of their data with respect to the "most important" quality measures.

Second, because the tool describes methodological aspects of nutritional epidemiologic data, descriptors for data analysis and data interpretation were not considered. Such items are typically included in tools that appraise study quality based on information reported in manuscripts (13).

Third, throughout the discussion, we decided to allocate several items under minimal study data requirements. These minimal study data requirements are mandatory and ensure basic information is added to describe uploaded data for interpretation and use. For instance, previous studies indicate that the source of funding could bias study findings (57). This information was considered different from the methodological aspects and rather part of minimal study data requirements. Unlike the minimal study data requirements, descriptors related to study quality are presented as an optional set of questions for those uploading data to databases. The number of answered descriptors, however, can also be used as a quality parameter to indicate how well uploaded data are described.

To minimize the burden to the data providers, only descriptors related to methodological issues of data collection were considered. We acknowledge that the methodological considerations of studies here are only one aspect to describe data quality (58). Equally relevant to data quality are data entry accuracy and data completeness. This information,

TABLE 4 Descriptors for measurement of anthropometry

No.	Descriptors	Options	Referred definitions
1	Training of assessors	• Self-reported, without assessors or with assessors not trained using standard operating procedures • Trained, not using standard operating procedures • Trained and using predefined standard operating procedures	Standard operating procedures (30): detailed, written instructions to achieve uniformity of the performance of a specific function.
2	Weight	• Self-measured, self-reported or proxy reported	Proxy (24): A person authorized to decide or act for another person, for example, a person having durable power of attorney.
		• Measured with no clothing instructions by an assessor	Body weight (24): The mass or quantity of heaviness of an individual. It is expressed by units of pounds or kilograms.
		• Measured naked or with only light clothing by an assessor	
3	Height	• Self-measured, self-reported, or proxy reported	Proxy (24): A person authorized to decide or act for another person, for example, a person having durable power of attorney.
		• Measured with shoes	Body height (24): The distance from the sole to the crown of the head with body standing on a flat surface and fully extended.
		• Measured barefoot	
4	Waist circumference	• Self-measured, self-reported, or proxy reported	Proxy (24): A person authorized to decide or act for another person, for example, a person having durable power of attorney.
		• Measured with no clothing instructions	Waist circumference (24): The measurement around the body at the level of the abdomen and just above the hip bone. The measurement is usually taken immediately after exhalation.
		• Measured naked or with only light clothing	
5	BMI status (categories)	• Self-reported using no aids • Assessed using pictograms or silhouettes • Measured using objective measures (weight and height, body scanner...)	BMI (25): BMI, anthropometric measure, defined as kg/m^2.
6	Whole-body adiposity	• Using bioelectrical impedance analysis • Using DXA • Waist-to-hip ratio • Skin fold	Adiposity (24): The amount of fat or lipid deposit at a site or an organ in the body, an indicator of body fat status.

however, can be assessed objectively from the data and does not require additional information provided by data providers (30). A combination of methodological and statistical aspects (e.g., data entry accuracy, data completeness, data cleaning approaches, etc.) of data is needed to fully describe data quality. Further efforts will be devoted to developing data quality descriptors based on statistical aspects of data in the next years.

Information collected through the data descriptors will be made available to those interacting with the DASH-IN (14) system as options during the construction of data queries. When users extract data from the system, study descriptors will be available that allow users to *1*) construct queries by choosing appropriate study quality descriptors and minimal study data requirements and *2*) check the quality characteristics of data retrieved by a query. To guide users toward the best data source, a summary statistic will be provided to indicate the relative share of its descriptors filled. Querying of the data system using the descriptors will hence enable exploratory and associational analysis and predictive modeling.

Together with minimal study data requirements, we integrated the set of essential quality descriptors in Mica (59), an open-access infrastructure to describe and share epidemiologic data. The JavaScript Object Notation script to define the descriptors in Mica is available publicly to encourage use and further development (https://github.com/enpadasi/enpadasi-mica-forms).

As a generic tool for observational data in nutrition, this tool can be applied to nutrition data systems other than DASH-IN and is a relevant contribution to initiatives such as the Global Dietary Database (7), which collects pooled food intake data worldwide. Similarly, the FAO/WHO Global Individual Food Consumption Data Tool aims to make food intake data available for reuse and analysis (60). Adding the tool to the templates and study data descriptors will enable the careful consideration of the quality of data considered and sensitivity of the pooled analysis.

The present report describes a controlled vocabulary of study descriptors by an interdisciplinary group of domain experts. Additional efforts are needed to integrate them in the nutrition research data infrastructure, including DASH-IN, among others. Machine-operable terms and their relations, attributes, and values are required to enable the interoperability of data (61, 62). To ensure interoperability of nutrition data systems, ENPADASI is developing an Ontology for Nutritional Studies (ONS) (26, 63). All descriptors of these study data characteristics will be made part of ONS and implemented

as such in the research infrastructure. The descriptors for data quality will be mapped to existing or newly developed ontology terms. Integration of study quality characteristics with the ONS will enable the consideration of study quality during the querying of the nutrition research infrastructure and interoperability with other data systems.

The present set of descriptors was informed by existing tools and guidance on study quality appraisal. Our search, however, was limited to MEDLINE, and although it is considered as the most comprehensive database for medical literature to date, we are conscious that we may have missed some quality appraisal tools. The aim of the literature search, however, was to derive a set of quality descriptors that could be discussed and complemented by consortium participants in a consecutive consultation.

Although validity and reliability assessment of a tool are essential, these properties have only been assessed for a few quality appraisal instruments until now (64). During the following years, the set of descriptors will be evaluated and extra modules will be added. The modular structure of the tool enables easy integration of descriptors related to other study designs (e.g., intervention study, etc.) or measurements (e.g., physical activity, smoking, etc.). In addition, data descriptors of both observational and intervention studies will be linked in DASH-IN to enable the description and extraction of data from hybrid collection events (e.g., observational analyses from clinical trials, etc.). Care will be taken not to inflate the number of descriptors to go beyond what is practically acceptable by data providers. An online survey for both those uploading and extracting data will be organized to determine the acceptable number of descriptors in the tool.

The descriptors of quality characteristics proposed in the present report will contribute to an adequate description of nutritional and dietary intake data as a determinant of disease and can facilitate the re-use and uncertainty analysis of risk factors for diseases in this regard.

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