

# BMJ Open Methodology for developing and evaluating food-based dietary guidelines and a Healthy Eating Index for Ethiopia: a study protocol

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## ABSTRACT

**Introduction** Food-based dietary guidelines (FBDGs) are used to promote and maintain healthy eating in a population, by providing country-specific guidance. However, many African countries like Ethiopia do not have FBDGs. This paper describes the methodology for the development of Ethiopian FBDGs and for creating and evaluating a Healthy Eating Index and a scoring tool that can be used to monitor the adherence of the population to FBDGs.

**Methods and analysis** A multidisciplinary technical working group will be tasked to develop FBDGs for the general population above 2 years of age based on identification of priority diet-related public health problems and risk factors, and a systematic review of dietary patterns in relation to the identified priority health outcomes, following a multistep process. FBDGs will be translated into daily food choices for specific subpopulations by applying linear programming using data from the National Food Consumption Survey (NFCS) of 2011. FBDGs will be evaluated for cultural appropriateness, acceptability, consumer understanding and practicality. A dietary gap assessment will be conducted by comparing the national food supply with the country's food demand. In addition an Ethiopian Healthy Eating Index (EHEI) will be developed based on the FBDGs using the NFCS data. The EHEI will be evaluated by comparing the EHEI Score based on 24 hours diet recall with that of the EHEI Score based on a Food Frequency Questionnaire, by analysing the association of the EHEI Score with population characteristics and micronutrient intake with or without additional adjustment for energy intake. Finally, a brief Food Quality Screening tool scoring for the important EHEI components will be developed to enable evaluation for counselling.

**Ethics and dissemination** Ethical approval is received from the Scientific and Ethical Review Office of the Ethiopian Public Health Institute. The findings will be disseminated through peer-reviewed publications. A dissemination workshop will be organised with key implementing sectors of the food system for a healthier diet (<http://a4nh.cgiar.org/our-research/research-flagships/>) and with key public and private partners. The findings from this study will be translated into FBDGs and shared through conferences, reports and the mass media (TV and radio).

## Strengths and limitations of this study

- Systematic reviews and secondary data analyses on the five selected topics (priority diseases and relation with diet, dietary intake gap analysis, food availability, accessibility and seasonality, consumer preference and effective behavioural change communication) will provide science-based evidence for developing technical dietary recommendations of food-based dietary guidelines (FBDGs).
- The methodological framework applied to develop and evaluate FBDGs and the Ethiopian Healthy Eating Index for Ethiopia will set a good example for other developing countries interested in developing FBDGs.
- Findings from the national dietary gap assessment targeting the adherence of FBDGs will provide policy recommendations for the Ethiopian food system for a healthier diet of the general population.
- A limitation of the study is the time availability of Ethiopian nutrition stakeholders; the FBDGs development process requires significant engagement of their time and this may be a challenge because of competing priorities and demanding workloads.
- A second limitation is the availability of only one nationally representative quantitative dietary intake survey from 2011.

**Trial registration number** NCT03394963; Pre-results.

## INTRODUCTION

Ethiopia's economy has experienced rapid growth over the past 10 years.<sup>1</sup> This has been accompanied by a changing food environment, characterised by declining total shares of household (HH) income spent on food<sup>2</sup> and increased access to non-staples, processed foods, edible fat and sugary beverages.<sup>3</sup> The National Food Consumption Survey (NFCS) conducted by the Ethiopian Public Health Institute (EPHI) in 2011 indicated major dietary gaps, including

inadequate intakes of vitamin A, calcium and folate; similarly a national micronutrient survey conducted by the EPHI in 2016 showed that zinc, vitamin A, iodine, folate and vitamin B<sub>12</sub> deficiencies are public health problems among all population groups in Ethiopia.<sup>45</sup> Stunting among young children has reduced impressively from 57% in 2000 to 38% in 2016.<sup>6</sup> Nevertheless, the prevalence of stunting is still among the highest in the world due to factors such as underweight among mothers, low birth weight, inadequate dietary intake and diet-related health outcomes as possible determinants.<sup>7,8</sup> The national nutrition survey conducted by EPHI in 2015 indicated that 20% of women of reproductive age (WRA) were underweight (body mass index (BMI) <18.5 kg/m<sup>2</sup>) and 13% overweight (BMI >25 kg/m<sup>2</sup>). Overweight among women increased by 10% between 2009 and 2015 from 3% to 13%.<sup>9–11</sup> Similar to other low-income and middle-income countries (LMICs), Ethiopia is suffering from the triple burden of malnutrition (ie, undernutrition, micronutrient deficiencies and overnutrition).<sup>9,12–16</sup>

An unhealthy diet is one of the most important risk factors that needs to be addressed to tackle the triple burden of malnutrition<sup>17–19</sup> and diet-related diseases<sup>20,21</sup> in LMICs like Ethiopia. Dietary factors were responsible for 60 402 deaths (95% uncertainty interval 44 943 to 74 898) in 2013 among all Ethiopians—almost a quarter (23.0%) of those deaths were due to non-communicable diseases (NCDs; like diabetes, cardiovascular diseases, cancer and others).<sup>22</sup> Diets low in fruits, vegetables and high in sodium are the leading dietary risk factors and contribute 14.3%, 6.1% and 6.3%, respectively, to NCD deaths in Ethiopia.<sup>22</sup> In sub-Saharan African countries like Ethiopia, micronutrient intake has declined over the past 50 years as shown by a reduced dietary micronutrient density index (average micronutrient density of the food supply based on 14 micronutrients, calcium, copper, iron, folate, magnesium, niacin, phosphorus, riboflavin, thiamin, vitamin A, vitamin B<sub>12</sub>, vitamin B<sub>6</sub>, vitamin C and zinc). Reasons for this include increased availability of grains (rice, maize and wheat) and vegetable oils which have low micronutrient density, and decreased proportional availability of pulses, dairy products, meat, nuts and seeds, fruit, and vegetables.<sup>23</sup> Recent changes in dietary patterns in LMICs,<sup>24,25</sup> and Ethiopia (rise in both unhealthy and healthy components of diet) in particular,<sup>26,27</sup> indicate that an important gap needs to be addressed towards improving diet quality for better health, prevention of diet-related diseases and reduction of the triple burden of malnutrition.<sup>28,29</sup>

A healthy diet means eating a variety of foods that provide adequate intakes of energy and different nutrients needed to maintain or improve health and feel good,<sup>30</sup> and limits components such as salt, sugar and some types of fat (eg, trans fat) proven to increase health risk. A critical area of focus is that people eat foods and not individual nutrients. Food-based dietary guidelines (FBDGs) must therefore be translated into culturally appropriate diet. Important considerations for Ethiopia

are the variation in food availability across regions, by season and in rural/urban settings. The nutrients needed for a healthy diet include protein, carbohydrates, the right type of fat, dietary fibre, water, vitamins and minerals. Moderate intake of salt and sugar as well as avoiding unwanted foods such as alcohol, trans fatty acids and ultraprocessed foods are part of a healthy diet.<sup>31,32</sup> Promoting healthy eating in LMICs can also reduce social inequality in diet between the poor and the rich, especially when it targets disadvantaged population groups and because of both short-term and long-term economic benefits to HHs due to better health and educational outcomes.<sup>33</sup>

FBDGs are a set of simple advisory statements that give direction to consumers on healthy eating patterns and the type of food or food groups or sometimes nutrients (sodium) that need attention, to promote better nutrition and well-being and to address diet-related health conditions in a country.<sup>34,35</sup> FBDGs should be specific to a given country or setting, and appropriate in terms of the sociodemographic profile, nutritional status, health status and dietary patterns. FBDGs can help improve health,<sup>22,36,37</sup> work and learning capacity, promote growth for different populations and facilitate national food supply planning,<sup>38,39</sup> reduce healthcare costs<sup>40</sup> and assist the food industries in food product reformulation. Country-specific FBDGs are important because they are tailored to national food habits, and include commonly consumed and available foods and also are developed recognising the prevailing health and nutrition problems within the country. The nutrients in different foods may interact differently, and the methods of food preparation, processing and cooking (ie, food culture) influence the nutritional values of food. FBDGs should target the total diet, including all foods in daily meals and snacks. The list of food groups used in FBDGs should be recognisable by the targeted consumers/population and permit maximum flexibility in food choices to accommodate different eating traditions in a country. The description of food serving size should be in terms of commonly used HH measures that the given population can relate to as widely as possible.<sup>35</sup>

Out of 58 African countries, only 7 (Benin, Kenya, Namibia, Nigeria, Seychelles, Sierra Leone and South Africa) have FBDGs.<sup>41</sup> To maintain healthy eating in the population in Ethiopia, it is crucial to develop and implement country-specific FBDGs.<sup>42,43</sup> Furthermore, the development of a healthy eating index that will be derived from FBDGs, will enable tracking of adherence of the population to the FBDGs so that positive trends can be maintained and negative trends mitigated through appropriate interventions.<sup>44</sup> Wageningen University, the Agriculture for Nutrition and Health programme led by the International Food Policy Research Institute (IFPRI) and EPHI have initiated the development of FBDGs and the Ethiopian Healthy Eating Index (EHEI) for the Ethiopian population above 2 years of age in the next 4 years (2017–2021), in collaboration with the Food and

Agriculture Organization of the United Nations (FAO) and other key local partners. This paper describes the methodological approach used to generate knowledge, data and tools to support the development and evaluation of FBDGs and EHEI in Ethiopia.

### Aim and objectives

Overall, the methodological approach aims to develop and evaluate FBDGs and EHEI for the Ethiopian population above 2 years of age and generate lessons to inform similar processes in other parts of the African continent with the following objectives:

1. To develop FBDGs for Ethiopia informed by systematic reviews and data analyses from global and national data sets.
2. To translate the general guideline messages into daily practical food choices using linear mathematical programming and evaluating the FBDGs developed for cultural appropriateness, consumer understanding, acceptability and practicality.
3. To develop an EHEI for the general population based on the developed FBDGs, and to evaluate this index among WRA in urban and rural settings.
4. To develop and evaluate a brief food quality screener to assess adherence to Ethiopian FBDGs.
5. To assess whether the national food supply can support adherence to FBDGs for Ethiopia.

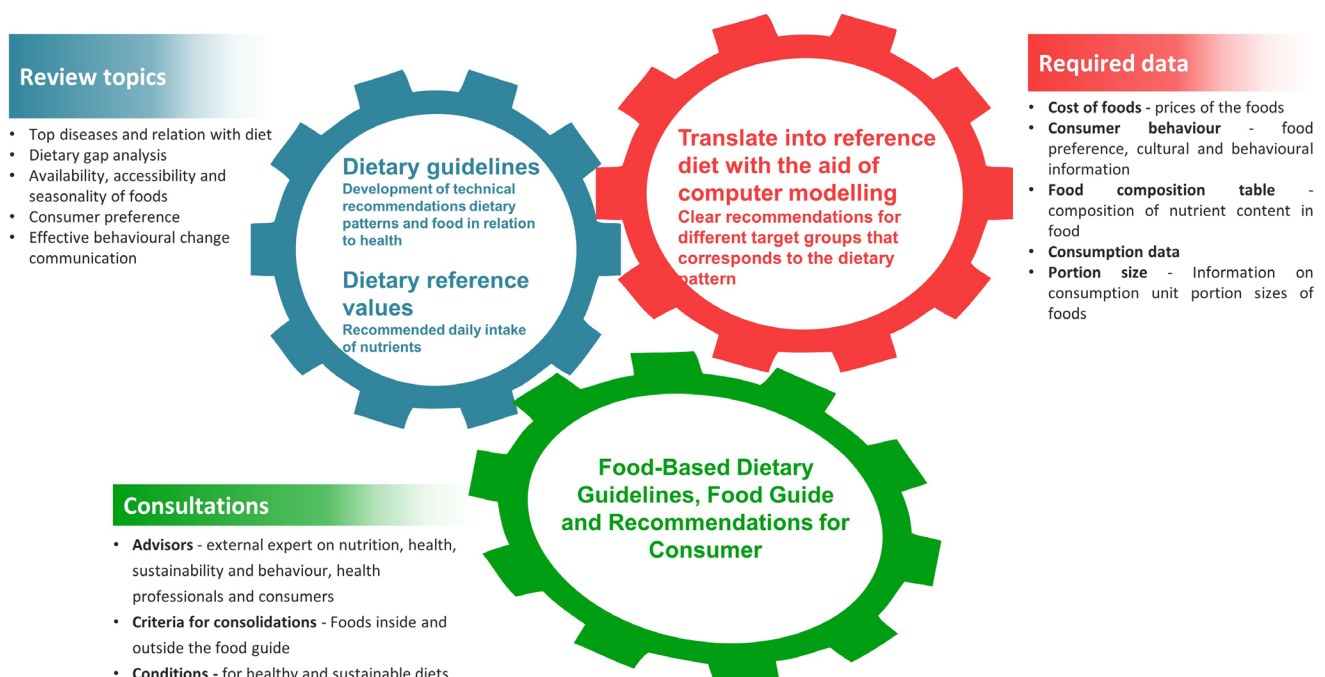
### METHODS AND ANALYSES

The methodology to develop Ethiopian FBDGs and EHEI has been adapted from the 1998 FAO/WHO preparation

and use of FBDGs<sup>45</sup> and the process used to develop the 2015 Dutch FBDGs and Dutch Healthy Diet Index.<sup>46–48</sup> The methodology is adapted to the Ethiopian context and will consider existing (or prevailing) diet-related public health problems, cultural and dietary habits, and socioeconomic status.

A multidisciplinary National Technical Working Group (NTW) composed of senior experts from the ministries of health, agriculture and education, universities, research institutes, UN organisations, and Non-Governmental Organizations (NGOs) will be established to oversee the process of developing FBDGs. The NTW will prepare a working document (terms of reference) that will define the role and responsibilities of the working group in the development of Ethiopian FBDGs. Next, the NTW will identify key evidence-based dietary recommendations (guidelines) for addressing diet-related public health problems in Ethiopia based on the evidence on the relationship between diet and priority diseases generated by the Wageningen University and Research (WUR) and EPHI. The NTW will also evaluate the quality and strength of research used to develop evidence-based dietary recommendations (guidelines).

The FBDGs' development process, described below in detail and in figure 1, comprises two major parts. The first part is developing evidence-based dietary guidelines for the general population above 2 years of age. These general guidelines will be translated into everyday healthy dietary choices for specific population subgroups, such as WRA, school-age children, adolescent girls, adults and the elderly, based on their dietary reference values using linear mathematical programming. A food guide (a visual representation



**Figure 1** Methodological framework for the development of Ethiopian food-based dietary guidelines (FBDGs).

of the FBDGs) will be designed for the general population using the most commonly consumed foods in the different regions of the country. In addition, the amount of deviation between the current dietary practices of the population and the new recommendations will be assessed. The second part will be the development of EHEI and a brief Food Quality Screening (FQS). These tools for assessing diet quality will be used to evaluate the adherence to FBDGs.<sup>45–49</sup> Once developed, the EHEI and FQS will be evaluated among WRA living in both rural and urban settings in different regions of the country.

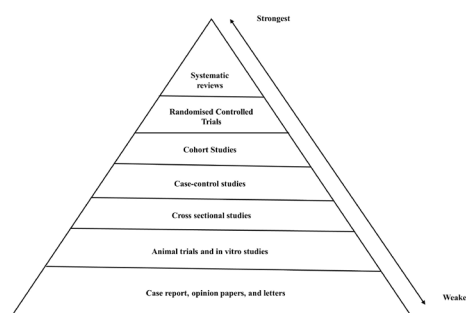
### Developing FBDGs for Ethiopia by systematic reviews and analyses of global and national data sets

A two-step approach will be followed for determining evidence-based dietary guidelines for Ethiopia. First, the top 10 diet-related diseases will be identified. The data sources that will be used for estimation of the total number of deaths, years living with disability (YLDs) and disability-adjusted life years (DALYs) in Ethiopia will be obtained from the Global Health Data Exchange (<http://ghdx.healthdata.org/>). The comparative risk assessment framework was developed by the Global Burden of Disease (GBD) team for estimation of the 2016 GBD levels and trends in exposure, attributable deaths and attributable DALYs, for behavioural and metabolic risks or clusters of risks. The details of data sources, collation and the computation process for 2016 GBD risk factors have been published in *The Lancet* in 2017.<sup>50</sup> Based on the average ranking of the total number of deaths, YLDs and DALYs of the top 20 diseases in Ethiopia, the top 10 diet-related diseases will be identified from this GBD database.

Additional secondary data analysis on trends in nutrition status and dietary intake gap will be conducted using 2000, 2005, 2011 and 2016 Ethiopian demographic and health surveys,<sup>6 51–53</sup> the most recent NFCS of 2011, and other national health, nutrition and dietary data available. The NFCS is a national representative cross-sectional survey conducted to provide information about food access and utilisation in Ethiopia's lean season, representing just one season's food pattern. A total of 8267 HHs comprising 8133 women (98% response rate), 8079 children (97% response rate) and 380 men were included across all regions of Ethiopia (Ethiopia is a Federal State with nine regional states, two city administrations, 800 districts/woredas and around 15 000 villages/kebeles (5000 urban and 10 000 rural)) that present diverse eating patterns. A single 24 hours dietary recall used in the survey is assumed to be appropriate to capture the diversity of foods at the national and subnational levels.<sup>4</sup> The Ethiopian food composition table will be used to estimate the nutrient values of the food consumed. The amount of food consumed will be converted into the amount of nutrients. To define the distribution of consumption across the country between regions and to compare actual nutrient intakes with reference values, the variance ratio of between-person values for Ethiopia will be combined with the within-person values available from a recent survey in Uganda, a neighbouring

country.<sup>54</sup> The development of technical recommendations of the FBDGs will be based on the secondary data analysis of top 10 diet-related diseases, nutrient gaps, food availability, accessibility and seasonality, and systematic review.

Second, a systematic literature review will be conducted by searching meta-analyses and systematic reviews of the impact of dietary interventions on prevention of the top 10 diseases identified. If there is no strong meta-analysis or systematic review (studies that fulfil our screening criteria and the AMSTAR (A MeaSurement Tool to Assess systematic Reviews) quality appraisal) available, the review team will search for randomised controlled trials or prospective cohort studies. An initial search of PubMed, SCOPUS and Google Scholar will be undertaken followed by screening of the titles and abstracts, and of the index terms used to describe the article. This will inform the development of a search strategy which will be tailored for each information source (PubMed, SCOPUS and Google Scholar) and paper screening criteria for further revision. The review will consider studies that include all age groups above 2 years, and studies that evaluate dietary patterns, foods or nutrients with diet-related health outcomes. The quality of systematic review and meta-analysis will be assessed by two individuals separately using the AMSTAR checklist before the results and recommendations are extracted.<sup>55</sup> The primary outcomes will be dietary risk of cardiovascular diseases, type 2 diabetes, protein-energy deficiency and micronutrient (vitamin A, zinc, calcium and folate) deficiencies. Intermediate outcomes will be identified during review of selected studies by considering the most reported indicators. Studies published in English since 2014 will be included. In general, the formulation of guidelines will only be based on strong evidence (meta-analysis, systematic review, randomised controlled trials and prospective cohort studies) as it is explained on the hierarchy of clinical evidence (figure 2).<sup>56</sup> Recommendations on meal frequency and portion size for Ethiopia will be crosschecked with guideline messages designed for other developing countries.



**Figure 2** The hierarchy of clinical evidence (adapted from Rosner AL).<sup>56</sup>

## Translating the general FBDGs into daily practical food choices for specific subpopulation groups: diet optimisation modelling

Linear mathematical programming will be used to model the FBDGs for the general population above 2 years of age into everyday healthy food choices for specific subpopulation such as WRA (15–49 years), adolescent girls, school-age children and adults.

Local foods for the modelling will be identified using the most commonly consumed foods; foods contributing 5% or more of the total energy intake (comparable to what has been used in another study<sup>57</sup>) by the different subpopulation groups from the most recently conducted NFCS from 2011 as well as potentially beneficial underused foods and nutrient-dense foods. To come up with an affordable diet, the modelling will consider the prices of foods that are most commonly consumed. The cost of each identified most commonly eaten food item will be taken from the most recently conducted, 2016 Household Income Consumption Expenditure (HICE) Survey; an additional market survey (composed of both urban and rural, and big supermarket, medium and small open markets) will be conducted in case there is missing information on costs for specific food items from the HICE Survey. The recommended energy and nutrient intake for WRA and other population subgroups as set by WHO will be used for nutrient optimisation with minimum cost.<sup>58</sup> The recommended daily meal frequency and portion sizes will be taken into consideration from the newly developed evidence-based dietary guidelines during diet optimisation. Different scenarios (eg, only foods including nutrient-dense and underused foods, foods plus the national fortification programme into consideration, foods plus the national fortification and supplementation programme into consideration) will be considered for optimum food planning for WRA, adolescent girls, school-aged children and adults. To prevent inclusion of excessive (unrealistic) amounts of any food items, the upper and lower consumption bounds will be set based on the habitual intake of WRA and other population subgroups in Ethiopia.

### Feasibility study for adherence to FBDGs

The main goal of the feasibility study is to evaluate cultural appropriateness, acceptability, consumer understanding and practicality of making daily food choices that adhere to the FBDGs. Consumers will be represented by the WRA group at the community level. Focus group discussions and key informant interviews will be conducted with different experts, implementers and community groups to evaluate the FBDGs. The summary of focus areas, key questions, possible outcomes and the target study population as stated in [table 1](#) are adapted from a method on feasibility studies designed by Bowen *et al.*<sup>59</sup>

Focus Group Discussions (FGDs) will assess the cultural appropriateness and acceptability of FBDGs by nutrition experts and consumers. Preparation for FGDs will be done by interviewing some (maximum five) individual nutrition experts with good understanding of Ethiopian food systems and dietary habits. FGDs will be conducted among

high-level local nutrition experts, front-line community health extension workers (HEWs) and consumers. At the community level, at least 30 WRA who are married and live with their husband in urban and rural settings will be invited to take part in the FGDs. WRA from urban Addis Ababa and from rural Amhara, Oromia, Tigray and Southern Nations and Nationalities People (SNNP) regions will be selected to provide a representative picture of the regions of Ethiopia. The FGDs will be led by experienced moderators from EPHI who are trained on how to conduct FGDs and a note taker will also be assigned for each session. Key informant interviews will be conducted with high-level local nutrition experts, media experts, front-line community health workers and community representatives to understand better whether the FBDGs translated into daily food choice are understood and the feasibility of adherence. For both FGDs and key informant interviews (as described in [table 1](#)), the level of saturation will be checked during data collection by assessing the degree of repetition in the new data compared with the previous data. Data collection will be stopped when the level of saturation is reached and no new information is acquired.

A total of six FGD sessions (one FGD with high-level experts, two FGDs with front-line community HEWs, two FGDs with community representatives of WRA in rural areas and one FGD with community representatives of WRA in urban areas) will take place. Each of the six FGDs will take a maximum of 90–120 min and will have 10–12 participants per group. Consumers, community health workers and high-level experts will have a separate FGD session. Amharic will be the language of communication; the interview will be recorded with permission, then transcribed and translated into English by two people separately for the same record to maintain the meaning in the translation process. A third person can be brought into the discussion if there is no agreement. After the translation, grammar will be verified by a native English language speaker. Analysts will read all transcripts and develop and implement a coding frame through discussion and consensus. Then the codes will be categorised into themes and subthemes to understand the meaning of each response about the guidelines among participants. The analysis will be facilitated by QSR International's NVivo V.11 software.

### Development and evaluation of EHEI

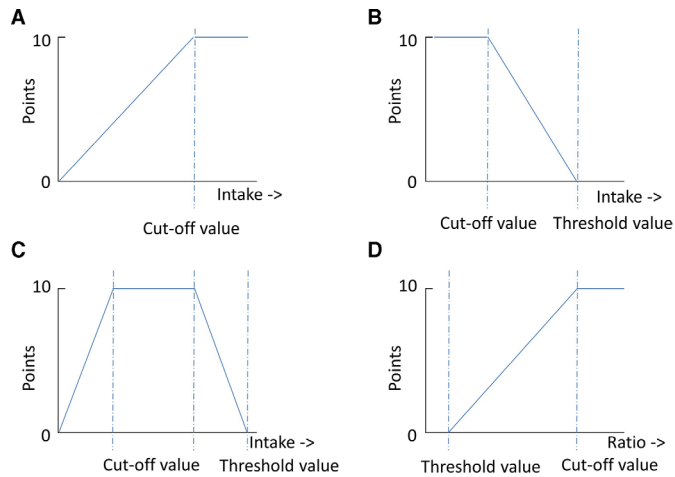
#### Developing EHEI

The healthy eating index is a tool for assessing the adherence of the population to FBDGs.<sup>48</sup> EHEI has multiple healthy eating components, representing the foods in the guidelines, with a scoring that expresses the extent of adherence to the relevant component. Assigning foods into food groups will be conducted based on food grouping in the FBDGs before choosing the scoring system. Depending on the kind of component, the scoring system will be proportional or dichotomous. Each proportionally scored component of the Healthy Eating Index will have a minimum score of 0 and maximum score between 5 and

**Table 1** Key areas of focus for feasibility studies and possible outcomes adapted from Bowen *et al*

Area of focus	The feasibility study asks...	Outcomes of interest	Sample study design	Target population
Cultural appropriateness	To what extent are the words and images used in the FBDGs appropriate to the community?	<ul style="list-style-type: none"> <li>▲ Appropriateness of words used in the messages for different communities</li> <li>▲ Appropriateness of images used in the food guide for different communities</li> </ul>	<ul style="list-style-type: none"> <li>▲ <b>Focus groups</b> in the target population</li> </ul>	<ul style="list-style-type: none"> <li>▲ High-level local experts</li> <li>▲ Front-line community HEWs</li> </ul>
Acceptability	To what extent can the guideline messages in the FBDGs be judged as suitable, satisfying or attractive to programme deliverers and to programme recipients?	<ul style="list-style-type: none"> <li>▲ Satisfaction</li> <li>▲ Intent to continue use</li> <li>▲ Perceived appropriateness</li> <li>▲ Fit within organisational culture</li> <li>▲ Perceived positive or negative effects on organisation</li> <li>▲ Actual use</li> <li>▲ Expressed interest or intention to use</li> <li>▲ Perceived demand</li> </ul>	<ul style="list-style-type: none"> <li>▲ <b>Focus groups</b> in the target population participants to understand how the recommendations would fit in daily-life activities</li> </ul>	<ul style="list-style-type: none"> <li>▲ High-level local experts</li> <li>▲ Front-line community HEWs</li> <li>▲ Community representatives (WRA who are married and live in their own house)</li> </ul>
Front-line health workers and consumer understanding	To what extent do consumers understand the key messages in the guidelines? How are the messages transferred by different implementers?	<ul style="list-style-type: none"> <li>▲ Understanding of the messages and images used for the FBDGs by HEWs</li> <li>▲ Understanding the messages and images used for the FBDGs by the media</li> <li>▲ Understanding the messages and images used for the FBDGs by consumers</li> </ul>	<ul style="list-style-type: none"> <li>▲ <b>Key- informant</b> interviews</li> </ul>	<ul style="list-style-type: none"> <li>▲ Front-line community HEWs</li> <li>▲ Community representative (WRA who are married and live in their own house).</li> </ul>
The practicality of the key messages	To what extent can the key message be implemented by the target population using existing means, resources and circumstances and without outside intervention?	<ul style="list-style-type: none"> <li>▲ Amount, type of resources needed to implement</li> <li>▲ Factors affecting implementation ease or difficulty</li> <li>▲ Efficiency, speed or quality of implementation</li> <li>▲ Positive/negative effects on target participants</li> <li>▲ Ability to implement what is recommended by individual guidelines</li> </ul>	<ul style="list-style-type: none"> <li>▲ Small-scale demonstration study to examine predicted cost, burden and benefit because of appropriate intensity, frequency, duration of the intervention, using <b>key- informant</b> interviews to gather data</li> </ul>	<ul style="list-style-type: none"> <li>▲ High-level local experts</li> <li>▲ Frontline community HEWs</li> <li>▲ Community representative (WRA who are married and live in their own house).</li> </ul>

FBDGs, food-based dietary guidelines; HEW, health extension worker; WRA, women of reproductive age.



**Figure 3** Graphic presentation of scoring for the Ethiopian Healthy Eating Index (EHEI) for different types of components: (A) Adequacy component. (B) Moderation component. (C) Optimum component. (D) Ratio component (adapted from Looman *et al*<sup>48</sup>).

20. The components will be scored in a way that a higher value indicates better adherence to the FBDGs. The total EHEI score will range from 0 to 100, with higher scores indicating higher diet quality. The EHEI will be categorised into adequacy, optimum, moderation and ratio components based on the healthier options provided in the food group of FBDGs (figure 3).<sup>48</sup>

The 24 hours dietary recall data from the NFCS data collected in 2011 will be used to develop the EHEI. The completeness and quality of the 24 hours data will be checked before starting the data analysis. Selection of foods and nutrients will be made based on public health importance and availability of the nutrient list of the Ethiopian food composition table. If there are missing data in the food composition table for Ethiopia, food composition table data will be borrowed from other sources. The scoring of the adequacy components for each individual will be computed based on the following formula (figure 3A):

$$\text{Scoring of the intake from 0} \\ \text{--max. value (5-20)} = \frac{\text{The reported intake}}{\text{Cut-off value}} \times \text{max. value (5-20)}$$

For moderation components (eg, fat, sugar, salt), the threshold value will be determined based on the 85th centile of average intake of the sample population if there is lack of evidence on the cut-off value. Zero will be taken as above the threshold and maximum value will be taken as the cut-off (figure 3B). In this case, the score will decrease when the intake is increased. The scoring for each individual intake will be computed using the formula:

$$\text{Scoring between the} \\ \text{threshold and cut-} \\ \text{off values} = \frac{\text{The reported intake value cut-off value}}{\text{Threshold value - Cut-off value}} \times \text{max. values (5-20)}$$

For the optimum component, zero will be taken for no intake and maximum value will be taken if intake is within the given range (figure 3C). In this case, the score will

increase when the intake is increased within the given range for that component. The scoring for each individual intake will be computed using the following two formulas:

$$\text{Scoring (intake lower than} \\ \text{the cut-off value)} = \frac{\text{The reported intake value}}{\text{The lower cut-off value}} \times \text{max. value (5-20)}$$

$$\text{Scoring between the} \\ \text{threshold and higher than} \\ \text{the cut-off value} = \frac{\text{The reported intake value cut-off value}}{\text{Threshold value - Cut-off value}} \times \text{max. value (5-20)}$$

For the ratio component, zero will be taken as below the threshold and maximum value will be taken as the values above the cut-off (figure 3D). The cut-off and threshold values of the ratio components will be set to calculate the ratio. In this case, the score will increase when the ratio is increased. The scoring for each individual intake will be computed using the formula;

$$\text{Scoring between the cut-} \\ \text{off and threshold values} = \frac{\text{The ratio - threshold value}}{\text{Cut-off value - threshold value}} \times \text{max. value (5-20)}$$

The data will be analysed using the latest version of STATA software. Correlation, association and other appropriate advanced statistical techniques will be applied as needed to answer the questions in this study.

### Evaluating EHEI

EHEI will be evaluated by comparing the Healthy Eating Index Score calculated based on 24 hours dietary recalls with a Healthy Eating Index Score calculated based on the Food Frequency Questionnaire (FFQ) for population characteristics (such as age, education level, income, HH food security) and micronutrient and macronutrient intake with or without adjusting for energy intake. Associations of EHEI Scores with intakes of macronutrients and micronutrients, intake biomarkers such as urinary protein, nitrogen, sodium, potassium, sugar, creatinine excretion and thiamine and BMI measurements will be determined. An EHEI based on food frequency data is chosen for comparison because FFQ is most frequently used in nutrition epidemiological studies because of the ease of using the questionnaire and the related reporting.<sup>60</sup> As has been mentioned in the development of the EHEI, the required amount of consumption stated in the guidelines will be used as a cut-off for the maximum score. The minimum zero score point will be given for no intake except intake of the moderation component. A dichotomous scoring system might be applied when the cut-off value becomes lower than the dietary recommendation.

The 2016 Ethiopia Demographic and Health Survey (EDHS) dietary intake data and anthropometric data and the 2011 NFCS will be used to evaluate the Healthy Eating

Index. Additional primary data on 24 hours dietary recall and FFQ as well as 24 hours urine will be collected from 500 HHs from four regions (Amhara, Oromia, Tigray, and Southern Nations and Nationalities) and one city administration, Addis Ababa, for evaluation of EHEI.

### Development and evaluation of the brief FFQ to check diet quality and adherence to Ethiopian FBDGs

Once the country-specific FBDGs are developed and implemented, it is important to monitor their implementation/adherence to improve the eating behaviour towards a healthier diet. To do so, the use of a Healthy Eating Index is very useful, but implementation is time-consuming and costly especially in a clinical setting and public health interventions. Therefore, we will develop a brief FQS tool that should require only 10–15 min to complete. In addition the FQS should cost less than the EHEI to administer as well as to reduce the respondent burden. The FQS will be used for scoring the EHEI and can be used during diet counselling and public health interventions to assess and monitor the adherence to FBDGs by individuals. During evaluation, the target population group at the HH level will be healthy WRA (15–49 years).

The FQS will be developed using 24 hours dietary recall data of Ethiopian WRA. Foods that contribute most to the level and variation of intake of the foods in the FBDGs are selected for the food list of the FQS; this is similar to the Dutch FQS.<sup>61 62</sup> The food items representing the food groups in the FBDGs will also be included in the selected food item lists for FQS. Then we will add food items that contribute significantly to the between-person variation in nutrient intakes from 24 hours dietary recall. The questionnaire will be designed including those selected food items. The answer will have a category range from never to everyday. Portion size will be estimated using commonly used HH measures. The HH measures were converted and standardised into standard measurements during the NFCS.

For evaluation of FQS we will use primary data that will be collected in four regions (Amhara, Oromia, Southern Nations and Nationalities People Region (SNNPR) and Tigray) and one city administration (Addis Ababa). Each region and administrative city will have 100 HHs randomly selected from a total of 10 districts. Two districts per region will be purposively selected to consider different living scenarios. Of the four regions, the first district will have a relatively high agricultural productivity and the second district a relatively low agricultural productivity. These will be selected in consultation with the regional agriculture bureau. From the Addis Ababa city administration two districts will be selected; the first district will have a relatively high living standard and the second one will be an urban slum area. These districts will be selected in consultation with the Addis Ababa city administrative office. At the district level, villages will be randomly selected and a fresh listing of HHs will be conducted. From the listed HHs, 50 HHs will be selected using

systematic random sampling. From each selected HH a WRA (15–49 years) will be enrolled as a study participant. For the target study population, dietary data, anthropometry measurements, and sociodemographic and lifestyle characteristics will be collected together with both the brief FQS and repeated 24 hours recall. The brief FQS and repeated 24 hours recall will be administered alternatively within 2 months on the same study participants with 24 hours urine sample collection for biomarker analysis.

### Dietary gap assessment based on the newly developed FBDGs in Ethiopia: policy recommendations

Adequate national food supply (both production and import) is very critical for a country to be able to adhere to country-specific FBDGs. The aim of this part of the study is to assess whether Ethiopia has adequate food supply and the needed diversity for the population to be able to respond positively to the newly designed FBDGs.

The methodology of this study is adapted from Kuyper *et al*<sup>57</sup> who conducted a similar study in Cameroon. The FAO food balance sheet data will be used by crosschecking the accuracy of the data with the national data from technical reports to come up with an estimate of the country's food supply in different food groups included in the FBDGs. The food groups (a collection of foods that share similar nutritional properties or biological classifications) and serving sizes (converted in to grams) determined in the FBDGs and current population supply estimation (g/c/day) for Ethiopia will be used to estimate the target food supply or the demand. The gaps will be estimated by analysing the difference between the recommendation and supply of foods from each food group, by comparing the current food supply with recommended healthy eating in the FBDGs. This is expected to contribute to policy recommendations on agriculture production, food trade, consumption and other issues related to the food system of Ethiopia for healthy eating.<sup>63</sup>

### Patient and public involvement

Patients (study participants) were not involved in the development of the research questions, design of the study and setting outcome measures. Patients will be involved in the data collection process by providing information during data collection.

### ETHICS AND DISSEMINATION

The study is a collaboration of WUR, FAO, EPHI and IFPRI. Informed consent will be taken before the interviews and collection of biological samples. Findings will be used for the development of FBDGs and EHEI for Ethiopia and inform policy recommendations towards a healthier diet.

### Study status

The overall proposal is written and comments from FAO and collaborators are incorporated. The first objective, that is determining FBDGs for Ethiopia, by



systematically analysing global and national data, and conducting systematic reviews began in January 2018. Developing guidelines for the general population will be completed in 2018. The guidelines will be translated to daily food choices of specific population groups and evaluated for WRA in 2019. The EHEI and a brief FQS from the FBDGs will be developed and evaluated in 2020. The overall technical report, FBDGs, EHEI and brief FQS will be released in 2021. In addition, the current national dietary gap assessment based on the FBDGs will be conducted in 2021.

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## REFERENCES

- Cheru F. Emerging Southern powers and new forms of South–South cooperation: Ethiopia's strategic engagement with China and India. *Third World Q* 2016;37:592–610.
- Humphries DL, Dearden KA, Crookston BT, *et al*. Household food group expenditure patterns are associated with child anthropometry at ages 5, 8 and 12 years in Ethiopia, India, Peru and Vietnam. *Econ Hum Biol* 2017;26:30–41.
- Desalew A, Mandesh A, Semahegn A. Childhood overweight, obesity and associated factors among primary school children in dire dawa, eastern Ethiopia; a cross-sectional study. *BMC Obes* 2017;4:20.
- EPHI. *Ethiopia national food consumption survey*, 2013.
- Zerfu MD, Mesert W, Ayana G, *et al*. *Ethiopian national micronutrient survey F.S.a.N. Research*: EPHI, 2016.
- ICF CSAEa. *Ethiopia demographic and health survey 2016: key indicators report*. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF, 2016.
- Wirth JP, Rohner F, Petry N, *et al*. Assessment of the WHO Stunting Framework using Ethiopia as a case study. *Matern Child Nutr* 2017;13:e12310.
- Haile D, Azage M, Mola T, *et al*. Exploring spatial variations and factors associated with childhood stunting in Ethiopia: spatial and multilevel analysis. *BMC Pediatr* 2016;16:49.
- Tebekaw Y, Teller C, Colón-Ramos U. The burden of underweight and overweight among women in Addis Ababa, Ethiopia. *BMC Public Health* 2014;14:1126.
- EPHI. *Ethiopian national nutrition program end-line survey*, 2015.
- Abrha S, Shiferaw S, Ahmed KY. Overweight and obesity and its socio-demographic correlates among urban Ethiopian women: evidence from the 2011 EDHS. *BMC Public Health* 2016;16:636.
- Black RE, Victora CG, Walker SP, *et al*. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* 2013;382:427–51.
- Popkin BM, Gordon-Larsen P. The nutrition transition: worldwide obesity dynamics and their determinants. *Int J Obes Relat Metab Disord* 2004;28:S2–S9.
- Kimani-Murage EW, Muthuri SK, Oti SO, *et al*. Evidence of a double burden of malnutrition in urban poor settings in Nairobi, Kenya. *PLoS One* 2015;10:e0129943.
- Arthur SS, Nyide B, Soura AB, *et al*. Tackling malnutrition: a systematic review of 15-year research evidence from INDEPTH health and demographic surveillance systems. *Glob Health Action* 2015;8:28298.
- Darnton-Hill I, Mkpuru UC. Micronutrients in pregnancy in low- and middle-income countries. *Nutrients* 2015;7:1744–68.
- Zeba AN, Delisle HF, Renier G. Dietary patterns and physical inactivity, two contributing factors to the double burden of malnutrition among adults in Burkina Faso, West Africa. *J Nutr Sci* 2014;3.
- Fikadu T, Assegid S, Dube L. Factors associated with stunting among children of age 24 to 59 months in Meskan district, Gurage Zone, South Ethiopia: a case-control study. *BMC Public Health* 2014;14:800.
- Fekadu Y, Mesfin A, Haile D, *et al*. Factors associated with nutritional status of infants and young children in Somali Region, Ethiopia: a cross-sectional study. *BMC Public Health* 2015;15:846.
- Naicker A, Venter CS, MacIntyre UE, *et al*. Dietary quality and patterns and non-communicable disease risk of an Indian community in KwaZulu-Natal, South Africa. *J Health Popul Nutr* 2015;33:12.
- Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr* 2006;84:289–98.
- Melaku YA, Temesgen AM, Deribew A, *et al*. The impact of dietary risk factors on the burden of non-communicable diseases in Ethiopia: findings from the Global Burden of Disease study 2013. *Int J Behav Nutr Phys Act* 2016;13:122.
- Beal T, Massiot E, Arsenault JE, *et al*. Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes. *PLoS One* 2017;12:e0175554.
- Malik VS, Willett WC, Hu FB. Global obesity: trends, risk factors and policy implications. *Nat Rev Endocrinol* 2013;9:13–27.
- Romieu I, Dossus L, Barquera S, *et al*. Energy balance and obesity: what are the main drivers? *Cancer Causes Control* 2017;28:247–58.
- Worku I DM, Minten B. *Diet transformation in Ethiopia*, 2015.
- Aurino E, Fernandes M, Penny ME. The nutrition transition and adolescents' diets in low- and middle-income countries: a cross-cohort comparison. *Public Health Nutr* 2017;20:72–81.
- Lachat C, Otchere S, Roberfroid D, *et al*. Diet and physical activity for the prevention of noncommunicable diseases in low- and middle-income countries: a systematic policy review. *PLoS Med* 2013;10:e1001465.
- Delobelle P, Sanders D, Puoane T, *et al*. Reducing the role of the food, tobacco, and alcohol industries in noncommunicable disease risk in South Africa. *Health Educ Behav* 2016;43:70S–81.
- What does healthy eating mean? 2017 [http://www.breastcancer.org/tips/nutrition/healthy\\_eat](http://www.breastcancer.org/tips/nutrition/healthy_eat) (cited Jul 2017).
- He FJ, MacGregor GA. Reducing population salt intake worldwide: from evidence to implementation. *Prog Cardiovasc Dis* 2010;52:363–82.
- Monteiro CA, Levy RB, Claro RM, *et al*. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. *Public Health Nutr* 2011;14:5–13.
- Mayén AL, de Mestral C, Zamora G, *et al*. Interventions promoting healthy eating as a tool for reducing social inequalities in diet in low- and middle-income countries: a systematic review. *Int J Equity Health* 2016;15:205.
- Jankovic N, Geelen A, Streppel MT, *et al*. Adherence to a healthy diet according to the World Health Organization guidelines and all-cause mortality in elderly adults from Europe and the United States. *Am J Epidemiol* 2014;180:978–88.
- Gibson RS. *Principles of nutritional assessment*. USA: Oxford university press, 2005.
- Hunsaker SL, Jensen CD. Effectiveness of a parent health report in increasing fruit and vegetable consumption among preschoolers and kindergarteners. *J Nutr Educ Behav* 2017;49:380–6.
- Meegan AP, Perry IJ, Phillips CM. The association between dietary quality and dietary guideline adherence with mental health outcomes in adults: a cross-sectional analysis. *Nutrients* 2017;9:238.

38. Morón C. Food-based nutrition interventions at community level. *Br J Nutr* 2006;96(Suppl 1):S20–S22.
39. Jungert A, Spinneker A, Nagel A, *et al.* Dietary intake and main food sources of vitamin D as a function of age, sex, vitamin D status, body composition, and income in an elderly German cohort. *Food Nutr Res* 2014;58:23632.
40. Brunner E, Cohen D, Toon L. Cost effectiveness of cardiovascular disease prevention strategies: a perspective on EU food based dietary guidelines. *Public Health Nutr* 2001;4:711–5.
41. Erve Ivt, Tulen CBM, Jansen J, *et al.* Overview of elements within national food-based dietary guidelines. *European Journal of Nutrition & Food Safety* 2017;7:1–56.
42. EPHI. *The 2nd BSC Based EPHI's strategic management plan (2015/16 to 2019/20)*, 2015.
43. FMOH. *National nutrition program 2016–2020*. Addis Ababa Ethiopia, 2016.
44. Smitasiri S, Uauy R. Beyond recommendations: implementing food-based dietary guidelines for healthier populations. *Food Nutr Bull* 2007;28:S141–51.
45. Thorpe MG, Milte CM, Crawford D, *et al.* A revised Australian dietary guideline index and its association with key sociodemographic factors, health behaviors and body mass index in peri-retirement aged adults. *Nutrients* 2016;8:160.
46. Kromhout D, Spaaij CJ, de Goede J, *et al.* The 2015 Dutch food-based dietary guidelines. *Eur J Clin Nutr* 2016;70:869–78.
47. van Lee L, Feskens EJ, Hooft van Huysduynen EJ, *et al.* The Dutch Healthy Diet index as assessed by 24 h recalls and FFQ: associations with biomarkers from a cross-sectional study. *J Nutr Sci* 2013;2.
48. Looman M, Feskens EJ, de Rijk M, *et al.* Development and evaluation of the Dutch Healthy Diet index 2015. *Public Health Nutr* 2017;20:2289–99.
49. Acar Tek N, Yildiran H, Akbulut G, *et al.* Evaluation of dietary quality of adolescents using Healthy Eating Index. *Nutr Res Pract* 2011;5:322–8.
50. Schutte A. *Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016*, 2017.
51. Macro, C.S.A.E.a.O. *Ethiopia demographic and health survey 2000*. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Authority and ORC Macro, 2001.
52. Macro., C.S.A.E.a.O. *Ethiopia demographic and health survey 2005*. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ORC Macro, 2006.
53. International., C.S.A.E.a.I. *Ethiopia demographic and health survey 2011*. Addis Ababa, Ethiopia and Calverton, Maryland, USA: Central Statistical Agency and ICF International, 2012.
54. Kyamuhangire W, Kikafunda J, Kaaya A. *THE 2008 uganda food consumption survey*. Uganda: Makerere University Department of Food Science and Technology, 2010.
55. Shea BJ, Grimshaw JM, Wells GA, *et al.* Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol* 2007;7:10.
56. Rosner AL. Evidence-based medicine: revisiting the pyramid of priorities. *J Bodyw Mov Ther* 2012;16:42–9.
57. Kuyper EM, Engle-Stone R, Arsenault JE, *et al.* Dietary gap assessment: an approach for evaluating whether a country's food supply can support healthy diets at the population level. *Public Health Nutr* 2017;20:2277–88.
58. Joint, F. and W.H. Organization. *Vitamin and mineral requirements in human nutrition*, 2005.
59. Bowen DJ, Kreuter M, Spring B, *et al.* How we design feasibility studies. *Am J Prev Med* 2009;36:452–7.
60. Procter-Gray E, Olendzki B, Kane K, *et al.* Comparison of dietary quality assessment using food frequency questionnaire and 24-hour-recalls in older men and women. , 2017;4, 326–46.
61. Mark SD, Thomas DG, Decarli A. Measurement of exposure to nutrients: an approach to the selection of informative foods. *Am J Epidemiol* 1996;143:514–21.
62. Molag ML, de Vries JH, Ocké MC, *et al.* Design characteristics of food frequency questionnaires in relation to their validity. *Am J Epidemiol* 2007;166:1468–78.
63. Joint, F. and W.H. Organization. *Preparation and use of food-based dietary guidelines*, 1998.