Dietary Assessment in the MetaCardis Study: Development and Relative Validity of an Online Food Frequency Questionnaire

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ABSTRACT

Background The European study MetaCardis aims to investigate the role of the gut microbiota in health and cardiometabolic diseases in France, Germany, and Denmark. To evaluate long-term diet—disease relationships, a food frequency questionnaire (FFQ) was found to be the most relevant dietary assessment method for the MetaCardis study.

Objective The objectives of this study were to describe the development of three semiquantitative online FFQs used in the MetaCardis study—one FFQ per country—and to assess the relative validity of the French MetaCardis FFQ.

Design The layout and format of the MetaCardis FFQ was based on the European Prospective Investigation of Cancer (EPIC)-Norfolk FFQ and the content was based on relevant European FFQs. Portion size and nutrient composition were derived from national food consumption surveys and food composition databases. To assess the validity of the French MetaCardis FFQ, a cross-sectional study design was utilized.

Participants/setting The validation study included 324 adults recruited between September 2013 and June 2015 from different hospitals in Paris, France.

Main outcome measures Food intakes were measured with both the French Meta-Cardis FFQ and 3 consecutive self-administered web-based 24-hour dietary recalls (DRs).

Statistical analyses performed Several measures of validity of the French MetaCardis FFQ were evaluated: estimations of food groups, energy, and nutrient intakes from the DRs and the FFQ, Spearman and Pearson correlations, cross-classification, and Bland-Altman analyses.

Results The French MetaCardis FFQ tended to report higher food, energy, and nutrient intakes compared with the DRs. Mean correlation coefficient was 0.429 for food, 0.460 for energy, 0.544 for macronutrients, 0.640 for alcohol, and 0.503 for micronutrient intakes. Almost half of participants (44.4%) were correctly classified within tertiles of consumption, whereas 12.9% were misclassified in the opposite tertile. Performance of the FFQ was relatively similar after stratification by sex.

Conclusions The French MetaCardis FFQ was found to have an acceptable level of validity and may be a useful instrument to rank individuals based on their food and nutrient intakes.
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RECENT FINDINGS SUGGEST THAT THE DEVELOP-ment of metabolic alterations and, therefore, potentially the development of cardiometabolic diseases (CMDs), can be mediated through an altered gut microbial structure and function.[1] Studies addressing lifestyle aspects influencing CMDs have highlighted the influence of fat, carbohydrate, fiber, and particular food components (eg, prebiotics, probiotics, and food additives) on gut microbiota composition.[2] It has been demonstrated that longer-term food habits influence individuals' microbiota composition the most.[3] More specifically, a study conducted in 98 healthy adults showed that Bacteroides

enterotype was positively associated with higher protein intake, whereas Prevotella enterotype was positively associated with increased sugar and carbohydrate intakes.[3] Another study conducted in 49 overweight and obese adults showed that *Akkermansia muciniphila* abundance was positively associated with a healthier metabolic status (insulin sensitivity) and better outcomes after a 6-week caloric restriction period.[4] In the same group, it was also found that a healthier cluster of dietary patterns was positively associated with lower inflammatory markers and higher microbial gene richness.[5] The goal of the multicenter European study MetaCardis is to identify biological

relationships between gut microbiota and host phenotypes to improve physiopathologic understanding and develop innovative care for CMDs like obesity, diabetes, and coronary diseases.[6] For the MetaCardis study, adults with various stages of CMD were recruited in France, Germany, and Denmark between September 2013 and June 2015. Therefore, an appropriate method of dietary assessment was required to evaluate dietary intakes in the study.

Although many methods of dietary assessment exist, the two most relevant methods were identified to be the food frequency questionnaire (FFQ) and the repeated 24-hour recall.[7] Although both methods are retrospective, they differ in terms of details collected, time period of reporting, and logistics.[7] FFQs display a preselected list of foods for which individuals are asked to indicate the typical frequency of consumption over a period of time and sometimes to state the average amount consumed.[7,8] Semiquantified FFQs use individual or standard portion sizes to estimate food quantities.[7,8] The number of foods on the list varies (from around 20 to more than 200) and the consumption period usually covers the past 12 months.[7,8] Twenty-four—hour recalls involve individuals being asked to provide estimates of their entire food and beverage consumption, during the preceding 24 hours, or during a midnight to midnight period.[7] Because FFQs are relatively inexpensive, simple to complete, and provide an overview of long-term food habits, they are widely used as the primary dietary assessment tool in epidemiologic studies. Although FFQs are known to underestimate true energy, protein, potassium, and sodium intake and more globally cannot be relied upon to produce accurate estimates of absolute intake of foods and other nutrients, they have been shown to have good validity for ranking food and nutrient intakes within a population, and also distinguish these intakes between subpopulations.[8-11] Thus, they were found to be the most relevant method for the MetaCardis study.[7-11]

Several FFQs developed for French, German, and Danish populations were available but their purposes, accessibility, and formats varied widely.[12-14] For example, the French participants of the Supplementation en Vitamines et Mineraux Antioxydants (SU.VI.MAX) study, which aimed to test the efficacy of vitamin and mineral supplementation on the incidence of cancers, ischemic heart diseases, and overall mortality, were asked to report their average intake of 240 food items categorized in 22 food groups over the past year.[12] By contrast, the Danish participants of the Inter99 study, which aimed to decrease the incidence of cardiovascular diseases, were asked to report their average intake of 198 food items categorized in 16 food groups over the past month.[14] Thus, these differences would have made the between-country comparison of dietary intake data extremely difficult. Therefore, the available FFQs were considered inappropriate for use in the MetaCardis study. As a consequence, the development of FFQs adapted to France, Germany, and Denmark in terms of eating and drinking habits and language, but also consistent and standardized in terms of layout and format was needed.

The objectives of the present study were to describe the development of three semiquantitative online FFQs and to assess the relative validity of the French MetaCardis FFQ compared with self-administered web-based 24-hour dietary recalls (DRs).

MATERIALS AND METHODS

Development of the MetaCardis FFQ
The layout and format of the MetaCardis FFQ was based on the extensively validated and used European Prospective Investigation of Cancer (EPIC)-Norfolk FFQ[15-17] and the list of foods was based on relevant FFQs that have been already developed for each country included in the MetaCardis project: the SU.VI.MAX FFQ for France, the German EPIC FFQ for Germany, and the Inter99 FFQ for Denmark.[12-14] The MetaCardis FFQ was designed to measure a participant's usual dietary intake during the previous year. Each food and beverage item of the FFQ represented either an individual food (eg, apple), a combination of individual foods (eg, waffles and pancakes), or a food type further described by examples of individual foods (eg, fatty fish such as salmon, mackerel, sardines, and herring). When developing the food lists based on the previously mentioned FFQs, particular attention was given to balance the incorporation of relevant country-specific food items and keep the three MetaCardis FFQs consistent and standardized to increase comparability over the main food groups. The food lists were reviewed by local dietitians to ensure that local dietary habits would be captured. As a result, the French MetaCardis FFQ contains 159 food and beverage items, the German MetaCardis FFQ contains 143 items, and the Danish MetaCardis FFQ contains 153 items. A generic portion size that was described in terms of units or common portions (eg, 1 apple, 1 slice of bread, or 1 average portion) or household measures (eg, glass, cup, or teaspoon) was assigned to each food or beverage item. The frequency of intake of each item was assessed within a set of nine frequency choices for consumption ranging from "never or less than once a month" to "6 or more times per day." For example, in cases where an individual typically consumed 3 slices of bread per day over the past year, they would report their bread intake as "2 or 3 times per day."

The MetaCardis FFQ included a set of additional questions to collect further information on type and brand of fat consumed with bread or vegetables; type and brand of fat used in cooking; type and brand of breakfast cereal; consumption of sugar or milk with coffee, tea, or herbal infusion; and quantity of salt used in cooking and at the table. These questions were designed, where possible, to be linked with particular items on the food list. Questions on the use of vitamin and mineral supplements were also included.

Method of Administration. The three MetaCardis FFQs were developed and made available in the relevant language for the study country, on a dedicated website. The web-based format was the preferred option for the data collection given that, compared with traditional methods, time spent on coding data is minimized, data are automatically stored, and nutrition outputs can be rapidly generated.[18] Because the FFQs, together with the additional questions, were to be reviewed by research staff, instructions, and standard operating procedures for the data collection and review were developed and training sessions were provided at each study site. Evaluation questionnaires for participants and research staff were also developed to help identify any difficulties with FFQ completion. An analysis of the FFQs and evaluation questionnaires for the first 50 participants from each study center showed appropriate use of the FFQs, as well as high