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Controversies about population, clinical or basic research studies related with food, nutrition, physical activity and lifestyle

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Abstract

Nutritional studies including food and beverage consumption assessment are needed for different purposes in the field of nutrition, food supply monitoring, toxicology or in the context of intervention strategies that include changes in eating behaviors. Different methods have been used, each with strengths, weaknesses, biases and limitations that must be considered when choosing the most appropriate in each case. The development of new technologies offers exciting developments to improve the validity and accuracy of these methods, as well as their efficiency and commodity. The characteristics of the individuals under study, its environment and the resources available should be considered as well.

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Key words: Food consumption assessment. Validity. Precision. New technologies.

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Abbreviations

AECOSAN: Agencia Española de Consumo, Seguridad Alimentaria y Nutrición.
AMPM: Automated Multiple Pass Method.
EC: European Community.
EFSA: European Food Safety Authority.
FAO: Food and Agriculture Organization of the United Nations.
FIVR: Food Intake and Voice Recognizer.
MAGRAMA: Ministerio de Agricultura, Alimentación y Medio Ambiente.
TADA: Technology Assisted Dietary Assessment.
ANIBES: Antropometría, Ingesta, y Balance Ener gético en España.
ENPE: Estado Nutricional de la Población Española.
ENIDE: Encuesta Nacional de Ingesta Dietética.
PREDIMED: Prevención con Dieta Mediterránea.
PERSEO: Programa piloto Escolar de Referencia para la Salud y el Ejercicio contra la Obesidad.
NHANES: National Health and Nutrition Examination Survey.

Introduction

Health status is influenced by different genetic, individual and environmental factors that in variable proportionality interact with well-being, the morbidity/mortality and the vital projection towards future generations.

Under this assumption, knowledge and analysis of food habits, physical activity, energy balance and other lifestyle factors can be of great help in nutritional epidemiology studies and in processes of health-planning, development of dietary recommendations or when dealing out health plans.

Regarding these studies and their findings, doubts and controversies arise depending on the complexity and diversity of the methodologies to be used, the criteria employed to set cut-off points, or the normality ranges of different variables; or, more frequently, the doubts are concerned with the insufficient quality data obtained during field-work interviews.

In this regard, one of the characteristics of most population studies is a large percentage of energy miss-reporters, but also for some specific food groups, nutrients, or self-reported physical activity and a lack of specification of the energy balance of the individuals and groups under study.

With these limitations seems very risky to use the results obtained in a study to modify sustainably the current diet, to generate recommendations and to plan actions towards public health.

Based on this strategic approach it seems necessary to encourage the implementation of representative surveys of food use reality and its determinants, where the evaluation of physical activity, culinary habits and individual sensitivity on sustainable production, ecological and emotional balances, are blocks of variables considered for an operational analysis.

Purpose and interest of food consumption studies

In general, the studies related to food and beverage intake have multiple streams of application, ranging from institutional commitment for monitoring food intake or shopping basket to a more commercial interests linked with marketing strategies and market analysis.

Some of these areas of application are summarized in the following sections (table I):

1.- Nutritional interest

- Estimation of the adequacy of the food and nutrient intake to the Recommended Dietary Intake and Dietary Guidelines in each region or country. For example, the recent studies carried out in Spain such as the ANIBES study, the ENPE project or the ENIDE study.

- Evaluation of the relationship between diet-nutritional status-health: nutritional epidemiology. In this section we consider for example the recent contributions of the PREDIMED study in Spain.

- Assessment Tool for evaluating nutrition education programs, nutritional interventions and food fortification programs, for instance, some of the phases of the PERSEO project.
2.- Food and Nutrition Planning

- Analysis of the production and availability of food in a region or country (FAO Food Balance Sheets)\(^3\).

- Analysis of supply and distribution of food and beverages (Household Budget Surveys\(^5\), MAGRAMA\(^10,11\) or MERCASA\(^12\) surveys in Spain).

- Food and Nutrition Surveillance Programs (AECOSAN)\(^11\).

- Food regulation, food fortification and nutritional education projects as some of those led by AECOSAN on salt content of some foods.

3.- Toxicological aspects of food supply

- Total Diet Studies to determine trace elements and contaminants in food. Several regions have developed such studies, as also did AECOSAN recently\(^14\).

- EU Menu, project coordinated by the European Food Safety Agency (EFSA) aiming to promote the collection of data on food consumption in European countries with standardized procedures, in order to assess the exposure and risk analysis more accurately and efficiently. It will collect data about the European population menu between 2012 and 2017.

Some common concerns in nutritional studies

There are many elements to consider in all population studies, from the selection of the sample to the interpretation of the results, but one of the limiting factors is related with the validity and reliability of the selected methodology for data collection on food intake. Table II summarizes frequent issues and controversies related to food consumption and nutrition surveys.

From the available methods and their variants, the procedure chosen usually depends on the purpose, budget, resources and characteristics of the sample group. In all cases, our ultimate goal is to determine the usual intake of the individuals and groups under study\(^15\).

Knowledge of the usual and real intake is a demanding goal. The application of different complementary supportive methods based on food records will be required, such as, one or more 24-hour recalls or the Automated Multiple Pass Method (AMPM). The latter one is a computerized method used to systematically collect the reminders of food eaten in 24 hours by telephone or face-to-face interview. Other methods include food frequency questionnaires and even diet history questionnaires. Based on the information collected, appropriate statistical analysis will help to model usual intake and provide estimates closer to real intake.

Data collection is key in this process. Planning the adequate strategy for data collection is as important as choosing the appropriate method and protocol, preparing the suitable arrangements to involve trained and qualified personnel. They can motivate respondents to collaborate and get them to contribute as best the quality and complete information as possible.
This work requires the support of validated tools for the interpretation of weights and portion sizes as well as a appropriate use of new technologies as means to save this information in a quick, precise and easy manner. This is undoubtedly one of the key points of nutritional studies.

EFSA work-teams have suggested a methodological approach to make a consistent data collection and nutritional assessment in order to obtain reliable data and hence be able to compare the data collected in surveys conducted in different countries as well as provide the possibility to combine efforts and data from different countries in the European Community (EC)\textsuperscript{16,17}.

**Table II**

*Issues and controversies in food and nutrition studies*

<table>
<thead>
<tr>
<th>Issue</th>
<th>Controversy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validity</td>
<td>Cost-effectiveness</td>
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<tr>
<td></td>
<td>Estimation of usual intake</td>
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<td></td>
<td>Appropriate method according to aims and resources</td>
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<td></td>
<td>Harmonization – comparability of data</td>
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<td></td>
<td>Energy balance</td>
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<td></td>
<td>Underreporting- Overreporting</td>
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<tr>
<td>Portion size</td>
<td>Food models and replicas</td>
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<td></td>
<td>Photograph models</td>
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<td></td>
<td>New technologies</td>
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<tr>
<td>Special foods and additions</td>
<td>Bread</td>
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<td></td>
<td>Salt</td>
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<td></td>
<td>Water and beverages</td>
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<tr>
<td></td>
<td>Fats and oils</td>
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<td></td>
<td>Supplements</td>
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<td>Respondent burden</td>
<td>Influence eating behavior</td>
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<tr>
<td></td>
<td>Response rate</td>
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<td>Special population groups</td>
<td>Cognitive ability</td>
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<td></td>
<td>Surrogate response</td>
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<tr>
<td>Energy and nutrient intake estimates</td>
<td>Food composition databases</td>
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<td></td>
<td>Suitable software- platforms</td>
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<td>Biomarkers</td>
<td>Energy and nutrient intake</td>
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<td></td>
<td>Physical activity</td>
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<td>Omics</td>
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<td>Physical activity</td>
<td>Questionnaires</td>
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<td>Accelerometry</td>
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<td>New technologies</td>
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<td>Data analysis</td>
<td>Response rate</td>
</tr>
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<td></td>
<td>Bias and adjustments</td>
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</tbody>
</table>

This work requires the support of validated tools for the interpretation of weights and portion sizes as well as a appropriate use of new technologies as means to save this information in a quick, precise and easy manner. This is undoubtedly one of the key points of nutritional studies.

Portion size models and dietary intake assessment

As mentioned earlier, the portion size and weight estimations of food intake are limiting factors in nutritional studies. We are interested in gathering all information on the consumption of food and drinks in a given period of time, but also, we may want to assess the portion of sizes and weights of foods consumed and food ingredients.

Different kinds of food models have been used in food and nutrition surveys since the Nutrition Survey of Canada in 1974. In that survey, sizes and thicknesses of cardboard, calibrated containers and other gadgets were used as food models to estimate the portion sizes of foods consumed. Other procedures include food replicas, household measures (plates, spoons, glasses, cups...) and even modeling with fingers and hands. Currently, photographic models and technology based aids are the most widely used resources\textsuperscript{18}. Photographic models are suitable for being specifically designed for each study, considering four or more volumetric references for food or food group\textsuperscript{19-23}. The description of the average servings consumed as small, medium, large or very large can also be useful, depending on the level of the information required.

These days, web pages, laptops, tablets or mobile phones with specific applications are frequently used for this purpose. Sometimes, images are recorded to display the choice of food in catering or during the process of buying in small shops or supermarkets or even to support food records\textsuperscript{21-28}. Technology Assisted Dietary Assessment (TADA) system is one of such new technological applications,
which involves capturing photos with the mobile before and after food consumption. These photos are tagged with supporting details to estimate the portion size and subsequent automatic analysis from a link to a database of food composition analysis.

The Food Intake and Voice Recognizer (FIVR) system allows us to capture images with the mobile and simultaneously record comments about the prepared dishes to be consumed. The information is processed with the estimation of food portion sizes and volumes. The end result is a dietary study with automated nutritional assessment.

The sensor system e-button, for ubiquitous evaluation, allows image capturing and logging of data for a day or a set period. This method is based on the use of a device with sensors and a recording camera that allows for a real-time collection of information from environmental factors, food shopping, food intake, cooking techniques used, physical activity, leisure time activities, and consumption of drinks or other substances. It is a process of great interest in the future of telemedicine and health research.

Main difficulties in estimating dietary intake

Dietary assessment is a complex procedure. All foods, fresh or processed, need a special attention to get a more precise picture and avoid the leak of any details to the overall assessment. However, there are some elements of the diet are particularly difficult for accurate quantification.

Water and beverages

The estimated consumption of water and other drinks require special attention and the use of specific validated questionnaires. Many people have trouble remembering their water and overall beverages intake and its variability further complicates the assessment of the usual intake. Use of biomarkers and urine output are recommended.

Alcoholic beverages

The assessment of alcohol intake in alcoholic beverages users requires a thorough interview about this particular product, starting from the time of getting up to bedtime and even at night-times. This section should be completed at the end of the interview with a sensible approach and empathy.

Salt intake

Assessment of salt and total sodium intake is a difficult challenge. Information can be derived from the buying and spending of salt in a given time period by the number of users in each family. Information on the use of extra salt at the table and/or contribution of salt marked with lithium. We can draw on 24 hour urine collection for the determination of sodium and particularly, we can draw on a good food composition table or on a duplicate portion analysis system.

Intake of oil and other added fats

Quantification of oil consumption individually or in a group have varying degrees of difficulty depending on culinary techniques, added oil, type of oil, or the ratio between oil availability and intake, among others. A homogenous criteria needs to be placed for allocating oil consumption depending the type of dish and food volume and wherever possible it should be accompanied by the use of biomarkers.

For fat spreads the recipe will be used, home servings or quantities allocated according to the size of the receiving surface.

Bread

In some situations, bread is a food of difficult characterization. We will need to know the sizes and weights of the most used breads in each region, along with the weight and size of the loaves and alike. Photographic models, home measures and the usual shopping will help in quantifying bread consumption.

Other critical variables

Along with the complexity of assessing the diet as a whole and some foods or products in particular, various challenges arise regarding the relationship between the respondent and the interviewer throughout the fieldwork process. This issue will be discussed with particular thoroughness in some sections of this monograph. This is about getting a good rate of valid responses on a well selected theoretical sample. Adapt the whole dynamic of the process to encourage the participation and collaboration of respondents and nonetheless conduct an adequate analysis of the nonresponse rate.

Other added peculiar features should be noted in some groups such as the elderly, children, disabled, homeless, immigrants or people affected by illness, etc. Also in cases of surrogate responses.

Some studies have important limitations based on low response rates, important under-response sub-groups and the use of low quality or difficult to compare food composition tables.

Some biases are related with the lack of quality information on nutritional supplements or dietetic products intake. Also bias can be related with the use of just few days for intake analysis or periods that do not allow integrating seasonal or monthly variability.
Instrumental assessment: anthropometry and physical activity

Some nutritional studies and almost all the studies aimed at assessing nutritional status incorporate a relatively extensive section on anthropometric measurements. This section requires a large technical training, approved/homologated instrumentation, calibration and daily quality controls. The preceding work before a study begins will allow achieving a high level of training in making measurements, along with the decision of the cut-off points and the reference values to be used.

As explained earlier, a key points related to the investigation of physical activity and caloric expenditure of each study participant. The use of validated questionnaires will be aided by incorporating modern instruments and new technologies such as specific applications in connection with accelerometers, pedometers and other technical utilities. The relevance of incorporating haematological and biochemical indicators, other biological tests or genetic determinants will be discussed by the research team depending on the objectives of the project and the characteristics of the study group. Finally, Ethics Committees will be an added guarantee of balance in our overall proposals.

Other lifestyles

In this preliminary review on the various factors to consider in the development of population studies on nutritional status, we cannot forget to include smoking, alcohol, medications and other drugs, along with accurate indicators of mental health/well-being and quality of life. From the modelled framework of the Mediterranean Diet we will not forget the chronobiological aspects, time and environment dedicated to each meal, sustainability criteria, characteristics of food production, the balance of remains, leftovers and other anthropological variables related to diet.

All of them are factors related with and determinants of dietary habits and health status. These data, in varying degrees, will be of great use for our future proposals of intervention initiatives and nutrition education.

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