Dietary Exposure Assessment Indicators

Overview

With an estimated 600 million cases of foodborne illnesses annually, unsafe food is a threat to human health and economies globally. Foodborne diseases cost at least US$100 billion in low- and middle-income countries (LMIC) each year, with 28 countries having losses exceeding US$500 million, according to a recent World Bank study (World Bank, 2018 [1]). The Second International Conference on Nutrition (ICN2) held in 2014 stressed the link between food safety and human nutrition and the key role of food safety in achieving the Sustainable Development Goals (WHO, 2017 [2]). The first global study on Food-borne Disease (FBD) was conducted by the Food-borne Disease Burden Epidemiology Reference Group (FERG) of the World Health Organization (WHO) and found that a considerable proportion of this burden of FBD falls on LMICs (Havelaar et al., 2015 [3]; Gibb et al., 2015 [4]; Gibb et al., 2018 [5]). Still, estimating the overall impact of food safety hazards in LMICs with the desired confidence is especially challenging as good quality data are not frequently available.

Risk assessments follow a four-step method: hazard identification, hazard characterization, exposure assessment, and risk characterization (FAO/WHO, 2018 [6]). Dietary exposure assessment is a critical step in risk assessment for microbiological or chemical agents in food (FAO/WHO, 2009 [7]; EFSA, 2011 [8]). Dietary exposure is estimated by combining food consumption data with food chemical concentration data. Estimates of exposure can be obtained for the total population (including non-consumers) or for the sub-group who is exposed (consumers). Each consumer's exposure is estimated from his/her individual consumption records and the distribution of these values is compared with the health-based guidance values for the chemical or microbiological agent of concern.

Method of Construction

Chronic food consumption: Average food consumption of at least two non-consecutive reporting days for a given food or group of foods and can be presented as:

- *Grams per day* (total population or consumers only): Estimated by considering the average food consumption of at least two non-consecutive reporting days for a given food or group of foods. Median consumption and high percentiles of consumption (for example 95th, 97.5th, or 99th) can be obtained for the total population and for consumers only; or
- *Grams per kilogram body weight per day* (total population or consumers only): Estimated by considering the average food consumption of at least two non-consecutive reporting days for a given food or group of foods and dividing it by the subject's body weight (in kilograms). Median consumption and high percentiles of consumption (for example 95th, 97.5th, or 99th) can be obtained for the total population and for consumers only.

Acute food consumption: Total consumption of a given food or group of foods during a consumption day or eating occasion. It can be presented as:

- *Grams per day*: Estimated by considering the total daily consumption amount (in grams) of a given food or group of foods during each reporting day. Median consumption and high levels of consumption (for example 95 th, 97.5th, or 99th) can be obtained for each of the days covered in the survey or to consumption days only.

- *Grams per kilogram body weight per day*: Estimated by considering the total daily consumption amount (in grams) of a given food or group of foods during one reporting day and dividing it by the subject's body weight (in kilograms). Median consumption and high levels of consumption (for example 95th, 97.5th, or 99th) can be obtained by considering each of the days covered in the survey or consumption days only.
- *Grams per eating occasion:* Estimated by considering the total consumption amount (in grams) of a given food or group of foods during one eating occasion. Median consumption and high levels of consumption (for example 95th, 97.5th, or 99th) can be estimated considering only the eating occasions for which the food has been consumed.
- *Grams per kilogram body weight per eating occasion:* Estimated by considering the total consumption amount (in grams) of a given food or group of foods during one eating occasion and dividing it by the subject's body weight (in kilograms). Median consumption and high levels of consumption (for example 95th, 97.5th, or 99th) can be estimated considering the eating occasions for which the food has been consumed.

Number of consumers or consumption days*:* Displays the number of consumers (for chronic food consumption) or the number of consumption days (for acute food consumption) of a given food or group of foods in the survey.

Percentage of consumers or consumption days*:* Obtained by dividing the number of consumers (for chronic food consumption) or consumption days (for acute food consumption) of a given food or group of foods by the total number of subjects or total number of consumption days (respectively) in the survey.

Uses

Food consumption combined with chemical occurrence data forms the basis for calculating food safety indicators. To estimate the potential dietary exposure to hazards over long periods, *chronic* food consumption is combined with mean or median occurrence data to perform dietary exposure assessment. On the other hand, food safety indicators based on *acute* food consumption can be used to quantify potential exposure to biological or chemical hazards during a short period in time (i.e. one reporting day or one eating occasion).

Strengths and Weaknesses

Strengths:

- Estimates are based on age- and sex-disaggregated dietary data that can be combined with occurrence data, which allows the estimation of high percentile of dietary exposure to a variety of sources, whereas this is not possible when only summary statistics are available.
- Availability of age- and sex-disaggregated food consumption data enables dietary exposure assessment of different population groups.

Limitations:

- Small sample sizes of surveys that are not representative at a national level and/or a small number of consumers (for rarely consumed foods) decrease the reliability of the estimates, in particular estimates of high levels of consumption.
- Daily food consumption amounts for occasionally consumed foods based on 24-hour dietary data tend to be overestimated, which can overestimate the potential exposure of high consumers, and lead to the imposition of overly restrictive risk management measures.
- The available dietary data may be outdated and not reflect current food supply and industry practices, providing a greater uncertainty when assessing consumption of foods introduced to the market or for which there may have been changes in consumption patterns after the surveys were conducted, and hence influence the results of dietary exposure assessment.

Data Sources

To estimate dietary exposure, two different types of data are needed: food consumption data and chemical occurrence data in food (FAO/WHO, 2009 [9]). Availability of adequate food consumption data is often a limiting factor in dietary exposure assessments. In high-income countries, national institutes usually collect food consumption surveys, including individual dietary intake surveys, at regular multi-year frequencies. On the other hand, in LMICs the availability of food consumption data is often limited, and, if national sources exist, they are often outdated or lack adequate disaggregation (i.e. data are only available at the household level in the case of Household [10] Consumption Expenditure Surveys [10]). Although available, per capita estimates from Food Balance [11] Sheets [11] and household-level data do not allow for refined exposure estimations for different population groups. Similarly, individual food consumption summary statistics are an important piece of information for risk managers as an interim solution to compare conservative exposure estimates with health-based guidance values, but microdata is needed to perform refined exposure assessment when health-based guidance values are exceeded(EFSA, 2011 [12]). Individual-level quantitative dietary data, such as those collected through 24-hour Dietary Recalls [13]and weighted Food Records [14], are the most complete source of information on food consumption for refined dietary exposure assessments.

The Food Agriculture Organization of the United Nations (FAO) and the World Health Organization(WHO) collaborate in the development of FAO/WHO GIFT [15](Global Individual Food Consumption Data Tool).FAO/WHO GIFT [15] provides harmonized, age and sex-disaggregated dietary data, both in the form of indicators and microdata available for download (Leclercq et al., 2019 [16]). These data can be combined with occurrence data, such as microbiological or food chemical concentration data to perform dietary exposure assessments. In addition, the Food Safety Collaborative Platform (FAO/WHO FOSCOLLAB [17]) is an online tool hosted by WHO that integrates multiple sources of reliable food chemical concentration data to support food safety professionals as well as the FAO/WHO risk assessment process.

Both dietary data and chemical occurrence data that are shared through FAO/WHO GIFT [15]and FOSCOLLAB, [17] respectively, are mapped with the FoodEx2 system. Experts interested in performing dietary exposure assessment by using probabilistic or deterministic models for which microdata are needed can easily combine the microdata on food consumption shared through the FAO/WHO GIFT [15]platform with the chemical occurrence data available on FOSCOLLAB [17]. FAO/WHO GIFT [15]andFAO/WHO FOSCOLLAB [17]are growing initiatives with frequent public releases of new datasets of indicators and microdata.

Links to Case Studies

No case study to show for this indicator.

Links to guidelines

- European Food Safety Authority (2011). Use of the EFSA Comprehensive European Food Consumption Database in Exposure Assessment. [8]
- FAO/WHO (2009). Chapter 6: Dietary Exposure Assessment of Chemicals in Food. [9]

Links to validation studies

- De Ruyck et al. (2020). Mycotoxin exposure assessments in a multi-center European validation study by 24-hour dietary recall and biological fluid sampling. Environment international. [18]
- Cámara et al. (2020). Removal residues of pesticides in apricot, peach and orange processed and dietary exposure assessment. Food chemistry. [19]

Links to illustrative analyses

- Carballo et al. (2019). Dietary exposure assessment to mycotoxins through total diet studies. A review. Food and Chemical Toxicology. [20]
- Lu et al. (2018). Neonicotinoid residues in fruits and vegetables: an integrated dietary exposure assessment approach.Environmental science & technology. [21]
- Chang et al. (2020). Dietary exposure assessment to perchlorate in the Taiwanese population: A risk assessment based on the probabilistic approach.Environmental Pollution. [22]

Food Security Dimensions

- Safety [24]

Data Collection Levels

- Individual [25]

Data Sources and Methods

- 24-Hour Dietary Recall (24HR)
- Weighed Food Record (WFR)

Requires Food Composition Database

- No [26]

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