Meat-consumption statistics: reliability and discrepancy

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Interest in meat consumption and its impact on the environment and health has grown markedly over the last few decades and this upsurge has led to greater demand for reliable data. This article aims to describe methods for producing meat-consumption statistics and discuss their limitations and strengths; to identify uncertainties in statistics and to estimate their individual impact; to outline how relevant data are produced and presented at the national (Swedish), regional (Eurostat), and international (FAOSTAT) levels; to analyze the consequences of identified discrepancies and uncertainties for estimating the environmental and health effects of meat consumption; and to suggest recommendations for improved production, presentation, and use of meat-consumption statistics. We demonstrate many inconsistencies in how meat-consumption data are produced and presented. Of special importance are assumptions on bone weight, food losses and waste, weight losses during cooking, and nonmeat ingredients. Depending on the methods employed to handle these ambiguous factors, per capita meat-consumption levels may differ by a factor of two or more. This finding illustrates that knowledge concerning limitations, uncertainties, and discrepancies in data is essential for a correct understanding, interpretation, and use of meat-consumption statistics in, for instance, dietary recommendations related to health and environmental issues.

KEYWORDS: meat production, food consumption, statistical analysis, environmental effects, public health

Introduction

Quality national and international data are essential for understanding social dynamics that are often the foundation for scientific research and policy development. Recent decades have given rise to growing interest in meat consumption and its effects on the environment and health, leading to a greater demand for reliable meat-consumption data. Such statistics are used in research to assess present and historical nutrient intake and environmental impacts, but also to predict future trends. Data on meat consumption are also used to develop guidelines, policy programs, and strategic interventions regarding health, climate change, and land-use issues.

Methodologies for producing consumption statistics suffer from a number of limitations and uncertainties that affect the overall reliability of the data. Lack of harmonization of definitions and regulations concerning how data are obtained and presented further complicates the combination and comparison of data from different countries and regions (e.g., EU by Eurostat) and globally (e.g., by FAOSTAT). Examples of factors that influence meat-consumption data are whether bones are included in weight calculations, waste is accounted for at different stages along the food chain, weight refers to raw or cooked meat, and whether ingredients of nonmeat origin in mixed processed-meat products and ready meals are included. Awareness of inclusions and exclusions in the data, and of its limitations and uncertainties, is essential for correct understanding, interpretation, and use of such statistics. This article seeks:

- To describe the methods for producing meat-consumption statistics and discuss their limitations and strengths.
- To identify uncertainties in statistics and estimate their individual impact.
- To outline and compare how meat-consumption statistics are produced and presented at the national (Swedish), regional (Eurostat), and international (FAOSTAT) levels.
- To analyze consequences of identified uncertainties and discrepancies for assessments investigating the environmental and health impacts of meat consumption.
- To suggest improvements in the methodology for producing, presenting, and handling meat-consumption statistics.

Methodology and Assessment Approach

This study relies on data and other information from scientific articles, statistical reports, online databases, and personal communication with authorities in the field. We analyzed, processed, and categorized information and data as outlined below to formulate relevant comparisons and conclusions.
The categorization is based on the following:

- **Type of survey methods (see Methods for Producing Meat-Consumption Data):** whether data are based on agricultural supply, household-budget surveys (HBSs), or individual dietary surveys (IDSs). This section describes ways of producing meat-consumption data, limitations and strengths of existing methods, and appropriate usage of data produced with different methods.

- **Type of meat data (see Uncertainty Factors in Meat-Consumption Data):** whether meat-consumption data i) refer to carcass weight or bone-free weight, ii) are adjusted for food losses and waste, iii) refer to raw or cooked meat, and iv) include or exclude nonmeat components in mixed-meat products and prepared meals. This section describes factors contributing to discrepancies in meat-consumption data, explains how different types of survey methods deal with this variability, and estimates their individual impact.

- **Type of statistical sources (see Meat-Consumption Statistics on National, Regional, and International Levels):** whether meat-consumption data are provided at the national (Sweden), regional (Eurostat), or international (FAOSTAT) level. This section describes how meat-consumption data are produced and presented, discrepancies among statistics at the different levels, and factors affecting accuracy and reliability.

Results from previous research are used to discuss and illustrate the consequences of variability in data for assessments investigating the environmental and health impacts of meat consumption.

**Results**

**Methods for Producing Meat-Consumption Data**

There are several methods of producing data on meat consumption. The specific method should reflect the purpose for which the data will be used and will influence how they should be interpreted. Data on food consumption can be derived from agricultural supply, HBSs, or IDSs (Naska et al. 2009; SFA, 2011a). Table 1 provides a summary of methods used for generating meat-consumption data and the factors that determine their correct use and interpretation.

**Food-Consumption Data Based on Agricultural Supply**

Per capita consumption data are generally based on agricultural and trade information and provide insight into the average quantity of the commodity in question available for use within a country or region (FAO, 2001; SFA, 2011a). Food-balance sheets (FBSs) at regional (e.g., Eurostat) and global (e.g., FAOSTAT) levels provide standardized supply data and represent an important knowledge base that permits comparative analyses over time.

In agricultural statistics, meat refers to the flesh of animals used for human food and hence excludes meat unfit for human consumption (EC, 2009; FAO, 2011a). The available supply of meat in a country is typically calculated as (national production + import + opening stocks) – (exports + usage input for food + feed + nonfood usage + wastage + closing stocks). Per capita supply data are obtained by dividing the national available supply by the number of inhabitants (FAO, 2001; EC, 2011a). Although the data in agricultural statistics only provide information on the available per capita supply of meat, these data are often used, due to economic constraints and lack of other data, as a proxy for per capita meat consumption.

Agricultural supply data can either be presented as the available supply of raw material per person (i.e., cereals, milk, sugar), or as the available supply of food per person (i.e., bread, cheese, candy) (Eidstedt & Wikberger, 2011; SFA, 2011a). Depending on how data are presented, adjustments for food losses (beginning of the food chain) and waste (end of the food chain) may or may not be accounted for. Factors affecting the reliability of agricultural supply data include the risk of incomplete and/or inaccurate underlying national statistics (e.g., in certain developing countries), limited information on losses and waste along the food chain, and incomplete reporting of noncommercial products (e.g., game) (FAO, 2001; Hawkesworth et al. 2010).

Agricultural supply data makes it possible to study consumption trends over time and to compare consumption across different regions and countries. The data are useful for evaluating a country’s agricultural situation (and thus to projecting future demand and supply of food), setting targets for agricultural production and trade, and evaluating national food and nutrition policies (FAO, 2001). As the data are based on the available supply per person, they are not completely accurate in describing what people actually eat (SFA, 2011a). The available supply of food thus represents only the quantities reaching the consumer (after losses and waste during harvest, storing, processing, distribution, and retail) and it does not take into account household wastage during storage, preparation, and cooking. Furthermore, agricultural supply data provide no specific insights...

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1 Usage input for food refers to the amount of originating meat required for obtaining an output of a derived meat product.
about consumption characteristics in different populations, regions, socioeconomic groups, or among individuals in households (FAO, 2001). Despite these limitations, agricultural supply data are often used to describe food consumption.

There is currently no international regulatory framework for how statistics on agricultural supply should be produced (Eidstedt, 2011), although global recommendations and guidelines exist for appropriate approaches to obtain and present data (FAO, 2001; De Henauw et al. 2002; EC, 2011b; European Statistical System, 2011). This means that national data on agricultural supply from different time periods may not be comparable if methods used to produce the data changed over time and that accurate comparisons across different countries may be difficult (Serra-Majem et al. 2003; Eidstedt, 2011; SFA, 2011a).

**Food-Consumption Data Based on Household Budget Surveys**

HBSs are generally conducted by national statistics offices and provide information on how much money is spent on different foods per household and sometimes also on the quantity of food purchased per household (Naska et al. 2009; SFA, 2011a). The data can either be obtained from trade-sales figures or from self-reported household expenditures.

Statistics based on these surveys are useful for comparing expenditures on different foods and consumption across different regions, populations, and socioeconomic groups. These data generally provide no information about what happens to food after purchase (i.e., whether the food is eaten or not, or how consumption is allocated among individuals in the household) (Hawkesworth et al. 2010; SFA, 2011a). Consumption data based on HBSs are therefore more appropriate for studying food intake in a population than for individuals (Naiken, 2003; Serra-Majem et al. 2003). Furthermore, data based on HBSs are often expressed as food categories rather than individual foods, which may cause difficulties due to lack of harmonization of categories in different surveys (Serra-Majem et al. 2003).

Like other self-reporting methods, HBSs are challenged by various uncertainties, such as recall and reporting errors. To study food consumption using HBSs, data should ideally be collected both on

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Table 1: Appropriate use of meat-consumption statistics and factors of importance for the correct use and interpretation of data produced by different methods.a

| Method | Appropriate Use | Important Factors for Correct Use and Interpretation |
|--------|-----------------|---------------------------------------------------|
| Data based on agricultural supply (e.g., FBSs) | - For description of the average quantity of meat available for use within a country.  
- For studying consumption trends over time and for comparing consumption in different countries and world regions.  
- Less accurate for describing what people actually eat and consumption characteristics in different national populations groups and regions. | - Is consumption of noncommercial meat accounted for?  
- Have the data been recently updated?  
- Are food losses and waste accounted for?  
- How is meat content in processed products and prepared meals reported? |
| Household Budget Surveys (HBSs) | - For comparison of consumption between different regions and socio-economic groups.  
- For monitoring changes in consumption patterns over time.  
- More appropriate for studying food intake in a population than for individuals. | - Is the selection of participants representative of the population studied?  
- How good/bad is the participation rate?  
- Is there a risk of under-, over- or mis-reporting?  
- Has the method been internally or externally validated?  
- Are the food categories used comparable?  
- Do the data account for meat consumed outside the household?  
- Is food waste in the household accounted for? |
| Individual Dietary Surveys (IDSs) | - For description of individual consumption.  
- Provides information about the amount of meat actually eaten.  
- For mapping dietary habits, studying the relationship between diet and health, and quantifying determinants and consequences of food choices. | - What survey method has been used to obtain the data?  
- Is the selection of participants representative of the population studied?  
- How good/bad was the participation rate?  
- Is there a risk of under-, over- or mis-reporting?  
- Has the method been internally or externally validated?  
- Has food waste in the household been accounted for?  
- Does the consumption refer to raw or cooked weight? |

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a For references, see Methods for Producing Meat-Consumption Data
food consumed in the household and away from home. If household expenditure is used to estimate food intake, there is a risk that food eaten outside the home will be excluded. Other reliability issues arising from the use of these surveys include the difficulty of accounting for food consumed by guests in the household and of adjusting for food that is purchased and stored without being consumed during a recall period (as well as the reverse, if food is consumed that was purchased prior to the recall period) (Smith, 2003; Hawkesworth et al. 2010). The representativeness of data based on HBSSs further depends on the participation rate and whether the sampling consists of a uniform distribution between, say, urban and rural areas, poorer and wealthier households, and single and multi-individual households (Hawkesworth et al. 2010). The reliability of HBSSs can be increased by covering longer recall periods and by conducting multiple rounds, as well as by collecting complementary information about food habits in the household (Smith, 2003).

**Food-Consumption Data Based on Individual Dietary Surveys**

IDSs provide data on the amount of food actually eaten by individuals and groups and are one of the most accurate (and costly) methods for obtaining data on food consumption (Naska et al. 2009). These data are typically used to map dietary habits, to study the relationship between diet and health, and to quantify determinants and consequences of food choices (Naska et al. 2009; SFA, 2011a).

There are several methods for studying eating habits. The most common approaches are 24-hour recall, dietary history interviews (DHIs), food-frequency questionnaires (FFQs) (retrospective methods), and dietary records (prospective methods). Twenty-four hour recall and DHIs entail interviewing participants about the amount and type of food previously eaten. In a 24-hour recall, only food eaten during the past day is reported, while DHIs typically are used to inventory food consumption over a longer period. Reported intake that deviates from the person’s average consumption is presumed to average out across the whole sample. FFQs are based on instruments in which participants report information on the quantity and type of food eaten. Dietary record methodology can vary, but the basis is that the participants report in writing all food eaten during a specified period. The amount of food consumed can either be estimated or weighed and the survey period can vary. The reported intake in dietary records is assumed to be representative of the person’s average food consumption.

Statistics based on IDSs offer the possibility of studying food consumption on an individual level and of matching consumption patterns with specific characteristics such as gender, age, employment, and cultural and ethnic background. Unlike data based on agricultural supply and HBSSs, IDSs usually refer to food intake after adjustment for household waste and may also provide insight on methods of preparation.

It is well known that existing methods used to assess dietary intake on an individual level are hampered by various limitations and inherent errors that affect reliability. Sources of errors can be divided into random and systematic errors. Random errors refer to problems such as day-to-day variability of food intake and seasonal variations (i.e., that reported food intake in dietary surveys is not representative of average consumption). The risk of random errors can be reduced by increasing the number of surveyed days and subjects. Systematic errors, such as problems with under-, over-, and misreporting, are common in retrospective methods that require a good memory and sincerity (Ferro-Luzzi, 2003; SFA, 2011b). To overcome uncertainties in data and to enhance the quality of data on food consumption based on IDSs, internal or external validation of the method used is recommended (Ferro-Luzzi, 2003).² A more detailed summary of recommendations for the improvement of the quality of IDSs can be found in De Henauw et al. (2002).

**Uncertainty Factors in Meat-Consumption Data**

The previous description of existing methods for producing meat-consumption data makes clear the various factors that may affect reliability and accuracy. To be aware of the factors that contribute to uncertainty and to know their individual impact facilitates accurate interpretation and use of the resultant data. Based on the previous description of methods and the summary in Table 1, we have identified four main uncertainty factors affecting the accuracy and reliability of meat-consumption statistics. Table 2 provides an overview of these issues and their estimated impacts.

**Weight of Bones**

Agricultural statistics on meat consumption and production are generally presented as carcass weight or as bone-free carcass weight. The carcass weight typically refers to the total weight of the slaughtered animal’s body after removal of inedible body parts (e.g., skin, offal, slaughter fats, head, feet, tail, and genital organs) and body parts used for nonfood pur-

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² Examples of validation methods are comparing data against results produced by another method, using biomarkers, or relating energy-intake levels with measurements/estimations of energy expenditure.
Food Losses and Waste

Food losses and waste can occur at virtually any stage along the food chain. At the global level, it is estimated that between one third and one half of all food produced is spoiled before or after it reaches the consumer (Lundqvist et al. 2008; FAO, 2011b). The magnitude of these estimates illustrates the importance of accounting for food spoilage in consumption statistics. Where in the supply chain food losses occur and how large proportions are lost vary by commodity as well as by country and region. For example, in developed countries food waste at retail and consumer levels accounts for a sizable fraction of food losses, whereas losses in the early stages of the supply chain (e.g., storage and distribution) are more common in developing countries (FAO, 2011b).

Various sources, including enterprises and manufacturing surveys, provide information on losses occurring along the food chain. Food losses refer to “the decrease in edible food mass along the supply chain leading to edible food for human consumption,” and thus exclude meat intended for nonfood uses (e.g., feed and industrial uses) and inedible parts (FAO, 2011b). Products originally intended for human consumption that end up being used for a nonfood purpose may, however, be categorized as food loss. Food waste refers to losses occurring at retail or consumer levels. The estimated losses and waste of meat after agricultural production (e.g., postharvest handling, storage, processing packaging, distribution, retail, and consumption) ranges between 15–21% of the total production, depending on global region (FAO, 2011b).

Postfarm losses and technical losses in processing up to the retail stage may or may not be accounted for in meat-consumption data based on agricultural supply, depending on the country concerned. In addition, household-food waste is not taken into account in agricultural supply data, such as that provided by FAOSTAT. Furthermore, in consumption statistics based on HBSs and IDSs, waste at the household level is in general not accounted for. However, this depends on the specific design of the method used to obtain the data. Food waste in the household is estimated to account for about 25% of all food purchased (by weight) in the UK (WRAP, 2009), for 8–11% of the meat purchased in industrialized regions, and for 2–6% in developing regions (FAO, 2011b).

Raw or Cooked Weight

Data on meat consumption can either be presented as raw weight or weight after cooking. One kilogram (kg) of raw meat is roughly equivalent to 700 grams (g) of cooked meat. However, the conversion factor may vary between 0.5 and 0.8 depending on, for example, the cut of meat, proportions of lean to fat, as well as method and extent of cooking (KF & ICA Provköök, 2000; WCRF/AICR, 2007). The weight difference is due to the water content, which partially evaporates during cooking. The water content in beef, pork, and chicken is approximately 58–73%, 65–75%, and 53–75%, respectively (Amcoff, 2011).

Meat-consumption statistics based on agricultural data and HBSs in general refer to the raw weight of meat, whereas statistics based on IDSs, as well as nutritional recommendations, can be reported either as raw or cooked weight, depending on the design of the method.

Mixed-Meat Products and Prepared Meals

Meat is often eaten in the form of mixed-meat products, such as sausages and other mixed-charcuterie products and prepared meals. A Swedish Board of Agriculture (SBA) (1998) study examined...
the meat content in processed meat products on the Swedish market and showed that the average meat content in mixed-charcuterie products and prepared meals was 53% and 41%, respectively. Despite the fact that the meat content is considerably less than 100% in these products, the total weight of such products is commonly reported in meat-consumption statistics (Eidstedt, 2011).

In statistics based on agricultural supply, only the meat content in mixed-meat products and prepared meals is generally included in figures for the total consumption of different types of meat. By contrast, in the cases where meat consumption is reported as products of a higher degree of processing (e.g., “direct consumption” in Swedish statistics), consumption often refers to the total weight of the mixed products and prepared meals. Furthermore, in consumption statistics based on IDSs, mixed-meat products and prepared meals in general refer to the total weight of such products. If meat-consumption statistics are based on data that do not distinguish between meat and nonmeat components in mixed-meat products and prepared meals, consumption risks being overestimated (Riley & Buttriss, 2011).

### Meat-Consumption Statistics on National, Regional, and International Levels

Statistical institutes at national, regional, and international levels publish per capita meat-consumption statistics. Consumption statistics at different levels are produced by various methods based on nonstandardized assumptions and thus vary in reliability and accuracy. Being aware of the procedures used to collect data, the assumptions on which they are based, and the discrepancies between meat-consumption data at different levels will improve the prospects for correct understanding, interpretation, and use of this information. The following sections describe how per capita meat-consumption statistics from Sweden, Eurostat, and FAOSTAT are produced and presented. The statistics are based on agricultural data and thus refer to the available supply for human consumption, i.e., excluding meat for nonfood purposes. Table 3 provides a summary of methods and assumptions used to produce meat-consumption statistics at national, regional, and global levels.

#### Swedish Statistics on Meat Consumption

Sweden has three different sources of meat-consumption statistics: agricultural data provided by SBA, HBSs developed by Statistics Sweden, and dietary surveys carried out by the Swedish Food Agency (SFA, 2011a). This section describes meat-consumption statistics distributed by SBA, which are used to calculate Swedish per capita meat consumption.

Swedish meat-consumption statistics are either presented as “total meat consumption” or “direct meat consumption.” “Total meat consumption” refers to the overall supply of raw meat (including bones) available for human consumption at the farm gate.

### Table 3 Methods and assumptions used to produce meat-consumption statistics in Sweden, Eurostat, and FAOSTAT.

| Weight of Bones | Food Losses and Waste | Raw or Cooked Weight | Mixed-Meat Products and Prepared Meals |
|-----------------|-----------------------|----------------------|----------------------------------------|
| **Swedish Agricultural Statistics** | • Total meat consumption, including bone weight. | • Total meat consumption: no deduction for losses/waste between slaughter and consumption. | • Total meat consumption: exclude weight for nonmeat content of processed products. |
| | • Direct meat consumption, excluding bone weight in beef and pork (25% and 15.2% of carcass weight), including bone weight in poultry. | • Direct meat consumption: assumed losses/waste between slaughter and retail corresponds to 5% of bone-free carcass weight. | • Direct consumption: total weight of the processed product. |
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| **Eurostat** | • Consumption refers to carcass weight, i.e., including bones. | • Losses/waste between slaughter and retail is adjusted for. | • Mixed products made up of meat from several species are included in the “other meat” balance. |
| | • No information found on assumed bone weight in relation to carcass weight. | • No information found on assumptions for food losses and waste. | |
| **FAOSTAT** | • Consumption refers to carcass weight, i.e., including bones, unless otherwise stated. | • Meat-supply data are adjusted for food manufacture and losses/waste up to the stage of retail. | • Food-supply data include both primary commodities and processed-food products. |
| | • No information found on assumed bone weight in relation to carcass weight | • No information found on assumptions for food losses and waste. | |

*For references, see Meat-Consumption Statistics on National, Regional, and International Levels*
(plus estimated quantities of noncommercial meat), after correction for imports and exports (Eidstedt & Wikberger, 2011). In mixed products, such as charcuterie products and prepared meals, “total meat consumption” refers to meat excluding the weight of nonmeat ingredients (Eidstedt, 2011).

“Direct meat consumption” refers to the total supply of food available for private households and catering (Eidstedt & Wikberger, 2011). The data exclude the weight of bones in beef and pork (25% and 15.2% of carcass weight, respectively) but includes bone weight in poultry. Losses due to inputs in processing and losses up to the stage of retail are adjusted for, and assumed to correspond to, 5% of the bone-free carcass weight. “Direct meat consumption” statistics present data on the consumption of charcuterie products and frozen prepared meals as separate categories. For charcuterie products and frozen prepared meals containing meat, data refer to the total product weight (i.e., including nonmeat contents) (Eidstedt, 2011).

Swedish per capita consumption statistics are based on several sources, such as data from agriculture and trade statistics, SBA statistics, Swedish Statistics, Swedish Food Agency, and so forth and production information is obtained from specific commercial producers. The reliability of Swedish-consumption statistics largely depends on the quality of the underlying data. National consumption statistics are presented annually and give statistics referring to data that are about one-and-a-half years old. Continuous changes in methodology and classification may mean that statistics from year to year are not fully comparable, and therefore consumption changes seen over short time periods should be interpreted with caution (Eidstedt & Wikberger, 2011). Other factors affecting the accuracy and reliability of national agricultural statistics have previously been described in Methods for Producing Meat-Consumption Data.

**European Statistics on Meat Consumption**

The European Statistical System (ESS) provides European statistics on meat consumption in different countries, which are freely available via the online database Eurostat. ESS is based on a partnership between the Commission (Eurostat), the national statistical institutes (NSIs), and the national authorities in individual member states. The main role of ESS is to harmonize statistics to provide comparable information at the European level (EC, 2011d). Eurostat presents statistics on consumption of commodities in FBSs as the gross human apparent consumption, which is “a proxy indicator for the availability of a commodity to the consumer.” Human consumption is defined as “the quantity of products placed at the disposal of human consumption in all forms: quantities consumed without modification and processed quantities,” and is quantified as “the balance between production, imports and exports, stock changes, and by its uses as food, waste, food manufacture, and others” (EC, 2011a).

Meat-consumption data in Eurostat are expressed in carcass weight (i.e., in raw weight excluding offal and hide but including weight for bones). Information on which body parts are included in the carcass weight of different animals is described in the manual for compilation of supply-balance sheets in Eurostat (EC, 2009), according to which food-supply data are adjusted for losses during stocking, transport, processing, and packing (i.e., up to the stage of retailing). No information has, however, been found on assumptions regarding the proportions assumed for bone weight in relation to carcass weight or on the magnitude of losses and wastage at different stages along the food-supply chain. Mixed products made from meat of several species (e.g., sausages) are included in the “other meat” balance. Further information on how consumption statistics for mixed-meat products are presented could not be found.

Statistics presented in Eurostat are mainly based on data collected by statistical authorities in individual member states, but also on data from unpublished national contributions, subsets of national contributions, and specifically designed European statistical surveys (ESS, 2011). Factors affecting the accuracy and reliability of national agricultural statistics have previously been described. As consumption statistics from different countries are based on various methods and assumptions, they may not be consistent and are thus not appropriate for direct comparison. After collection, data must therefore be harmonized to provide comparable statistics at the European level (EC, 2011d). To increase the quality, comparability, and reliability of European statistics, data should be produced, developed, and disseminated according to the uniform standards in the European Statistics Code of Practice (ESS, 2011).

**Global Statistics on Meat Consumption**

Global statistics on meat consumption in different countries and regions are provided on a yearly basis by the Food and Agriculture Organization of the United Nations (FAO) and are freely available via the online database FAOSTAT. FAO’s FBSs provide statistics on domestic supply quantities, defined as “the total quantity of the foodstuff produced in a

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3 See http://cpp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home.

4 See http://faostat.fao.org.
country added to the total quantity imported and adjusted to any change in stocks (from production to retail and all actors holding a stock of a meat-based commodity) that may have occurred since the beginning of the reference period.” In addition, the domestic use of each commodity is presented, with a distinction made between quantities fed to livestock (feed), used for seed (seed), processed for food and nonfood uses (processed), lost during storage and transportation (waste), available for human consumption at the retail level (food), and other use (other utilization). Food-supply data, expressed in metric tons or as kilograms per capita per year (kg/capita/year), are provided in FAOSTAT both under the category of “food supply” and in the FBSs (food-supply quantity, food). The food-supply data refer to the domestic supply quantity after a deduction for feed, seed, food manufacture, and waste (FAO, 2001; Jacobs & Sumner, 2002; FAO, 2012a).

In FAO’s FBSs, the supply of meat is expressed as carcass weight (i.e., weight including bones, unless otherwise stated, excluding pieces unfit for human consumption as well as inedible offal and unused fats) (FAO, 2011a; Westhoek et al. 2011). Food-supply data are adjusted for losses and waste at all stages between the level of production and household (i.e., during storage, transportation, processing, and retail). Data on average carcass weight in relation to live weight and on waste of supply of crops and derived products are presented in FAO’s publication on technical conversion factors for agricultural commodities (FAO, 2012b). However, no information has been found regarding the assumed proportions of bone weight in relation to carcass weight or assumed magnitude of losses and wastage of meat supply. FAO food-supply data include both the supply of primary commodities and processed foods derived therefrom, expressed in amounts of the original farm commodity. The amount needed to produce a processed food product is quantified based on technical conversion factors provided per commodity and country (FAO, 2012b).

Underlying data in the FBSs are based on a wide variety of sources of varying quality, including both official and unofficial documentation such as national trade and agriculture statistics, sample surveys, questionnaires, censuses, administrative records, and best estimates. Missing data are often estimated on the basis of surveys as well as technical expertise available at FAO (2001; 2012a).

The accuracy of data in FAO’s FBSs to a large extent depends on the quality of the underlying data in official national statistics. Factors affecting accuracy and reliability of national agricultural statistics have previously been described. As supply data from different countries may be produced via different methods and based on different assumptions, they may not be appropriate for direct comparison. To allow for international comparisons, data are adjusted by FAO before being disseminated (FAO, 2001; 2012a; Jacobs & Sumner, 2002).

Discussion

The purpose of this article is to identify uncertainties and discrepancies in meat-consumption statistics and to discuss their potential impact on assessments of environmental and health effects of dietary patterns. The results show various uncertainty factors in how these data are produced and highlight issues that encourage more subtle understanding and interpretation. We also find the transparency of information pertaining to methods and assumptions in the generation of food-consumption statistics deficient on Swedish, European (Eurostat), and international (FAOSTAT) levels.

The importance of accounting for uncertainties in consumption statistics has previously been noted and discussed. Serra-Majem et al. (2003), for example, identified significant differences in consumption data produced by different methods. One example was that the quantity of food consumed, indicated by data based on HBSs, in general is lower than that from FBSs, and that FBS data often overestimate food and nutrition intake compared to data based on IDSs. Other studies, which confirm that quantities indicated by data based on HBSs are typically lower compared to those predicated on FBSs, suggest that the differences are at least 20% (Sekula, 1993; Serra-Majem et al. 1993; Naska et al. 2009). Naska et al. (2009) compared food-consumption statistics from FBSs and HBSs in eighteen countries and demonstrated that the correlations between data derived from FSBs and HBSs are quite strong for vegetables, fruit, fish, and oil (+0.69 – +0.93), whereas the correlation is lower for meat and meat products (+0.39).

To interpret consumption statistics correctly, one must remember that per capita data refer to the average intake level in a population. Per capita consumption data thereby conceal considerable inherent variation among different groups, such as between men and women, adults and children, and across socioeconomic groups (especially in developing countries). To draw general conclusions and formulate recommendations within a population based on per capita figures can thus lead to certain errors of interpretation. For example, it is well known that men generally consume more meat than women (Beardsworth et al. 2002; Kubberød et al. 2002; Prättälä et al. 2007). Results from Swedish nationwide nutrition surveys have shown that average meat intake among men is 35% higher than among women (Becker &
Pearson, 1998). Differences in meat intake, as well as in nutrient requirements among population groups, has implications for the quantity of meat that can be considered healthy and should thus be taken into account when designing recommendations for meat consumption.

An incomplete understanding of meat-consumption data entails the risk that the statistics will not be used appropriately, which could have widespread implications for research findings and recommendations. One direct effect of the several existing definitions of meat consumption, which are based on varying methodologies and assumptions, is that meat-consumption data vary depending on the statistical source. For example, the official figure for per capita meat consumption in Sweden is 83 kg per year (data for 2009) (Eidstedt & Wikberger, 2011). However, estimates based on IDSs show that annual per person meat consumption in the country is only 66 kg (Lagerberg-Fogelberg, 2008) and according to FAO’s FBSs the figure is 75 kg (data for 2009) (FAO, 2012c). The calculation of nutrient intake and environmental impact from Swedish meat consumption will thus be heavily dependent on which data set is employed. Furthermore, meat-consumption statistics do not include information on production systems, which will have a significant impact on the environmental performance of various types of meat (i.e., from grass-fed cattle or indoor grain-fed cattle) (De Vries & De Boer, 2010).

When using meat-consumption statistics, it is thus important to know what the data actually represent, specifically whether i) consumption refers to agricultural supply, purchased amount, or actual intake, ii) consumption refers to bone-free weight, iii) food losses and waste are accounted for, iv) consumption refers to raw or cooked weight, and v) weight of nonmeat ingredients in mixed-meat products are accounted for. Methodological descriptions providing this information are, however, often difficult to find and to interpret. An accessible and clear presentation of meat-consumption data, which outlines the procedures used to generate the information and documents the underlying assumptions, would facilitate appropriate usage and interpretation.

The factors that contribute to discrepancies in meat-consumption data may individually affect the data by 15–50%. A simple quantitative example illustrates how these factors can influence meat-consumption data. As previously mentioned, annual per capita meat consumption in Sweden was 75 kg in 2009 according to FAO supply data. However, the actual intake of meat, after adjustment for bone weight, household-food losses and waste, and weight reduction in cooking, is markedly lower. If the intake were adjusted for bone weight, annual per capita meat consumption in the country would be reduced to approximately 53 kg (assuming that bone-free weight represents 70% of carcass weight). If adjusted for household-food spoilage and waste (assumed to represent 11% of purchased weight) (FAO, 2011b) and weight reduction by cooking (assumed to be 30% of raw weight), the actual annual per capita intake of cooked, bone-free meat in Sweden would be approximately 33 kg.

On one hand, in environmental assessments, meat-supply data, expressed as raw meat including bones, are often used as the basis for calculations. When studying health effects or nutritional intake, on the other hand, data on actual consumption, expressed as uncooked or cooked meat, are generally employed. The example above shows that annual per capita meat consumption may differ by a factor of two or more depending on the data series. There is an obvious risk of mixing these data when consumption statistics are used for subsequent calculations of, for example, environmental and health effects. In environmental assessments of meat and in dietary recommendations, it is thus crucial to specify the functional unit and to define whether it refers to meat, including or excluding bones, and whether it is after weight reduction by cooking, as well as if losses in distribution and consumer level are included. The choice of meat-consumption data should further correspond to the functional unit in calculations used to formulate recommendations and policy decisions.

Conclusions and Recommendations

We have discussed the reliability of meat-consumption statistics with the aim of identifying limitations, strengths, and uncertainties in methods and data. The results show various discrepancies regarding how meat-consumption data are produced and presented, awareness of which is important for a correct understanding and interpretation of the statistics. Increased attentiveness to these issues, in turn, will have a significant impact on diet recommendations and policy tools related to health and environmental issues, such as climate change and land use.

We advance several recommendations to improve the production, presentation, and use of meat-consumption statistics. First, the definitions of meat consumption and supply on national, regional, and international levels should be standardized and harmonized to the greatest extent possible. Second, methods for obtaining meat-consumption data should be of the highest possible quality to ensure high statistical validity. Third, relevant national, regional, and international statistical agencies should enhance the transparency of meat-consumption data. Fourth, assumptions regarding weight of bones and other
inedible body parts of the animal, food losses and waste in the stages up to and after retail sale, weight reductions due to cooking, and nonmeat components in mixed-meat products and prepared meals, should be presented in a more accessible and straightforward manner. Finally, limitations, uncertainties and discrepancies in meat-consumption data should be addressed for correct utilization in subsequent calculations of, for instance, the environmental and health effects of meat.

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