

Management Information System administered by the Ministry of Health, and the Central Public Health Laboratory) on acute diarrhoea (1.9 million reported outpatient cases in 2012, approximately 5700 cases per 100 000; case definition: three or more watery stools in 24 hours but not lasting for more than 14 days), cholera, dysentery, brucellosis, hepatitis E and typhoid fever. Parasitic infections are reported as worm infections or intestinal worm infections. Although such infections are very common (approximately 1.8 million outpatient infections reported annually), aetiological data are few.

The reliability of these data has improved steadily with increased access to healthcare since 2000. Uganda has undergone a number of reforms that have influenced health service delivery. Among the major reforms, conducted in the early 1990s, was the decentralized governance of districts, with attendant devolution of powers to allocate resources and deliver services, including health care. Physical access to health facilities for the population living within 5 km of a health facility increased from 49% in 2001 to 72% in 2004 [241].

Other sources of data included the Ministry of Agriculture, Animal Industry and Fisheries; the Ministry of Trade, Industry and Cooperatives; the Ministry of Water and Environment; the Ministry of Local Government and Local Authorities; and research and academic institutions.

Of the chemical hazards, the most data were available for aflatoxins, with information on the prevalence of contamination for relevant foods being available. The incidence of hepatocellular carcinoma, an important health outcome of aflatoxin exposure, is also available. Acute poisoning due to methanol in illicit alcoholic beverages is often reported. Despite cassava consumption being high

in parts of Uganda, no reports of acute cyanide poisoning, *konzo* or tropical ataxic neuropathy were found.

It was important that both waterborne and foodborne transmission of diseases were included in the Ugandan study, as food safety was not considered to be independent from water safety. It was difficult to generate DALY estimates from the available data, particularly due to the shortage of community-level incidence data.

## 7.5 Findings and Lessons Learned

### 7.5.1 Data gaps

A lack of data prevented DALY calculations in several of the pilot studies. The data gaps included:

- ▶ information to assign aetiology for important syndromes such as acute gastrointestinal disease and parasitic infections;
- ▶ data on the incidence of diseases caused by some hazards, particularly chemical hazards; and
- ▶ limited outbreak and other data on which to base attribution for foodborne transmission.

### 7.5.2 Public and private data sources

In some countries, private hospitals provide a significant proportion of the available healthcare, and may not have the same reporting requirements as public hospitals [242]. Engagement with private hospitals and other facilities to provide a complete picture of the incidence of diseases caused by foodborne hazards may need to be specifically addressed. Data from primary producers and the food industry concerning foodborne hazards can be gathered, but economic implications, particularly for trade, mean that such data should be carefully handled and with discretion.

### 7.5.3 Foodborne versus waterborne disease

The separation of food and water as exposure vehicles for attribution purposes is often useful as different regulatory agencies may have responsibility for each source. However, at a community level, the differentiation between food and water may not be sensible in terms of how risks are managed. These issues should be specifically considered in a national burden study.

### 7.5.4 Situation analysis and knowledge translation

Social scientists, stakeholders and decision-makers need to be included in the study team from the earliest stages in order to effectively support knowledge translation and the development of science-based policies. Their involvement includes developing a situation analysis (for an example see [243]), and early and continuous efforts to recognize and incorporate knowledge translation and risk communication to audiences identified in the situation analysis. Differences in experience and perspectives can make collaboration between the social scientists and epidemiological/food safety technical participants challenging.

Knowledge translation and risk communication are usually specialist activities, and require on-going commitment and resources [244]. In order to promote uptake of research results, identified barriers and facilitators are described in the SA/KT/RC Manual.

Barriers to knowledge translation include:

- ▶ *Limitations resulting from lack of data and information.* Incomplete information, with associated caveats and uncertainty, may prevent clear conclusions being drawn for policy.
- ▶ *Differing time pressures.* Research may take months or years to complete, whereas policy-makers usually need to produce decisions in much shorter timeframes.
- ▶ *The weighting of evidence may differ.* Scientists are likely to value data and analysis most highly, whereas policy-makers may be also influenced by personal experience, anecdotal information, political and economic considerations, and other factors.

Knowledge translation can be facilitated by:

- ▶ *Strong personal relationships between researchers and policy-makers.* Face to face meetings and direct conversations can promote trust and credibility, and support formal written reports.
- ▶ *Presenting the results of research so that they address risk management questions.* Such questions are best formulated and delivered by policy-makers at the commencement of the research, but researchers should always expect to address questions of effectiveness, cost, and high risk groups.

## 7.6 Discussion

The pilot studies of national burdens-of-foodborne disease, initiated by WHO, have promoted the importance of such studies amongst the participating countries and disseminated internationally accepted methodology for such estimates. Few DALY estimates could be calculated, but this was not unexpected, due to data gaps. The first attempt at conducting such studies has

identified challenges in both process and information, including the recognition that data collection and analysis, development of situation analysis, and on-going knowledge translation and risk communication, require commitment of time and financial resources.

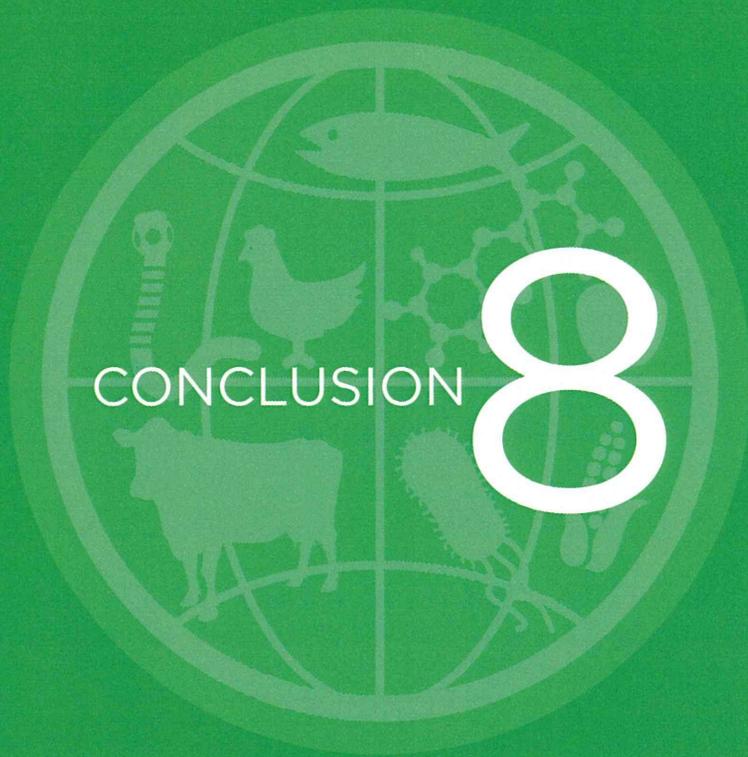
The WHO initiative has provided burden of foodborne disease estimates from global and regional perspectives. These estimates provide context and can fill many of the data gaps for individual countries undertaking foodborne burden-of-disease studies. In particular, the provision of aetiology estimates for syndromic surveillance data, and attribution estimates for foodborne disease, will be particularly difficult for studies in developing countries to address individually.

The Global Burden of Disease 2010 Study (GBD2010), undertaken by IHME, Seattle, USA, covers a broad range of disease and injuries, and has published country-specific estimates for these on its website [245]. Foodborne diseases are a subset of these estimates, although estimates are typically not stratified by transmission route. National foodborne disease studies as promoted by WHO and FERG include consideration of the national context in

a situation analysis (such as the existing national food control system). In addition, the WHO initiative sought to foster the knowledge translation of burden of disease data into policy through on-going cross-agency communication. Such activities are best undertaken by people from within a country.

National burden of foodborne disease studies, particularly in developing countries, now have an opportunity to fill data gaps, and assign aetiology and attribution to the incidence of foodborne diseases, using the data from the WHO initiative to augment local data. Such local data can also be used as a cross check to validate national estimates derived from regional estimates. This should allow the generation of at least preliminary burden estimates to inform national policy. The effective delivery of this information can be guided by the considerations and tools provided in the SA/KT/RC Manual. In the longer term, burden of foodborne disease information should be a fundamental component of a systematic approach to food safety, such as the risk management framework advocated by Codex [246]. Such an approach can enhance both public health and trade.







## CONCLUSION

This report presents the first global and regional estimates of the burden of foodborne diseases. The large disease burden from food highlights the importance of food safety, particularly in Africa, South-East Asia and other more greatly affected regions. Our results indicate that some hazards, such as non-typhoidal *S. enterica*, are important causes of FBD in all regions of the world, while others – such as certain parasitic helminths and aflatoxin – are of highly focal nature resulting in high local burden.

Despite the data gaps and limitations of these initial estimates, it is apparent that the global burden of FBD is considerable, and affects individuals of all ages, but particularly children <5 years of age and persons living in low-income regions of the world. By incorporating these estimates into policy development at both national and international levels, all stakeholders can contribute to improvements in safety throughout the food chain. These results will also help to direct future research activities.

### 8.1 Reflections on the WHO Initiative to Estimate the Global Burden of Foodborne Diseases

When the WHO Foodborne Disease Burden Epidemiology Reference Group (FERG) first met in September 2007, they were convinced of the necessity to present estimates of the global burden of foodborne disease, but did not yet know if, and how, it could be done. They were aware of national studies on the burden of foodborne diseases, but recognized that attempting a global estimate was a daunting task. The sheer complexity of the problem was challenging: food consumption across the globe is highly diverse and the range of potential contaminants in the food supply is astounding. Yet, with the help of an

army of more than a hundred scientists, specialized in their own fields, it turned out to be possible to present the first ever estimates of the global burden of foodborne disease. The process took eight years and an uncounted number of hours. All involved donated their time and experience to WHO, finding own sources of funding in addition to the limited means available and invested liberal amounts of personal time. In particular the Core Group (Task Force chairs and senior advisers) spent their time in numerous teleconferences at sometimes highly inconvenient hours, in particular for the colleagues from Australia and New Zealand. Initially annual meetings were organized, creating momentum and commitment. The global financial crisis inevitably hit FERG, and much more reliance was placed on teleconferences and other means of remote communication, slowing down the process and limiting the involvement to the Core Group mainly. Nevertheless, all FERG members and resource advisers continued to believe in and support the Initiative.

The global burden of foodborne disease was estimated in several distinct steps, building on established methods for estimating burden, as expressed in Disability Adjusted Life Years (DALYs). First, incidence of food-related diseases, including some chronic sequelae and mortality, were estimated for 31 hazards that were considered to contribute significantly to the burden, and for which sufficient data were available. The hazards included 18 enteric pathogens, 10 parasitic diseases and 3 toxic chemicals. For 5 hazards, the data were insufficient to present global estimates, and data were presented for high-income regions only. Next, information was generated on duration and severity of the incident cases of disease to produce estimates of Years Lived with Disability (YLD)

and on the number of Years of Life Lost (YLL) due to premature mortality. Many foodborne hazards are not exclusively transmitted by food, and a separate effort was set up for the attribution of exposure to different sources, including food, the environment and direct contact between humans or with animals. As many data are lacking for attribution, it was decided to apply structured expert elicitation to provide a consistent set of estimates. The global expert elicitation study involved 73 experts and 11 elicitors, and was one of the largest, if not the largest study, of this kind ever undertaken. Combining all streams of data resulted in estimates of the global burden of foodborne disease.

Unlike previously completed national burden of illness studies, FERG decided to also include chemical hazards. The inclusion of chemical hazards was particularly challenging, and it was only through determined efforts by the Chemicals and Toxins Task Force (CTTF) that several chemical hazards could be included. Whereas WHO committees such as the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and Joint FAO/WHO Meeting on Pesticide Residues (JMPR) typically use a risk assessment approach, a counterfactual attribution approach is commonly applied in global burden estimates of cancer, cardiovascular and other diseases. Deciding which of these approaches was most appropriate for FERG was a difficult, and as yet not fully resolved, process. As a result, burden estimates for several important chemical contaminants (methylmercury, lead, arsenic and cadmium) are expected to be presented at a later stage.

Even though all efforts were made to include the best available science in the estimates, FERG is fully aware of the limitations of the current work. Data

needs for burden of illness estimates are high, and crucial information was often lacking, particularly for some of the world's most populous countries, such as China, India and Russia. FERG used statistical models and expert input to estimate some missing data. In particular, Bayesian regression modelling has been used to estimate missing disease incidence data.

Due to the limitations in data availability, FERG decided to present its estimates on a regional level, even though all calculations were made on a national level. The regional estimates are considered more robust as they build on data from several countries in most regions. Yet, the regional estimates do not reflect the diversity of risks between countries in a region, or even within a country. Maps are therefore not presented as it was considered that these would not adequately reflect regional heterogeneity.

The results of the FERG project are presented in several formats. A PLOS collection entitled "The World Health Organization Estimates of the Global Burden of Foodborne Diseases", which can be accessed at a dedicated website.<sup>1</sup> The website presents the key results in a series of seven peer-reviewed papers, and also provides access to a large and growing number of reviews and description of methods that have been published in different peer-reviewed journals. This large body of evidence reflects the considerable support given to FERG by the global scientific community. These papers are also accessible through a dedicated WHO website.<sup>2</sup> WHO has also produced this report, documenting the results and the process of estimating

<sup>1</sup> <http://collections.plos.org/ferg-2015> accessed 2 December 2015

<sup>2</sup> [http://www.who.int/foodsafety/areas\\_work/foodborne-diseases/ferg/en/](http://www.who.int/foodsafety/areas_work/foodborne-diseases/ferg/en/) accessed 3 November 2015

the global burden of foodborne disease and an interactive website allowing stakeholders to explore the results from different perspectives.

Even though the currently presented burden of foodborne disease is substantial, it was not feasible to document the full burden, which is likely to be considerably higher. Not all relevant contaminants could be included, and for those that were included, not all relevant endpoints could be taken into account. FERG selected a shortlist of hazards at the onset, reducing a list of more than 100 contaminants to 40. Exclusions were based on initial judgments about the importance of the global or regional burden, but also on data availability. Of the 40 contaminants selected, analyses have not been completed for lead, methyl mercury, arsenic and cadmium for inclusion in this report. Of potentially relevant endpoints, only Guillain-Barré syndrome and haemolytic uraemic syndrome and invasive salmonellosis were included as outcomes for diarrhoeal diseases, but not irritable bowel syndrome or other functional bowel disorders that are increasingly linked to diarrhoeal disease in developed countries and are associated with a substantial burden. FERG estimates do not include the effects of foodborne diseases on malnutrition and development in low- and middle-income countries, and invasive salmonellosis in HIV co-morbid cases was also excluded, even though a major proportion of these infections may be foodborne. No stillbirths were included for listeriosis and toxoplasmosis, but many would be preventable by appropriate food safety interventions. The counterfactual approach for chemicals produces lower estimates than risk assessment approach

(as documented for aflatoxin, see Section 6.4).

Countries who want to build their national food safety strategies are advised to combine the global estimates with national data. It is our experience that a vast amount of additional data exist but has not yet been mined because it is not available in easily accessible databases but rather in paper form. Building on such data may provide sources of validation for any estimates derived from FERG numbers. As a next step, further development of national laboratory-based surveillance programs, should be a priority.

A crucial element of the initiative, often taking a back seat during the huge effort in generating global and regional burden estimates, was therefore the promotion of foodborne burden of disease studies and capacity building in individual countries. FERG was only able to make limited progress towards this objective, in the form of pilot studies in four countries. Since some of these pilot studies encountered significant resource barriers and data shortages, it is hoped that one legacy of the initiative would be to help overcome these through local use of regional estimates. Individual countries can evaluate and apply the FERG regional burden estimates to generate national DALY-based burden data for foodborne illness prioritization. Such a process should include local data for validation where available, and be undertaken by local scientists with an awareness of the food safety context in their country. FERG has also sought to promote knowledge translation of burden of disease estimates into food safety policy at a national level.

