Programme

Tuesday 15 December 2015

08.00-08.45 **Registration**

Opening session

Chair

Joke van der Giessen | WHO Collaborating Centre Risk Assessment of Pathogens in Food and Water, *National Institute for Public Health and the Environment, Bilthoven, the Netherlands*

08.45-09.30 Welcome speeches
Keiji Fukuda | *World Health Organization, Geneva, Switzerland*
André van der Zande | *National Institute for Public Health and the Environment, Bilthoven, the Netherlands*
Arie Havelaar | *Chair Foodborne Disease Burden Epidemiology Reference Group (FERG). University of Florida, Gainesville, FL, USA*

Session 1: Report from FERG Task Forces

Chairs

Keiji Fukuda | *World Health Organization, Geneva, Switzerland*
Jaap van Dissel | *National Institute for Public Health and the Environment, Bilthoven, the Netherlands*

09.30-09.55 **Brecht Devleesschauwer** | *University of Florida, Gainesville, FL, USA; Ghent University, Merelbeke, Belgium*
Methodological Framework for World Health Organization Estimates of the Global Burden of Foodborne Disease

09.55-10.20 **Tine Hald** | *National Food Institute, Technical University of Denmark, Sørborg, Denmark*
Source Attribution Estimates of the Relative Contributions to the Burden of Disease due to Selected Foodborne Hazards: a WHO Expert Elicitation

10.20-10.30 Discussion

10.30-11.00 Break

11.00-11.25 **Martyn Kirk** | *Australian National University, Canberra, Australia*
The Burden of Disease Caused by Enteric pathogens

11.25-11.50 **Paul Torgerson** | *Vetsuisse Faculty, Zurich, Switzerland*
The Burden of Disease Caused by Foodborne Parasites

11.50-12.15 **Herman Gibb** | *Gibb Epidemiology Consulting, LLC, Arlington, VA, USA*
The Burden of Disease from Chemicals in Food

12.15-12.30 Discussion

12.30-13.30 Lunch

Session 2: General Discussion and next steps towards better estimates

Chairs

Claudia Stein | *World Health Organization, Regional Office for Europe, Copenhagen, Denmark*
Hans van Oers | *National Institute for Public Health and the Environment, Bilthoven, the Netherlands*

13.30-14.00	General discussion
14.00-14.25	**Colin Mathers**	*World Health Organization, Geneva, Switserland* The Global Burden of Foodborne Disease – a WHO Technical Perspective
14.25-14.50	**David Pigott**	*Institute for Health Metrics and Evaluation, University of Washington, USA and Wellcome Trust Centre for Human Genetics, University of Oxford, UK* The Burden of Foodborne Disease – an IHME Perspective
14.50-15.00	Discussion
15.00-15.30	Break
15.30-16.30	Discussion on next steps towards better estimates
16.30-18.00	Networking reception

Wednesday 16 December 2015

Session 3 : From Science to Public Health Policy

Chairs

Renata Clarke | *Office of Food Safety, Food and Agriculture Organization of the United Nations, Rome, Italy*
David Goldman | *Food Safety and Inspection Service, USDA, Washington DC, USA*

09.00-09.25	**Arie Havelaar**	*University of Florida, Gainesville, FL, USA* The Global Burden of Foodborne Disease: Overview and Implications
09.25-09.50	**Rob Lake**	*Institute of Environmental Science and Research (ESR), Christchurch, New Zealand* Country Studies as a Component of the WHO Initiative to Estimate The Global Burden of Foodborne Disease
09.50-10.15	**Frederick Angulo**	*Centers for Disease Control and Prevention, Atlanta, Georgia, USA* The Global Burden of Foodborne Disease: From Science to Public Health Policy
10.15-10.30	Discussion
10.30-11.00	Break
11.00-12.30	Country testimonials **Karen Keddy**	*National Institute for Communicable Diseases, Johannesburg, South Africa* **Yuko Kumagai**	*National Institute of Infectious Diseases, Ministry of Health, Labour and Welfare, Tokyo, Japan* **Gijs Theunissen**	*Ministry of Economic Affairs, the Hague, the Netherlands* **Lisa Indar**	*Caribbean Public Health Agency, Port of Spain, Trinidad and Tobago* **Patricia Griffin**	*Centers for Disease Control and Prevention, Atlanta, GA, USA* **Mohammad Rokni**	*Tehran University of Medical Sciences, Iran*
12.30-13.30	Lunch

Session 4: Testimonials from stakeholders

Chairs

Kazuaki Miyagishima | *World Health Organization, Geneva, Switzerland*
Arie Havelaar | *University of Florida, Gainesville, FL, USA*

13.30-15.00	Use of estimates by stakeholders **Awilo Ochieng-Pernet**	*Chairperson, Codex Alimentarius Commission; Federal Food Safety and Veterinary Office, Bern, Switzerland* **Markus Lipp**	*Food and Agriculture Organization of the United Nations, Rome, Italy* **Laura Lamberti**	*Bill & Melinda Gates Foundation, Seattle, WA, USA* **Leon Gorris**	*Unilever R&D, Vlaardingen, the Netherlands* **Barbara Kowalcyk**	*Center for Foodborne Illness Research & Prevention, Raleigh, NC, USA* **Gillian Mylrea**	*World Organization for Animal Health (OIE), Paris, France*
15.00-15.30	Discussion
15.30	**Kazuaki Miyagishima**	*World Health Organization, Geneva, Switserland* WHO vision on future steps towards a safer global food supply
16.00	Closing of symposium

Abstracts

Brecht Devleesschauwer | *University of Florida, Gainesville, FL, USA; Ghent University, Merelbeke, Belgium*

Methodological Framework for World Health Organization Estimates of the Global Burden of Foodborne Disease

In 2012, the Foodborne Disease Burden Epidemiology Reference Group (FERG) established a Computational Task Force (CTF) to transform epidemiological information into foodborne disease (FBD) burden estimates.

The global and regional burden of 31 FBDs was quantified, along with limited estimates for 5 other FBDs, using Disability-Adjusted Life Years in a hazard- and incidence-based approach. To accomplish this task, the following workflow was defined: outline of disease models and collection of epidemiological data; design and completion of a database template; development of an imputation model; identification of disability weights; probabilistic burden assessment; and estimating the proportion of the disease burden by each hazard that is attributable to exposure by food (i.e., source attribution). All computations were performed in R and the different functions were compiled in the R package 'FERG'. Traceability and transparency were ensured by sharing results and methods in an interactive way with all FERG members throughout the process.

The CTF developed a comprehensive framework for estimating the global burden of FBDs, in which methodological simplicity and transparency were key elements. All developed tools have been made available and can be translated into a user-friendly national toolkit for studying and monitoring food safety at the local level.

Tine Hald | *National Food Institute, Technical University of Denmark, Søborg, Denmark*

Source Attribution Estimates of the Relative Contributions to the Burden of Disease due to Selected Foodborne Hazards: a WHO Expert Elicitation

The Foodborne Disease Burden Epidemiology Reference Group (FERG) was established in 2007 by the World Health Organization (WHO) to estimate the global burden of foodborne diseases (FBDs). This estimation is complicated because most of the hazards causing FBD are not transmitted solely by food; most have several potential transmission routes including transmission from animals, humans, and environmental routes including water. This paper describes an expert elicitation study conducted by the FERG Source Attribution Task Force to estimate the relative contribution of food to the global burden of diseases commonly transmitted through the consumption of food.

We applied structured expert judgment using Cooke's Classical Method to obtain estimates for 14 sub regions for the relative contributions of different transmission pathways for eleven diarrheal diseases, seven other infectious diseases and one chemical (lead). Experts were identified through international networks followed by social network sampling. Final selection of experts was based on their experience including international working experience. Enrolled experts were scored on their ability to judge uncertainty accurately and informatively using a series of subject-matter specific "seed" questions whose answers are unknown to the experts at the time they are interviewed. Trained facilitators elicited the 5^{th}, and 50^{th} and 95^{th} percentile responses to seed questions through telephone interviews. Cooke's classic method uses responses to the seed questions to weigh and aggregate expert responses. After this interview, the experts were asked to provide 5^{th}, 50^{th}, and 95^{th} percentile estimates for the "target" questions regarding disease transmission routes.
A total of 72 experts were enrolled in the study. Ten panels were global meaning that the experts should provide estimates for all 14 sub regions, whereas the 9 panels were sub regional, meaning that experts were allocated to provide estimates for one or more sub regions depending on their experience in the region. The size of the 19 hazard-specific panels ranged from 6 to 15 persons with several experts serving on more than one panel.

Pathogens with animal reservoirs (e.g. non-typhoidal *Salmonella* spp. and *Toxoplasma gondii*) were in general assessed by the experts to have a higher proportion of illnesses attributable to food than pathogens with mainly a human reservoir, where human-to-human transmission (e.g. *Shigella* spp. and Norovirus) or waterborne transmission (e.g. *Salmonella* Typhi and *Vibrio cholerae*) were judged to dominate. For many pathogens, the foodborne route was assessed as relatively more important in developed sub regions than in developing sub regions. The main exposure routes for lead varied across sub regions, with the foodborne route being assessed most important only in two sub regions of the European region.
For the first time, we present worldwide estimates of the proportion of specific diseases attributable to food and other major transmission routes. These estimates are essential for global burden of FBD estimates. While gaps exist, we believe the estimates presented here are the best current source of guidance to support decision makers when allocating resources for control and intervention, and for future research initiatives.

Martyn Kirk | *Australian National University, Canberra, Australia*

The Burden of Disease Caused by Enteric pathogens

Foodborne diseases are important worldwide, resulting in considerable morbidity and mortality. We present the first global and regional estimates of the disease burden of the most important foodborne bacterial, protozoal, and viral diseases. We synthesized data on the number of foodborne illnesses, sequelae, deaths, and Disability Adjusted Life Years (DALYs), for all diseases with sufficient data to support global and regional estimates, by age and World Health Organization region. The data sources included varied by pathogen and included systematic reviews, cohort studies, surveillance studies and other burden of disease assessments. We sought relevant data circa 2010, and included sources from 1990–2012. The number of studies per pathogen ranged from as few as 5 studies for bacterial intoxications through to 494 studies for diarrheal pathogens.

To estimate mortality for *Mycobacterium bovis* infections and morbidity and mortality for invasive non-typhoidal *Salmonella enterica* infections, we excluded cases attributed to HIV infection. We excluded stillbirths in our estimates. We estimate that the 22 diseases included in our study resulted in two billion (95% uncertainty interval [UI] 1.5 - 2.9 billion) cases, over one million (95% UI 0.89 - 1.4 million) deaths, and 78.7 million (95% UI 65.0 - 97.7 million) DALYs in 2010.

To estimate the burden due to contaminated food, we then applied proportions of infections that were estimated to be foodborne from a global expert elicitation. Waterborne transmission of disease was not included. We estimate that 29% (95% UI 23 - 36%) of cases caused by diseases in our study, or 582 million (95% UI 401 - 922 million), were transmitted by contaminated food, resulting in 25.2 million (95% UI 17.5 - 37.0 million) DALYs. Norovirus was the leading cause of foodborne illness causing 125 million (95% UI 70 - 251 million) cases, while *Campylobacter* spp. caused 96 million (95% UI 52 - 177 million) foodborne illnesses. Of all foodborne diseases, diarrheal and invasive infections due to non-typhoidal *S. enterica* infections resulted in the highest burden, causing 4.07 million (95% UI 2.49 - 6.27 million) DALYs. Regionally, DALYs per 100,000 population were highest in the African region followed by the South East Asian region.

Considerable burden of foodborne disease is borne by children less than five years of age. Major limitations of our study include data gaps, particularly in middle- and high-mortality countries, and uncertainty around the proportion of diseases that were foodborne. Foodborne diseases result in a large disease burden, particularly in children. Although it is known that diarrheal diseases are a major burden in children, we have demonstrated for the first time the importance of contaminated food as a cause. There is a need to focus food safety interventions on preventing foodborne diseases, particularly in low- and middle-income settings.

Paul Torgerson | *Vetsuisse Faculty, Zurich, Switzerland*

World Health Organization Estimates of the Global and Regional Disease Burden of 11 Foodborne Parasitic Diseases, 2010

Parasitic diseases often result in high burdens of disease in low and middle income countries and are frequently transmitted to humans via contaminated food. This study presents the first estimates of the global and regional human disease burden of 10 helminth diseases and toxoplasmosis that may be attributed to contaminated food.

Data was abstracted from 16 systematic reviews or similar studies published between 2010 and 2015, from 5 disease data bases accessed in 2015, and from 79 reports, 73 of which have been published since 2000, 4 published between 1995 and 2000 and 2 published in 1986 and 1981. These included reports from national surveillance systems, journal articles, and national estimates of foodborne diseases. This data was used to estimate the number of infections, sequelae, deaths, and Disability Adjusted Life Years (DALYs), by age and World Health Organization (WHO) region for 2010.

These parasitic diseases, resulted in 48.4 million cases (95% Uncertainty intervals [UI] of 43.4 -79.0 million) and 59,724 (95% UI 48,017 - 83,616) deaths annually resulting in 8.78 million (95% UI7.62 - 12.51 million) DALYs. We estimated that 48% (95% UI38% - 56%) of cases of these parasitic diseases were foodborne, resulting in 76% (95% UI 65% - 81%) of the DALYs attributable to these diseases. Overall, foodborne parasitic disease, excluding enteric protozoa, caused an estimated 23.2 million (95% UI 18.2 - 38.1 million) cases and 45,927 (95% UI 34,763 - 59,933) deaths annually resulting in an estimated 6.64 million (95% UI 5.61 - 8.41 million) DALYs.
Foodborne *Ascaris* infection (12.3 million cases, 95% UI 8.29 - 22.0 million) and foodborne toxoplasmosis (10.3 million cases, 95% UI 7.40 - 14.9 million) were the most common foodborne parasitic diseases. Human cysticercosis with 2.78 million DALYs (95% UI 2.14 - 3.61 million), foodborne trematodosis with 2.02 million DALYs (95% UI 1.65 - 2.48 million) and foodborne toxoplasmosis with 825,000 DALYs (95% UI 561,000 - 1.26 million) resulted in the highest burdens in terms of DALYs, mainly due to years lived with disability.
Foodborne enteric protozoa, reported elsewhere, resulted in an additional 67.2 million illnesses or 492,000 DALYs. Major limitations of our study include often substantial data gaps that had to be filled by imputation and suffer from the uncertainties that surround such models. Due to resource limitations it was also not possible to consider all potentially foodborne parasites (for example *Trypanosoma cruzi*).

Parasites are frequently transmitted to humans through contaminated food. These estimates represent an important step forward in understanding the impact of foodborne diseases globally and regionally. The disease burden due to most foodborne parasites is highly focal and results in significant morbidity and mortality among vulnerable populations.

Herman Gibb | *Gibb Epidemiology Consulting, LLC, Arlington, VA, USA*

The Burden of Disease from Chemicals in Food

Groups of foodborne chemicals, both natural and anthropogenic, were evaluated by the Chemical and Toxins Task Force for their potential to contribute to the burden of disease. Hazards were ranked on (1) the severity of potential health effects, (2) the prevalence of exposure, and (3) the availability of data to make estimates. Eight chemicals were chosen for analysis; the results for four of these chemicals (cyanide in cassava, peanut allergen, aflatoxin, and dioxin) are presented here.

Cyanide in cassava is associated with *konzo*, an irreversible spastic paraparesis of sudden onset. Although cassava is an important staple for over 800 million people in approximately 80 countries, estimates of *konzo* disease and mortality could be made for only six countries in Africa because of limited information. *Konzo* affects remote rural areas; thus many cases remain undiagnosed or unreported. The case-fatality rate of *konzo* is estimated to be 21%.

Aflatoxins are secondary metabolites of the fungi *Aspergillus flavus* and *Aspergillus parasiticus* and less frequently other *Aspergillus* species. These species are found in food crops, particularly maize, peanuts (groundnuts), oilseeds, and tree nuts in tropical and subtropical regions worldwide. Aflatoxin is associated with an increased risk of hepatocellular carcinoma (HCC) for which the survival rate is extremely poor (< 10% over 5 years).

Due to the bioaccumulating and lipophilic characteristics of dioxin, daily dietary exposure leads to accumulation of these compounds in human body fat. Dioxin is mainly found in meat and dairy products, fish, and shellfish and is associated with increased risks of infertility and hypothyroidism.

In developed countries, the prevalence of clinical peanut allergy in children is as high as 1.8%. Unlike other childhood allergies, peanut allergy rarely resolves. Virtually all human exposure to these four chemicals is through the food supply.

For 2010, the total number of illnesses, deaths, and DALYs for the four chemicals is estimated to be 339,000 (95% Uncertainty Interval [UI]: 186,000-1,239,000); 20,000 (95%UI: 8,000-52,000); and 1,012,000 (95%UI: 562,000-2,822,000), respectively.

Colin Mathers | *World Health Organization, Geneva, Switzerland*

The Global Burden of Foodborne Disease – a WHO Technical Perspective

WHO published the first Comparative Risk Assessment results in 2004, implementing a consistent framework, standards and criteria for causality and hazard assessment for 22 global risk factors. These analyses were updated and extended to 24 global risks in a report published in 2009.

Additionally, WHO has published comprehensive assessments of burden of disease for around 130 causes of death, disease and disability, most recently for years 2000 to 2012. This talk will review WHO standards and criteria for burden of disease and comparative risk assessment, and particularly focus on the criteria for calculation and clearance of assessments of the mortality and DALYs attributable to risk exposures. It will review the range of methodological and data issues arising in the FERG work on assessment of the attributable burden of foodbourne disease and examine a few specific examples in more detail.

The final discussion will attempt to identify some lessons learned and recommendations for future work in this area.