- the global burden of cystic echinococcosis;
- the global burden of neurocysticercosis;
- the global burden of aflatoxicosis; and
- the global burden of cassava cyanide ingestion.

In addition, the FERG experts appraised the progress made on the systematic reviews commissioned for other enterics, parasites and chemicals, and on the protocols to be used in the source attribution expert elicitation process and in the national FBD burden assessments and policy situation analyses. Each TF also made recommendations for new commissioned work.

The various TFs adopted their work plans for 2011 and beyond, which covered the continuation of the systematic reviews, the finalization of the pathogen priority lists, and the further strengthening of the interfaces between the different TFs. The Country Studies Task Force made the final preparations for initiating the pilot country studies in 2011. Four countries were selected for these studies: Albania, Japan, Thailand and Uganda.

July 2010 Mid-term evaluation commissioned from an external consultant

The overall verdict of this evaluation of the World Health Organization Initiative to Estimate the Global Burden of foodborne diseases was that it was making good progress. FERG experts and stakeholders considered it to be a very important Initiative and were in agreement with its goals and objectives. They recognized that information on the burden of foodborne diseases is required at country, regional and global levels in order to prioritize food safety interventions. The leadership and management of the Initiative by the WHO Secretariat was highly praised by the FERG experts, and described very favourably in comparison with other international advisory bodies in which some of the experts had been involved.

FERG experts recognized the complexity of the Initiative, and some reported that at the outset they had doubts about whether it was achievable. However, they had found that challenges had been overcome and continued to be addressed, many products were being produced and some had already been finalized. The project was being managed very energetically, and they expected successful outcomes in due course.

There was also a high satisfaction level with the guidance and direction of the FERG and Task Force Chairs. The global and regional representation of the FERG membership was valued and FERG experts reported that through their involvement, many of them had increased their own capacity. Stakeholder involvement was valued by FERG experts and by the stakeholders themselves. Continued expansion of stakeholder constituencies was also suggested by both groups.

A high quality of all outputs was considered very important by FERG experts, and should be maintained. Most FERG experts were satisfied with the outputs already produced– pathogen- and hazard-specific mortality and morbidity reports– although there was acknowledgement that there had been delays (some of which might not have been avoidable), and that there remained a lot more work to be done. The delays occurred initially and were mostly considered inevitable. They were dealt with, and FERG experts considered that the Initiative was progressing according to plan. Stakeholders were satisfied with the results presented at stakeholder meetings to date, and they looked forward to the production of more results.

The advocacy efforts of the coordinator of the Initiative were praised and considered to be very effective.

The main challenge to the Initiative was how to deal with the expansion to the scope of the Initiative. The need to plan to collect primary data, overcome methodological challenges, integrate knowledge translation and respond appropriately to the 63rd World Health Assembly (WHA) resolution on food safety- all these were part of the expanded scope of the Initiative. FERG experts were in agreement that the expansion of the scope was necessary and appropriate. Because quality must be maintained, adjustments must be made to timelines and resources. Timelines can be reviewed, but FERG experts and stakeholders stated that there was a limitation on timeline extension due to the risk of loss of momentum, and there was also the need to fulfil Member State and donor expectations for initial estimation of the global burden of foodborne diseases. Therefore, increasing the Initiative's human and financial resources was the most appropriate change that could be made.

FERG experts were concerned about a major threat to the Initiative, namely the dependence of the Initiative and its success on such a small number of key personnel in the WHO Secretariat. These few key people were considered excellent in terms of technical expertise, enthusiasm, energy, dedication and motivation, and much of the success so far was ascribed to these qualities. FERG experts were concerned that if there were any changes to personnel, the Initiative would be very vulnerable and could fail. They were concerned about sustainability and lack of a 'safety net', and therefore requested an expanded team at the Secretariat, with more of the existing skills. FERG experts requested that high level senior management at WHO reiterate their support for the Initiative through providing the necessary resources to ensure the success of the Initiative and the considerable investment that had been made.

7–10 November 2011– Strategy Meeting and Commencement of Country Studies, Durrës, Albania

1.8.3 Strategic revisions

In view of the increased complexity of the WHO FERG Initiative, as well as the changed environment in which the Initiative was operating, the WHO Secretariat convened a meeting with the objectives of:

- updating the Initiative's strategic framework, its milestones and timelines;
- redefining the technical scope of the Initiative, including the selection of priority areas for foodborne disease burden estimation;
- identifying key activities and resource needs for implementation; and
- updating FERG processes, roles and responsibilities.

1.8.4 Key decisions

- **Scope of technical work:** The thematic TF chairs, in consultation with their TFs, established a shortened list of pathogens and hazards for which they intended to deliver incidence and mortality estimates by the end of 2012.
- **Methodological decisions:** A range of important technical and methodological issues linked to the estimation of foodborne disease burden were discussed at the meeting in Albania, and actions agreed upon in order to ensure accuracy, utility and compatibility with other existing health metric indicatives.
- **New FERG Computational Task Force:** Continuing in this vein, a new Computational Task Force

(CTF) to work on the mathematical modelling to calculate DALYs would be established. The TF was currently set to be operational by the end of February 2012.

- **Source attribution expert elicitation:** An expert elicitation would be conducted in 2012 to determine what proportion of the burden of each hazard was foodborne, and which were the major foods associated with transmission. A list of hazards that would be included in the expert elicitation was established.

1.8.5 Country-level involvement

The 'kick-off' meeting of the FERG pilot country studies marked a major milestone for the work of the Initiative in fostering national studies of the burden of foodborne disease. For the first time, representatives of the FERG pilot countries met to present progress on the implementation of a national foodborne disease burden study. They also learnt about study tools that FERG had developed, as well as the future technical support that would be provided by FERG.

The pilot countries during the kick-off meeting:

- drafted pilot country study work plans outlining the way forward;
- provided recommendations and input to align FERG procedures and tools for national foodborne disease burden estimation and food safety policy situation analyses specific to country requirements; and
- delivered feedback and agreed on processes to communicate between participating countries, and between the countries and FERG Secretariat.

8–12 April 2013 – FERG 5, Geneva

There was a very clear path towards the end goal of publishing the estimates of burden of foodborne disease, completing the pilot studies and finishing the country tools. Each TF had outlined its priority activities for the coming year and WHO would use these to solicit the funding required to complete the FERG project.

The hazard TFs– EDTF, PDTF and CTTF– completed the technical review of the systematic reviews; reviewed and revised the final outcome trees; and made plans for completion for each hazard.

SATF finalized the expert elicitation protocol for: chemicals and toxins (inorganic arsenic, lead, cadmium and dioxins); for parasitic diseases (*Entamoeba histolytica*, *Cryptosporidium* spp., *Giardia* spp., *Echinococcus granulosus*, *Toxoplasma gondii*, *Echinococcus multilocularis* and *Ascaris* spp.); and for enteric diseases (diarrhoeal diseases [non-typhoidal *Salmonella* spp., *Campylobacter* spp., Shiga-toxin producing, enteropathogenic and enterotoxigenic *E. coli*, norovirus, *Shigella* spp., *Vibrio cholerae*], typhoid, brucellosis and hepatitis A).

The methodology and elicitation instrument were agreed with each of the hazard TFs. This expert elicitation would be the first time that the methodology had been applied at a global level for food safety and would involve disease experts from all six WHO regions. The logistics of such an enormous task were also mapped out and agreed during the meeting.

CTF (established October 2012) was able to agree on the disease models for the majority of the pathogens, as well as meeting individually with each TF to advance the DALY calculations. The database was revised, methods for imputation of missing data were advanced, and disability weights (DWs) were mapped to all outcomes.

CSTF and KTPG agreed the aims, objectives and outline for the joint

country study workshop, initiated the development of the communications strategy for the global and regional FERG results, and reviewed the situational analysis document and the outcome of the commissioned work.

23-25 June 2014- Strategy Meeting, Copenhagen

This working meeting involved detailed discussions of burden estimation across all the TFs. Progress was enhanced greatly by the attendance by Dr Colin Mathers, the Coordinator of the Mortality and Burden of Disease Unit in the Health System and Innovation Cluster at WHO, Geneva. This enabled the FERG estimation approaches to be harmonized with those used by the WHO unit.

1.9 Task Force Meetings

Only face-to-face meetings are listed. In addition to these meetings, numerous teleconferences were held by each TF. For the meetings marked*, finalized or draft meeting reports are available.

EDTF

7 - 9 June 2009 - Rome*
14 - 18 July 2010 - Tunis, Tunisia

CTTF

14 - 16 July 2009 - Geneva*
14 - 18 July 2010 - Tunis, Tunisia

PDTF

7 - 9 June 2009 - Rome*
14 - 18 July 2010 - Tunis, Tunisia

SATF

28 - 30 April 2008 - Kuala Lumpur, Malaysia*
20 - 22 April 2010 - Atlanta, USA*
14 - 18 July 2010 - Tunis, Tunisia

CTF

2 - 4 October 2012 - Establishment meeting, Antwerp, Belgium*
April 2013 - Sunday pre-meeting at FERG 5 Geneva, Switzerland
2 August 2013 - Data imputation meeting. RIVM, Bilthoven, The Netherlands
31 January 2014 - DALY calculation & Disability Weights meeting, Brussels
February 2014 - Data imputation meeting, Antwerp, Belgium

CSTF

10 - 12 June 2009 - Rome, Italy*
18 - 20 March 2010 - Atlanta, USA*
7 - 10 November 2011 - Kick off meeting (Albania, Japan, Thailand), Durrës, Albania
4 - 6 March 2012 - Kick off meeting (Uganda), Kampala, Uganda

1.10 Participants

See Appendix 1.

1.11 Declarations of Interest

All experts and resource advisers invited to participate in FERG meetings completed beforehand the WHO standard form for Declaration of Interests. At the start of each meeting, all participants were asked to confirm their interests, and to provide any additional information relevant to the subject matter of the meeting. All declared interests were assessed by the WHO Secretariat to ensure the neutrality and unbiasedness of the work.

COMMISSIONED WORK 2

COMMISSIONED WORK

Each TF commissioned specific pieces of work to provide scientific evidence on which to base estimates. Most of these were systematic reviews, either of available data on diseases, or reviews of methodology. The majority of commissioned work resulted in published papers, as listed below. Some of these publications were part funded by FERG, while others were generated as "in kind" contributions by the authors.

2.1 Enteric Diseases Task Force

The EDTF commissioned the following systematic reviews:

2.1.1 *Brucella* spp.

- Dean, A.S., Crump, L., Greter, H., Hattendorf, J., Schelling, E. & Zinsstag, J. 2012. Clinical manifestations of human brucellosis: a systematic review and meta-analysis. *PLOS Neglected Tropical Diseases*, 6(12): Art. e1929. Available at http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001929 Accessed 2015-10-16.
- Dean, A.S., Crump, L., Greter, H., Schelling, E. & Zinsstag, J. 2012. Global burden of human brucellosis: a systematic review of disease frequency. *PLOS Neglected Tropical Diseases*, 6(10): Art e1865. Available at http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001865 Accessed 2015-10-16.

2.1.2 Diarrhoeal disease

- Fischer Walker, C.L., Sack, D. & Black, R.E. 2010. aetiology of diarrhoea in older children, adolescents and adults: a systematic review. *PLOS Neglected Tropical Diseases*, 4(8): Art e768. Available at http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0000768 Accessed 2015-10-16.
- Fischer Walker, C.L., & Black, R.E. 2010. Diarrhoea morbidity and mortality in older children, adolescents, and adults. *Epidemiology and Infection*, 138(9): 1215–1226. Available at http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=7849267&fileId=S0950268810000592 Accessed 2015-10-16.
- Pires, S.M., Fischer Walker, C.L., Lanata, C.F., Devleesschauwer, B., Hall, A., Kirk, M.D., Duarte, A.S.R., Black, R.E., & Angulo, F.J. Aetiology-specific estimates of the global and regional incidence and mortality of diarrhoeal diseases commonly transmitted through food. *PLOS ONE*, vol 10, iss 12, DOI: 10.1371/journal.pone.0142927

2.1.3 *Mycobacterium bovis*

- Muller, B., Durr, S., Alonso, S., Hattendorf, J., Laisse, C.J., Parsons, S.D., van Helden, P.D. & Zinsstag, J. 2013. Zoonotic Mycobacterium bovis-induced tuberculosis in humans. *Emerging Infectious Diseases*, 19(6): 899–908. Available at: http://wwwnc.cdc.gov/eid/article/19/6/12-0543_article
- Durr, S., Muller, B., Alonso, S., Hattendorf, J., Laisse, C.J., van Helden, P.D. & Zinsstag, J. 2013. Differences in primary sites of infection between zoonotic and human tuberculosis: results from a worldwide systematic review. *PLOS Neglected Tropical Diseases*, 7(8): Art e2399. Available at http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0002399 Accessed 2015-10-16.

2.1.4 Shiga toxin-producing *Escherichia coli*

- Majowicz, S.E., Scallan, E., Jones-Bitton, A., Sargeant, J.M., Stapleton, J., Angulo, F.J., Yeung, D.H. & Kirk, M.D. 2014 Global incidence of human Shiga toxin-producing *Escherichia coli* infections and deaths: a systematic review and

knowledge synthesis. *Foodborne Pathogens and Disease*, 11(6): 447- 455. Available at http://online.liebertpub.com/doi/full/10.1089/fpd.2013.1704 Accessed 2015-10-17.

2.1.5 Norovirus

- Ahmed, S.M., Hall, A.J., Robinson, A.E., Verhoef, L., Premkumar, P., Parashar, U.D., Koopmans, M. & Lopman, B.A. 2014. Global prevalence of norovirus in cases of gastroenteritis: a systematic review and meta-analysis. *Lancet Infectious Diseases*, 14(8): 725- 730. Available at http://www.sciencedirect.com/science/article/pii/S1473309914707674 Accessed 2015-10-17.
- Verhoef, L., Hewitt, J., Barclay, L., Ahmed, S.M., Lake, R., Hall, A.J., Lopman, B., Kroneman, A., Vennema, H., Vinje, J. & Koopmans, M. 2015. Norovirus genotype profiles associated with foodborne transmission, 1999- 2012. *Emerging Infectious Diseases*, 45: 95- 99. Available at: http://wwwnc.cdc.gov/eid/article/21/4/14-1073_article

2.1.6 Invasive non-typhoidal *Salmonella enterica*

- Ao, T.T., Feasey, N.A., Gordon, M.A., Keddy, K.H., Angulo, F.J. & Crump, J.A. 2015. Global burden of invasive non-typhoidal *Salmonella* disease, 2010. *Emerging Infectious Diseases*, 21(6): 941- 949.
- Crump, J.A. & Kirk, M.D. Estimating the burden of febrile illnesses. *PLOS Neglected Tropical Diseases*, (in press).

2.1.7 *Listeria monocytogenes*

- Maertens de Noordhout, C., Devleesschauwer, B., Angulo, F.J., Verbeke, G., Haagsma, J., Kirk, M., Havelaar, A. & Speybroeck, N. 2014. The global burden of listeriosis: a systematic review and meta-analysis. *Lancet Infectious Diseases*, 14(11): 1073- 1082. Available at http://www.sciencedirect.com/science/article/pii/S1473309914708709 Accessed 2015-10-17.

2.2 Parasitic Diseases Task Force

PDTF commissioned the following systematic reviews:

2.2.1 *Taenia solium*

- Carabin, H., Ndimubanzi, P.C., Budke, C.M., Nguyen, H., Qian, Y., Cowan, L.D., Stoner, J.A., Rainwater, E. & Dickey, M. 2011. Clinical manifestations associated with neurocysticercosis: a systematic review. *PLOS Neglected Tropical Diseases*, 5(5): Art e1152. Available at http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001152 Accessed 2015-10-17.
- Ndimubanzi, P.C., Carabin, H., Budke, C.M., Nguyen, H., Qian, Y.J., Rainwater, E., Dickey, M., Reynolds, S. & Stoner, J.A. 2010. A systematic review of the frequency of neurocysticercosis with a focus on people with epilepsy. *PLOS Neglected Tropical Diseases*, 4(11): Art e870. Available at http://www.plosntds.org/article/info:doi/10.1371/journal.pntd.0000870 Accessed 2015-10-17.

2.2.2 Trematodes (includes *Echinostoma* spp., *Fasciolopsis buski*, *Heterophyes* spp. and *Metagonimus* spp.)

- Furst, T., Keiser, J. & Utzinger, J. 2012. Global burden of human food-borne trematodiasis: a systematic review and meta-analysis. *Lancet Infectious Diseases*, 12(3): 210- 221. Available at http://www.thelancet.com/journals/laninf/article/PIIS1473- 3099(11)70294-8/fulltext Accessed 2015-10-17.

2.2.3 *Echinococcus multilocularis*

- Torgerson, P.R., Keller, K., Magnotta, M. & Ragland, N. 2010. The global burden of alveolar echinococcosis. *PLOS Neglected Tropical Diseases*, 4: e722. Available at http://www.plosntds.org/article/info:doi/10.1371/journal.pntd.0000722 Accessed 2015-10-17.

2.2.4 *Trichinella* spp.

- Devleesschauwer B, Praet N, Speybroeck N, Torgerson P R, Haagsma J A, De Smet K, Murrell K D, Pozio E and Dorny P (2014) The low global burden of trichinellosis: evidence and implications. *International Journal of Parasitology*, 45(2-3): 95- 99. Available at http://www.sciencedirect.com/science/article/pii/S0020751914001374 Accessed 2015-10-17.
- Murrell, K.D. & Pozio, E. 2011. Worldwide occurrence and impact of human trichinellosis, 1986- 2009. *Emerging Infectious Diseases*, 17(12): 2194- 2202.

2.2.5 *Toxoplasma gondii*

- Torgerson, P.R. & Mastroiacovo, P. 2013. The global burden of congenital toxoplasmosis: a systematic review. *Bulletin of the World Health Organization*, 91(7): 501- 508. Available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3699792/ Accessed 2015-10-17.

2.3 Chemicals and Toxins Task Force

CTTF commissioned several systematic reviews and reports.

2.3.1 Aflatoxins

- Khlangwiset, P., Shephard, G.S. & Wu, F. 2011. Aflatoxins and growth impairment: A review. *Critical Reviews in Toxicology*, 41(9): 740- 755. Available at http://informahealthcare.com/doi/abs/10.3109/10408444.2011.575766 Accessed 2015-10-17.
- Wu, F. 2010. Global Burden of aflatoxin-induced disease: Final Report for the World Health Organization (WHO) Foodborne Disease Burden Epidemiology Reference Group (FERG) Chemical Task Force. Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health, Pittsburgh, PA, USA.
- Liu, Y. & Wu, F. 2010. Global burden of aflatoxin-induced hepatocellular carcinoma: a risk assessment. *Environmental Health Perspectives*, 118(6): 818- 824. Available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2898859/ Accessed 2015-10-17.
- Liu, Y., Chang, C.C., Marsh, G.M. & Wu, F. 2012. Population attributable risk of aflatoxin-related liver cancer: systematic review and meta-analysis. *European Journal of Cancer*, 48(14): 2125- 2136. Available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3374897/ Accessed 2015-10-17.

2.3.2 Arsenic

- Oberoi, S., Barchowsky, A. & Wu, F. 2014. The global burden of disease for skin, lung, and bladder cancer caused by arsenic in food. *Cancer Epidemiology Biomarkers and Prevention*, 23(7): 1187- 1194. Abstract available at http://cebp.aacrjournals.org/content/23/7/1187.abstract Accessed 2015-10-17.

2.3.3 Cassava cyanide

- Cliff, J. 2011. Incidence and prevalence estimates of cassava-cyanide induced diseases. Report for the FERG Chemicals and Toxins Task Force. Universidade Eduardo Mondlane, Mozambique.

2.3.4 Peanut Allergens

- Ezendam, J. & van Loveren, H. 2012. Parameters needed to estimate the global burden of peanut allergy: Systematic literature review. *European Journal of Food Research and Review,* 2(2): 46- 48. Available at http://www.rivm.nl/en/Library/Scientific/Reports/2012/april/Parameters_needed_to_estimate_the_global_burden_of_peanut_allergy_Systematic_literature_review Accessed 2015-10-17.

2.3.5 Dioxins

- Zeilmaker, M.J., Devleesschauwer, B., Mengelers, M.J.B., Hoekstra, J., Brandon, E.F.A. & Bokkers, B.G.H. The disease burden of dioxins: A global perspective. *RIVM Report* National Institute for Public Health and the Environment (RIVM), Netherlands.

2.4 Source Attribution Task Force

SATF commissioned the following papers:

- Pires, S.M. 2013. Assessing the applicability of currently available methods for attributing foodborne disease to sources, including food and food commodities. *Foodborne Pathogens and Disease,* 10(3): 206- 213.
- Pires, S.M., Evers, E.G., van Pelt, W., Ayers, T., Scallan, E., Angulo, F.J., Havelaar, A. & Hald, T. and the Med-Vet-Net Workpackage 28 team. 2009. Attributing the human disease burden of foodborne infections to specific sources. *Foodborne Pathogens and Disease,* 6(4): 417- 424.
- Hoffman, S., Aspinall, W., Cooke, R., Cawthorne, A., Corrigan, T., Havelaar, A., Gibb, H., Torgerson, P., Kirk, M., Angulo, F, Lake R, Speybroeck N, Devleesschauwer B, Hald T. 2015 Perspective: Research synthesis methods in an age of globalized risks: lesson from the global burden of foodborne disease expert elicitation. *Risk Analysis* DOI: 10.1111/risa.12385
- Aspinall, WP., Cooke, RM., Havelaar, AH., Hoffman, S., Hald, T. 2015. Science-based global attribution of foodborne diseases: Findings of WHO expert elcitiation. *PLOS ONE.* (in press).

2.5 Computational Task Force

- McDonald, S.A., Devleesschauwer, B., Speybroeck, N., Hens, N., Praet, N., Torgerson, P.R., Havelaar, A.H., Wu, F., Tremblay, M., Amene, E.W. & Döpfer, D. 2015. Data-driven methods for imputing national-level incidence in global burden of disease studies. *Bulletin of the World Health Organization,* 93(4): 228- 236 doi: http://dx.doi.org/10.2471/BLT.14.139972

The following two papers were not commissioned by the Computational Task Force, but several of the authors were TF members, and the papers are relevant to the Initiative estimates.

- Devleesschauwer, B., Havelaar, A.H., Maertens de Noordhout, C., Haagsma, J.A., Praet, N., Dorny, P., Duchateau, L., Torgerson, P.R., Van Oyen, H. & Speybroeck, N. 2014. Calculating disability-adjusted life years to quantify burden of disease. *International Journal of Public Health,* 59(3): 565- 569.
- Devleesschauwer, B., Havelaar, A.H., Maertens de Noordhout, C., Haagsma, J.A., Praet, N., Dorny, P., Duchateau, L., Torgerson, P.R., Van Oyen, H. & Speybroeck, N. 2014. DALY calculation in practice: a stepwise approach. *International Journal of Public Health,* 59(3): 571- 574.