

Meeting Report

EXPERT CONSULTATION TO ACCELERATE CONTROL OF FOODBORNE TREMATODE INFECTIONS, TAENIASIS AND CYSTICERCOSIS



17–19 May 2017
Seoul, Republic of Korea

WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR THE WESTERN PACIFIC

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MEETING REPORT

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TREMATODE INFECTIONS, TAENIASIS AND CYSTICERCOSIS

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NOTE

The views expressed in this report are those of the participants of the Expert Consultation to Accelerate Control of Foodborne Trematode Infections, Taeniasis and Cysticercosis and do not necessarily reflect the policies of the conveners.

This report has been prepared by the World Health Organization Regional Office for the Western Pacific for Member States in the Region and for those who participated in the Expert Consultation to Accelerate Control of Foodborne Trematode Infections, Taeniasis and Cysticercosis in Seoul, Republic of Korea from 17 to 19 May 2017.

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Keywords:

Foodborne diseases – prevention & control / Trematode infections – prevention & control /
Taeniasis – prevention & control / Cysticercosis – prevention & control / Tropical diseases

ABBREVIATIONS

DALY	disability-adjusted life year
EITB	enzyme-linked immunoelectrotransfer blot assay
ELISA	enzyme-linked immunosorbent assay
FAO	Food and Agriculture Organization of the United Nations
FBT	foodborne trematode
GMP	Good Manufacturing Practice
JEMRA	Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment
MDA	mass drug administration
NTD	neglected tropical disease
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
TB	tuberculosis
WHO	World Health Organization

SUMMARY

Foodborne trematode (FBT) infections, taeniasis and cysticercosis are noteworthy neglected tropical diseases. They are caused by trematodes (flatworms or “flukes”) or pork tapeworms that are acquired through ingestion of food contaminated with the larval stages, eggs or proglottids of the parasite. Transmission is linked to practices in producing, processing and preparing foods and livestock. These diseases are also zoonotic infections affecting domestic or wild animals. Strong intersectoral cooperation is accordingly required for control of their transmission. The morbidity burden is significant in the Western Pacific Region: liver flukes are classified as carcinogenic, long-term infections causing cholangiocarcinoma or bile duct cancer, and cysticercosis, particularly neurocysticercosis, is known to cause epilepsy and sometimes death.

The participants in the Expert Consultation to Accelerate Control of Foodborne Trematode Infections, Taeniasis and Cysticercosis acknowledged progress in epidemiological mapping of foodborne trematode infections, taeniasis and cysticercosis at country level in many affected countries of the Western Pacific Region. Countries that have sufficient information to accelerate control interventions and those that urgently need to complete risk mapping were respectively identified. Significant progress has also been made worldwide over the past decade in developing guidance and tools for the control and management of foodborne trematode infections, taeniasis and cysticercosis, both from public health and food safety standpoints.

The Consultation acknowledged that while preventive chemotherapy intervention has proven effective in reducing the prevalence of opisthorchiasis, clonorchiasis and taeniasis, multiple factors contribute to high reinfection rates immediately following preventive chemotherapy such as poor sanitation, poor food hygiene, the presence of animal reservoirs in close proximity to communities and cultural food habits. Therefore, preventive chemotherapy accompanied by community empowerment through the One Health approach, composed of effective risk communication, animal treatment, agricultural interventions, improved food safety, and water, sanitation and hygiene (WASH), was recommended anew as the core strategy to accelerate and sustain control of foodborne trematode infections, taeniasis and cysticercosis.

Regular monitoring and evaluation of interventions and associated severe adverse events for control of foodborne trematode infections, taeniasis and cysticercosis is essential. A procedure for systematic reporting of epidemiological and treatment data within countries, and from countries to WHO, and the standardization of diagnostic methods for foodborne trematode infections, taeniasis and cysticercosis both in humans and animals should be established with the support of WHO collaborating centres and other academic and research institutions.

WHO should also strengthen collaboration with other relevant international agencies, such as the Food and Agriculture Organization of the United Nations and World Organisation for Animal Health, in sharing information related to foodborne trematode infections, taeniasis and cysticercosis, and jointly supporting countries in building their capacities to intervene throughout the food value chain for effective control of foodborne parasitic diseases.

1. INTRODUCTION

1.1 Meeting organization

The Expert Consultation to Accelerate Control of Foodborne Trematode Infections, Taeniasis and Cysticercosis was held on 17–19 May 2017 at the JW Lee Center for Global Medicine in the Seoul National University College of Medicine in Seoul, Republic of Korea. It was attended by 13 experts and four representatives of the stakeholder organizations. The programme agenda is in Annex 1. The full list of participants is available in Annex 2.

1.2 Meeting objectives

The objectives of the Consultation were:

- 1) to review the current burden and endemicity of foodborne trematode (FBT) infections, taeniasis and cysticercosis in the Western Pacific Region, as well as country experiences and recent research on the control of these diseases;
- 2) to recommend strategic actions and research priorities, and estimate resource needs to accelerate control of such diseases in the Region; and
- 3) to identify and discuss integration opportunities with other disease control and surveillance activities that will contribute to acceleration of the control of FBT infections, taeniasis and cysticercosis in the Western Pacific Region.

2. PROCEEDINGS

2.1 Opening session

Dr Jong-Koo Lee, Director of the JW Lee Center for Global Medicine, Seoul National University, Republic of Korea, delivered the welcoming remarks. He said that the key need in elimination and control of communicable diseases was to fill three gaps: a knowledge gap, an implementation gap and an ambition gap. He also emphasized the importance of a comprehensive approach to combat foodborne and zoonotic parasitic diseases.

Dr Rabindra Abeyasinghe delivered the opening remarks on behalf of Dr Shin Young-soo, WHO Regional Director for the Western Pacific. The Regional Director recognized that FBT infections, taeniasis and cysticercosis remained a significant public health problem in the Western Pacific Region, given the severity of the burden caused by these diseases including cholangiocarcinoma or bile duct cancer due to opisthorchiasis and clonorchiasis, and seizure and epilepsy due to neurocysticercosis. Transmission was linked to practices of producing, processing and preparing foods and livestock. The diseases were also zoonotic infections affecting domestic or wild animals. In striving to effectively control them, strong multisectoral cooperation and political commitment were essential to improve food production, processing and hygiene practices, treat infected animals, and improve sanitation to prevent contamination of the environment and the infection of animal reservoirs. In closing, Dr Shin thanked the participants for sharing their expertise and experience to guide the Region in the fight against neglected tropical diseases (NTDs).

2.2 Background of the Consultation

The International Task Force for Disease Eradication, convened six times between 1989 and 1992 at the Carter Center of Emory University, evaluated 94 infectious diseases to determine candidates for

global eradication and concluded that six were potentially eradicable. Taeniasis/cysticercosis was included in the six diseases for the following reasons: (i) human beings are the only definitive hosts of *T. solium*; (ii) effective tools for surveillance to identify foci of transmission of *T. solium* and for mass treatment of humans to help eliminate such foci exist; (iii) there are countries and areas where *T. solium* has disappeared even without targeted control measures; and (iv) it causes a substantial economic burden to the pork industry justifying a global response.¹ FBT infections were considered not eradicable because of the presence of the nonhuman reservoir and many asymptomatic cases. However, the Task Force found that reduction of prevalence is possible through measures such as the promotion of sanitary disposal of human faeces.

In 1993, a meeting of the WHO Study Group on the Control of Foodborne Trematode Infections was convened in Manila, Philippines. The meeting reviewed the epidemiological status of clonorchiasis, fascioliasis, opisthorchiasis and paragonimiasis; summarized scientific advances relevant to control of the diseases; and recommended an integrated control strategy requiring the close collaboration of the health, agriculture, food safety and education sectors. Since then, a series of expert consultations have been convened and guidance published on public health and food safety interventions applicable for the control of FBT infections, taeniasis and cysticercosis, including the guidelines for the surveillance, prevention and control of taeniasis/cysticercosis jointly published by the Food and Agriculture Organization of the United Nations (FAO), World Organisation for Animal Health (OIE) and WHO in 2003.

A WHO Expert Consultation to Accelerate Control of Foodborne Trematode Infections, Taeniasis and Cysticercosis was held on 12–16 October 2009, in Vientiane, Lao People's Democratic Republic, to review information on geographical distribution and discuss control options in endemic countries in the Western Pacific Region. The Consultation identified the need to complete risk mapping in countries and recommended preventive chemotherapy as the primary strategy for clonorchiasis, opisthorchiasis and fascioliasis. Since then, significant progress has been made on risk mapping, but progress in prevention and control activities is still slow.

The present Consultation was therefore held to assess the current knowledge and information gaps and to narrow down a specific and simplified set of interventions that countries could focus on in coming years in order to accelerate control of FBT infections, taeniasis and cysticercosis.

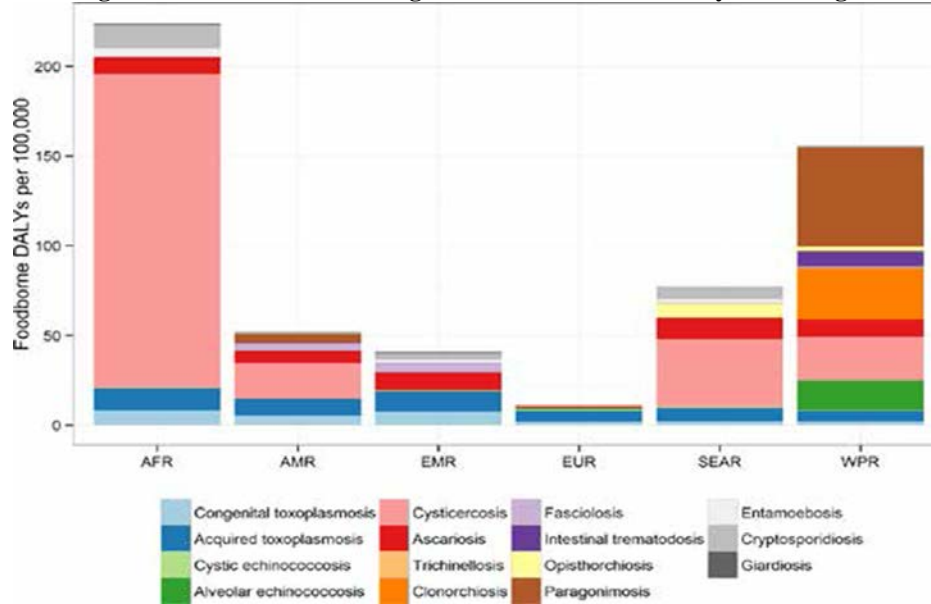
2.3 Global overview of control of FBT infections, taeniasis and cysticercosis

The WHO Western Pacific Region presents the second-largest burden of foodborne diseases and the highest mortality due to foodborne parasites in the world, according to the recent WHO estimates of the global burden of foodborne diseases released in 2015 (Fig. 1).² Of particular public health concern in the Region are FBT infections, including clonorchiasis, fascioliasis, opisthorchiasis and paragonimiasis, and taeniasis/cysticercosis (pork tapeworm), and these were the subjects of this Consultation.

¹ CDC (1993) Recommendations of the International Task Force for Disease Eradication. Morbidity and Mortality Weekly Report, 42(RR-16). Atlanta: Centers for Disease Control and Prevention.

² WHO (2015) WHO estimates of the global burden of foodborne diseases - Foodborne diseases burden epidemiology reference group 2007–2015. Geneva: World Health Organization. http://www.who.int/foodsafety/publications/foodborne_disease/fergreport/en/

Fig. 1. WHO estimates of the global burden of diseases by WHO region



DALY: daily-adjusted life year; AFR: African Region; AMR: Region of the Americas; EMR: Eastern Mediterranean Region; EUR: European Region; SEAR: South-East Asia Region; WPR: Western Pacific Region.

Transmission of these diseases is linked to practices in producing, processing and preparing foods and livestock. They are also zoonotic infections affecting domestic or wild animals. Effective prevention, detection, containment and elimination thus call for strong multisectoral cooperation and partnerships, as exemplified in the tripartite concept note on FAO–OIE–WHO collaboration.³

The targets and milestones have been set in *Accelerating Work to Overcome the Global Impact of Neglected Tropical Diseases – A Roadmap for Implementation*, the WHO NTD Roadmap⁴ for 2020 for the goal of controlling morbidity due to FBT infections, taeniasis and cysticercosis as follows:

Taeniasis/cysticercosis

- Validated strategy for control and elimination of *T. solium* taeniasis/cysticercosis available
- Interventions scaled up in selected countries for *T. solium* taeniasis/cysticercosis control and elimination (by 2020).

FBT infections

- 75% of population at risk reached by preventive chemotherapy (by 2020)
- Morbidity due to FBT infections controlled in all endemic countries (by 2020)

These goals, targets and milestones are still valid. In the absence of a solid global strategy to control and eliminate the diseases, the urgent development and validation of a proof of concept is an ethical necessity.

At the global level, progress has been made in recent years as follows: (i) guidelines for detection and treatment of neurocysticercosis are being finalized; (ii) target product profiles for diagnostics of *T. solium* taeniasis/cysticercosis have been developed; (iii) intervention packages for the elimination of taeniasis/cysticercosis are being piloted in selected countries; (iv) donation or sustainable bulk procurement of medicines (praziquantel, triclabendazole) is being negotiated with potential donors; (v) anthelmintics and a vaccine for animal reservoirs of taeniasis have been developed and their efficacy validated. High-level advocacy efforts also continue.

³ FAO–OIE–WHO collaboration: a tripartite concept note. http://www.who.int/foodsafety/areas_work/zoonose/concept-note/en/

⁴ WHO (2012) *Accelerating work to overcome the global impact of neglected tropical diseases – A roadmap for implementation*. Geneva: World Health Organization.

2.4 Updates on country burdens of FBT, taeniasis, and cysticercosis

2.4.1 China

According to provisional data from the third national survey on important parasitic diseases in China conducted in 2014–2016, clonorchiasis is endemic in both urban and rural areas in 31 provinces in mainland China, with an estimated infected population of 6 million. The provinces with the highest burdens are Guangxi and Guangdong in the south-east and Heilongjiang and Jilin in the north-east. Taeniasis is endemic in rural areas in 31 provinces in mainland China, with an estimated infected population of 0.37 million. The most affected provinces are Xizang, Sichuan and Yunnan in the south-east. For many years, cysticercosis has been known to be endemic in the north-east, central and south-west regions, but up-to-date information is not available. Prevalence in the north-east and central regions appears to have declined significantly, but the disease remains endemic in provinces in the south-east region such as Yunnan and Sichuan. Other FBT infections are not considered a public health problem at present.

For clonorchiasis, the recourse to chemotherapy – either mass drug administration (MDA) if prevalence is equal to or above 40%, selective treatment if prevalence is between 10% and 40%, or case management if the prevalence is below 10% – combined with health education and improvement of water, sanitation and hygiene (WASH) were administered as a pilot project between 2006 and 2009. For taeniasis and cysticercosis control, offices for taeniasis control and cysticercosis elimination were established in many provinces of northern China over the period from the 1970s to the 1990s, involving departments responsible for commerce, agriculture and health. These offices took charge of mass chemotherapy, latrine construction, management of pigpens, and inspection of pre-market pigs and treatment of cysticercoid pigs. However, no programme activities have been implemented since then.

2.4.2 Republic of Korea

Clonorchiasis remains a public health problem in the Republic of Korea. The 2012 nationwide survey found an egg positive rate of roughly 1.9%, while national health-care clinic medical check-ups in 2015 revealed an egg positive rate of 1.3%. Most clonorchiasis cases occur along rivers in the southern part of the country where the egg positive rate can be above 5% at district level, with Gyeongsangnam-do the province with the highest burden. The freshwater fish species *Pungtungia herzi* and *Squalidus gracilis majimae* were found to have the highest number of metacercariae of *C. sinensis*. In high-risk areas, the prevalence of infection among cats was found to be above 10%, whereas no infected cats were found in low-risk areas. There appears to be correlation between high-risk areas of cholangiocarcinoma and those of clonorchiasis, but so far such connections have not been analysed and confirmed.

The control measure currently in use is selective treatment using a test-and-treat strategy. Praziquantel is currently a prescription-only medicine, a major barrier for scaling up treatment in the country and using it for MDA campaigns in high-risk area. For elimination of clonorchiasis in the Republic of Korea, more involvement of local governments and communities in communicating the risks and free access to treatment for risk population may be required. The Korea Centers for Disease Control and Prevention is developing a rapid diagnostic test for *C. sinensis*, which is still being validated and improved.

Fascioliasis, paragonimiasis, taeniasis and cysticercosis are no longer public health problems in the Republic of Korea. The last known case of porcine cysticercosis occurred 25 years ago.

2.4.3 Lao People's Democratic Republic

Information is available on the geographical distribution of opisthorchiasis due to *Opisthorchis viverrini* in the Lao People's Democratic Republic, and each province has been classified by the estimated prevalence of infection. The disease is endemic in the entire country, with hyperendemic provinces in the central and southern part of the country (Borikhamxay, Khammouan, Savannakhet,

Saravane, Champasak and Attapeu) where village-level prevalence, measured using Kato–Katz stool examination, could be over 80%. The majority of egg positive individuals are co-infected with other minute intestinal flukes. A study conducted among adult patients in Saravane province showed a high prevalence of hepato-biliar morbidity, with over 90% of patients suffering from liver fibrosis and 1.2% of patients having liver masses indicative of cholangiocarcinoma.⁵ Control interventions against opisthorchiasis are limited to MDA using praziquantel in selected areas, and they depend on the availability of funds.

Paragonimiasis is considered to be focalized in mountainous areas, particularly in the northern region. However, a pilot project with integrated diagnosis of paragonimiasis in existing passive tuberculosis (TB) case detection activities found paragonimiasis in wider geographical locations, including the capital Vientiane.⁶ Currently, case detection and selective treatment of paragonimiasis patients is integrated in the existing TB programme. Information on endemicity of fascioliasis in the Lao People's Democratic Republic is limited.

A number of surveys on human intestinal helminth infections in different parts of the country over the last two decades have found taeniasis to be prevalent, ranging from 0% to 14% using stool examination across the country.⁷ More recent studies showed human taeniasis and cysticercosis prevalence of 8.4% (95% CI: 6.9–9.9%) and 2.2% (95% CI: 1.4–3.0%) using stool examination and self-reporting of tapeworm segments in faeces in northern provinces (Oudomxay, Luangprabang, Huaphan, and Xiengkhuang), and also identified a number of hyperendemic hotspots with the *T. solium* seroprevalence of up to 46.67% (95% CI: 21–72%) and cysticercosis of 66.67% (95% CI: 38–86%) in Phongsaly province.^{8,9} Control interventions are limited to operational research activities in selected villages.

2.4.4 Viet Nam

A wealth of epidemiological information is available on FBT infections in Viet Nam. Clonorchiasis is endemic in the northern parts of the country and opisthorchiasis in the central and southern parts of the country. Clonorchiasis is reported in almost all northern provinces, the prevalence ranging from 0.2% to 37.5%. The highest recorded rate is in Nam Dinh province (26.0–37.5%) followed by Ninh Binh province (23.5–31.0%).¹⁰ Opisthorchiasis is found in 10 central provinces, the prevalence ranging from 0.3% to 36.9%, and the highest recorded rate is in Phu Yen province.¹⁰

For clonorchiasis, MDA using a praziquantel 40 milligrams per kilogram (mg/kg) single dose was carried out in selected high-burden villages in the northern provinces between 2006 and 2016 where the prevalence was equal to or above 20%. The drug administration went in tandem with health education. The prevalence of clonorchiasis based on the Kato–Katz technique fell from 40.2% to 2.3% (two weeks post MDA) but gradually returned to 29.8% after 60 weeks of MDA. Nonetheless, the mean intensity of infection declined significantly, and most of the infected people presented light infection after one round of MDA.

Fascioliasis is considered prevalent throughout the country but the prevalence of fascioliasis in Viet Nam at community level is less than 10%. Consequently, there have been no specific public health interventions. The prevalence of paragonimiasis in some provinces (Lao Cai, Lai Chau and Yen Bai)

⁵ Ayé Soukhathammavong P, Rajpho V, Phongluxa K, Vonghachack Y, Hattendorf J, Hongvanthong B, et al. (2015) Subtle to severe hepatobiliar morbidity associated with *Opisthorchis viverrini* infection in Southern Laos. *Acta Trop* 141:303–9.

⁶ Odermatt P, Veasna D, Zhang W, Vannavong N, Phrommala S, Habe S, et al. (2007) Rapid identification of paragonimiasis foci by lay informants in Lao People's Democratic Republic. *PLoS Negl Trop Dis*.3(9):e521.

⁷ Conlan J, Khounsy S, Inthavong P, Fenwick S, Blacksell S, Thompson RC (2008) A review of taeniasis and cysticercosis in the Lao People's Democratic Republic. *Parasitology International*.57(3):252–5.

⁸ Conlan J, Vongxay K, Khamlome B, Dorny P, Sripa B, Elliot A, et al. (2012) A cross-sectional study of *Taenia solium* in a multiple taeniid-endemic region reveals competition may be protective. *Am J Trop Med Hyg*.87(2):281–91.

⁹ Okello A, Ash A, Keokhamphet C, Hobbs E, Khamlome B, Dorny P, et al. (2014) Investigating a hyper-endemic focus of *Taenia solium* in northern Lao PDR. *Parasites & Vectors*.7(134).

¹⁰ Doanh PN, Nawa Y (2016) Clonorchis sinensis and Opisthorchis spp. in Vietnam: current status and prospects. *Trans R Soc Trop Med Hyg*.110:13–20.

was reported as above 10% and MDA using a praziquantel 40 mg/kg single dose for two consecutive days was carried out in selected high-risk areas in the three provinces, coupled with intensive health education. Since then, the number of positive cases has declined significantly in all provinces and the survey conducted in Lai Chau province in 2014 showed a prevalence of 1.2% using the Kato–Katz technique and 7.9% using enzyme-linked immunosorbent assays (ELISA). MDA has therefore not been continued.

Human taeniasis has been seen in over 50 provinces, especially in the north of the country (Bac Ninh, Thai Binh and Thanh Hoa). Hundreds of cysticercosis patients are reportedly treated in the national and provincial hospitals annually. Prevalence rates for taeniasis and cysticercosis of up to 12.6% and 7.2% respectively have been reported from some endemic areas. However, the detection rate for infected pork at central and provincial slaughterhouses is relatively low (the survey conducted in 2007–2010 found 0.04% in Hanoi, 0.03–0.06% at provincial slaughterhouses in the north, and 0.9% in the south). A pilot implementation of MDA for taeniasis was carried out in high-endemic areas in the north between 2012 and 2015, targeting people reporting the habit of eating raw pork. A praziquantel 10 mg/kg single dose was used. The prevalence of taeniasis dropped from 10.2% to 4.1% after one round of MDA and to 0% after the second and third rounds. MDA was discontinued.

2.4.5 Other countries in the Western Pacific Region

Available epidemiological information on FBT infections, taeniasis and cysticercosis in Cambodia is limited. However, some studies reported prevalence of *O. viverrini* infection of 47.5% in Takeo province and *Fasciola* spp. prevalence of 46.5% among schoolchildren in Kandal province. In Kratie province, *O. viverrini* prevalence among adults was found to be close to 40%.¹¹ Stool surveys among primary schoolchildren and inhabitants in Koh Kong, Kampong Spek and Kampong Som provinces revealed the prevalence of *Taenia* spp. ranging from 0% to 4.6%, mainly with *T. saginata*.¹² The national population-based serosurvey conducted in 2012 using the multiplex bead assay estimated the weighted national estimates for prevalence of antibodies to cysticercosis antigens among adult women as 2.6% (95% CI: 1.8–3.7%).¹³

In the Philippines, a study reported the prevalence of paragonimiasis of 12.5% in Zamboanga del Norte province.¹⁴ As to taeniasis and cysticercosis, one study conducted in 2010 reported a seroprevalence of cysticercosis of 24.6% in Eastern Visayas.¹¹

In Malaysia, a study found that seroprevalence for cysticercosis was 2.2%, but more recent analysis indicates that it may be much higher, reaching beyond 10%, especially in some non-Muslim areas, in Sabah, where wild pigs are kept for sustenance.¹¹ In the peninsular regions of the country, seroprevalence was found to be 3.5% among indigenous communities.¹⁵

Taeniasis is considered the second most common parasitic infection among people living in Mongolia, with 198 cases of taeniasis reported between 2002 and 2012, 61% of which were recorded at the capital, Ulaanbaatar.¹⁶

¹¹ Conlan JV, Sripa B, Attwood S, Newton PN (2011) A review of parasitic zoonoses in a changing Southeast Asia. *Vet Parasitol.*182(1):22–40.

¹² Jeon HK, Yong TS, Sohn WM, Chai JY, Hong SJ, Han ET, et al. (2011) Molecular identification of *Taenia* tapeworms by *Cox1* gene in Koh Kong, Cambodia. *Korean J Parasitol.*49(2):195–7.

¹³ Priest JW, Jenks MH, Moss DM, Mao B, Buth S, Wannemuehler K, et al. (2016) Integration of multiplex bead assays for parasitic diseases into a national, population-based serosurvey of women 15–39 years of age in Cambodia. *PLoS Negl Trop Dis.*10(5):e0004699.

¹⁴ Berizaro V Jr, Totanes FI, Asuncion CA, De Leon W, Jorge M, Ang C, et al. (2014) Integrated surveillance of pulmonary tuberculosis and paragonimiasis in Zamboanga del Norte, the Philippines. *Pathog Glob Health.*108(2):95–102.

¹⁵ Sahu PS, Lim YAL, Mahmud R, Somanath SD, Tan CT, Ramachandran CP (2017) Needs of exploring the burden of recent onset seizures due to neurocysticercosis and challenges in Southeast Asia focusing on scenario in Malaysia. *Asian Pacific Journal of Tropical Medicine.*10(4):332–40.

¹⁶ Davaasuren A, Dorjsuren T, Yanagida T, Sako Y, Nakaya K, Davaajav A, et al. (2014) Recent situation of taeniasis in Mongolia (2002–2012). *Korean J Parasitol.*52(2):211–4.

Taeniasis has been found on the island of New Guinea, but there have been no specific studies on taeniasis prevalence.¹⁷

There are occasionally reported cases of cysticercosis and taeniasis in Japan, but most of them are imported cases and the most common taeniases are *T. saginata* infections.

2.5 Preventive interventions for accelerating control of FBT, taeniasis and cysticercosis

2.5.1 Preventive chemotherapy targeting human hosts

FBT infections

Praziquantel is effective for liver flukes, including *C. sinensis*, *O. viverrini* and *P. westermani*. The basic pharmacological mechanisms behind the efficacy of praziquantel against helminth parasites remain poorly understood, but it is presumed to cause rapid contraction of the worm musculature leading to a loss of worm movement, vacuolization of the tegument and rapid bleb formation.¹⁸ Preventive chemotherapy using praziquantel has proven effective in reducing the prevalence and more importantly the intensity of infection among the treated communities immediately after the intervention. The previous Expert Consultation in 2009 recommended annual MDA in high-risk areas with over 20% prevalence of clonorchiasis or opisthorchiasis, and biannual MDA or targeted treatment for people accustomed to eating raw freshwater fish in low-risk areas with a prevalence below 20%.¹⁹ A number of endemic countries accordingly initiated preventive chemotherapy in selected areas. However, experiences in the Lao People's Democratic Republic, Thailand and Viet Nam suggested that preventive chemotherapy alone is insufficient to sustainably reduce the prevalence and eliminate the disease. This is due to multiple factors contributing to high reinfection rates following preventive chemotherapy, such as poor sanitation and food hygiene, the presence of animal reservoirs, and cultural habits of eating raw or undercooked fish. A concern was raised that the currently recommended prevalence threshold of 20% to start preventive chemotherapy might be too high, considering the low sensitivity of the Kato–Katz method when commonly used in the field.

Additionally, studies suggest that repeated infection and treatment of *C. sinensis/O. viverrini* increases the risk of developing cholangiocarcinoma. Clarification of the association between cholangiocarcinoma and repeated infections by *C. sinensis* and *O. viverrini* and/or repeated treatment is urgently needed. At the same time, it is essential that preventive chemotherapy is accompanied by clear education about risks and other complementary actions to stop reinfection.

The impact of such education as a complement to preventive chemotherapy was demonstrated in the MDA campaign against paragonimiasis in the northern mountainous provinces (Lai Chau, Lao Cai and Yen Bai) of Viet Nam in 2007. The campaign targeted a high-risk population – people who live or work in forests – with praziquantel 40 mg/kg/day for two consecutive days, coupled with intensive health education. After the campaign, the proportion of people eating raw freshwater crab dropped significantly, as stated in section 2.4.4, and only a few cases have been found since then. MDA was discontinued.

There is relatively little experience of preventive chemotherapy against fascioliasis in the Western Pacific Region since information on endemicity of the disease is limited. Where such information exists, the prevalence at community level has been below 10%.

The occasional occurrence of adverse events following treatment with praziquantel was discussed. Occurrence rates vary by country, and, in countries where they occur, people are reluctant to take medication due to perceived negative side-effects, leading to reduced coverage over the years. Often,

¹⁷ Dwyer PD (2006) People, pigs and parasites in New Guinea: relational contexts and epidemiological possibilities. *Parasitol Int.*55Suppl:S167–73.

¹⁸ Chai JY (2013) Praziquantel treatment in trematode and cestode infections: an update. *Infection and Chemotherapy.*45(1):32–43.

¹⁹ WHO (2011) Report of the WHO Expert Consultation on Foodborne Trematode Infections and Taeniasis/Cysticercosis, Vientiane, Lao People's Democratic Republic, 12–16 October 2009.

the uptake of a drug is dependent on people's perception of side-effects, rather than actual side-effects. Proper training is accordingly required on how to ascertain the real side-effects from patients, along with public information about such side-effects, in order to reassure both providers and patients about the efficacy and safety of the drugs.

Taeniasis and cysticercosis

The 2009 Expert Consultation recommended mass or targeted chemotherapy for human taeniasis with praziquantel 10 mg/kg or niclosamide 2 g/kg, with the option of a higher dose of praziquantel in areas where preventive chemotherapy against schistosomiasis or FBT infections was being implemented. Niclosamide is considered safer as it is not absorbed from the intestinal tract and does not act against the cystic stage. The side-effects of praziquantel are generally mild, but on rare occasions anaphylactic reactions have been observed in individuals infected with *C. sinensis*/*O. viverrini*, as well as host immune reactions such as seizure in individuals who have cysticerci in the brain.¹⁸ Furthermore, Steinmann et al. reported a 100% cure rate of *Taenia* spp. infections in China, using the Kato–Katz technique, with a triple dose of 400 mg albendazole or mebendazole, and a 50% rate with a single dose.²⁰ In the Lao People's Democratic Republic, biannual mass treatment with the triple dose of albendazole over three consecutive days showed a *Taenia* spp. prevalence reduction of 79.4% after one round and 100% after two rounds, using the McMaster method.²¹ Albendazole is also reported to be effective in reducing the number of cysts and the occurrence of epileptic episodes among patients with viable parenchymal brain cysts.²²

Deworming of pre-schoolchildren and school-aged children (and also women of child-bearing age in some countries) against soil-transmitted helminthiasis, using either albendazole or mebendazole, and MDA against schistosomiasis, clonorchiasis and/or opisthorchiasis using praziquantel have been widely implemented every year in countries in the Western Pacific Region (or biannually in areas that are highly endemic for soil-transmitted helminthiasis). In such areas, programmatic monitoring of neurologic adverse reactions should be instituted, and the impacts of treatment with albendazole/praziquantel for each co-endemic disease should be evaluated in parallel to demonstrate collateral impacts and the adverse events of integrated preventive chemotherapy.

2.5.2 Veterinary interventions targeting at animal reservoirs

FBT infections

Other fish-eating mammals such as dogs, cats and pigs are known animal reservoirs of *C. sinensis* and *O. viverrini*. However, mathematical modelling of the transmission dynamics of *O. viverrini*, validated with data from Champasak province, Lao People's Democratic Republic, suggested that humans, rather than the reservoir hosts, such as dogs and cats, are the prime contributors to maintaining the transmission cycle of *O. viverrini*. This suggests that treatment of humans is essential to interrupt transmission of *O. viverrini*, while treatment of animal reservoirs is not. This matches the experience in Thailand where prevalence of *O. viverrini* infection has significantly declined without treatment of animal reservoirs. However, further validation of the model with data from other endemic countries and areas is needed.

Moreover, if other measures such as improving sanitation and food habits were built into in the model, this would help to demonstrate the most effective interventions and the improvements necessary in each intervention in order to interrupt transmission.

Taeniasis and cysticercosis

²⁰ Steinmann P, Utzinger J, Du ZW, Jiang JY, Chen JX, Hattendorf J, et al. (2011) Efficacy of single-dose and triple-dose albendazole and mebendazole against soil-transmitted helminths and *Taenia* spp.: a randomized controlled trial. PLoS One.6(9):e25003.

²¹ Ash A, Okello A, Khamlome B, Inthavong P, Allen J, Thompson RCA (2015) Controlling *Taenia solium* and soil transmitted helminths in a northern Lao PDR village: Impact of a triple dose albendazole regime. Acta Trop.S0001-706X(15):30011–5.

²² Garcia HH, Pretell J, Gilman RH, Martinez SM, Moulton LH, Del Brutto OH, et al. (2004) A trial of antiparasitic treatment to reduce the rate of seizures due to cerebral cysticercosis. N Engl J Med.350:249–58.

Recent years have seen significant progress worldwide on control tools targeting animal reservoirs of taeniasis and cysticercosis. TSOL18, a recombinant vaccine for use in pigs and the first parasite vaccine ever, was shown to provide nearly complete protection against *T. solium* infection in five separate pig vaccine trials.²³ The vaccine, produced under Good Manufacturing Practice (GMP) standards, was licensed in 2016 and a growing number of countries are submitting registrations for use. A benzimidazole drug (Oxfendazole) was also shown to kill all *T. solium* parasites encysted in the muscle tissues of pigs following a single oral treatment with 30 mg/kg dose. In 2013, Oxfendazole manufactured under GMP standards was licensed for the first time for use in pigs for treatment of cysticercosis, and registrations from countries are on the increase. Mathematical modelling and pilot studies have shown that if pigs are given the vaccine and administered Oxfendazole every three months, coupled with annual human mass treatment with praziquantel (10 mg/kg), the transmission cycle can be interrupted both in humans and pigs in three years.

In Phongsaly province, Lao People's Democratic Republic, in 2013–2014, a combination of biannual human MDA with albendazole 400 mg/kg for all individuals above 6 years of age in the target communities for three consecutive days, and a biannual pig intervention package of (i) TSOL18 vaccination of pigs and (ii) mass treatment of all pigs above 1 year of age in the target communities with Oxfendazole (30 mg/kg), was piloted in a hyperendemic focus of *T. solium*. One year of the One Health intervention package resulted in 78.7% reduction in crude prevalence of *T. solium* taeniasis. It also demonstrated significant cost-effectiveness compared to human MDA alone, particularly when pig vaccination against classical swine fever was included. The impact of MDA with albendazole on the prevalence of soil-transmitted helminthiasis was also measured as another added benefit (US\$ 2461 per DALY averted versus US\$ 14 per DALY averted).

2.5.3 Safe fish production, targeting second intermediate hosts

In 2016, WHO developed the Five Keys to safer aquaculture products with the technical assistance of FAO. Considering that small-scale subsistence aquaculture is common in many countries in Asia, it was designed to target small aquaculture producers for the prevention of microbial and chemical contamination. However, since faecal contamination is one of the prime modes of contamination, the Five Keys are directly applicable to preventing fish-borne trematode infections as well. The five keys are: (i) practice good personal hygiene; (ii) clean the pond site; (iii) manage water quality; (iv) keep fish healthy; and (v) use clean harvest equipment and containers. Cleaning the pond site to prevent gastropods breeding in vegetation around the pond and preventing faecal contamination of source water is particularly important for the prevention of fish-borne trematode infections. This can be included in capacity-building efforts for controlling fish-borne trematode infections.

Fish-borne Zoonotic Parasites in Viet Nam (FIBOZOPA), a research and capacity-building project was implemented from 2004 to 2012 by the Department of Veterinary Disease Biology at the Faculty of Health and Medical Sciences at the University of Copenhagen, the Research Institute of Aquaculture No 1 in Hanoi, and other partners, with support from the Danish International Development Assistance (Danida) and the Government of Viet Nam. Through the project, a variety of interventions for aquaculture systems were evaluated. They included education for fish farmers; creation of cement barriers in fish ponds; treatment of humans, dogs, cats, and pigs in the farms; drainage of fish ponds; filtering of source water; and removal of aquatic vegetables from the fish pond intake. Over two years, these pond management interventions, coupled with MDA, proved to be more effective than MDA alone in reducing the prevalence and intensity of cultured fish infection with metacercariae of *C. sinensis*. However, the Expert Consultation recommended further studies to determine the cost-effectiveness of such interventions not only for the individual farmer, but also for broader public. It was also emphasized that cyprinid fish caught in natural water bodies such as local lakes and streams are often more highly infested than the cultured fish.

²³ Assana E, Gauci CG, Kyngdon CT, Zoli AP, Dorny P, Geerts S, et al. (2010) Antibody responses to the host-protective *Taenia solium* oncosphere protein TSOL18 in pigs are directed against conformational epitopes. *Parasite Immunol.*32(6):399–405.

2.5.4 Food safety: Recommendations from JEMRA to the Codex Alimentarius Commission

In the area of food safety, FAO provides: (i) the secretariat for the Codex Alimentarius, (ii) scientific advice on food safety, (iii) an emergency prevention system for food safety; and (iv) capacity development on food safety and quality. The Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment (JEMRA) was established as an independent scientific expert advisory group to the Codex Alimentarius Commission in 2000. In response to the request from the Codex Committee on Food Hygiene (CCFH) in 2000, JEMRA initiated multicriteria ranking of global foodborne parasites for risk management. The top 15 ranking included *T. solium*, Opisthorchiidae, *Fasciola* spp., *Paragonimus* spp. and other NTDs such as *Echinococcus granulosus*, *E. multilocularis* and *Ascaris* spp. JEMRA recommended that the Codex take the exercise further, suggesting development of practical risk management guidance. Accordingly, the *Guidelines on the Application of General Principles of Food Hygiene to the Control of Foodborne Parasites* were published in 2016, listing a series of recommended food safety interventions for primary production of meat, milk and fish products as well as fresh fruits and vegetables. The WHO and/or FAO recommendations relevant to control of FBT infections, taeniasis and cysticercosis are summarized in Annex 3.

It is important to ensure that such guidance is disseminated to countries and support is provided for its implementation at community level. One major shortcoming identified was the absence of education on food safety risks, especially among consumers and primary producers who have no access to formal markets, and who are typical contributors to such foodborne parasitic diseases in the Region. FAO's main approach focuses on the value chain, which considers food from the primary producer to the consumer, but risk communication for consumers is often not prioritized. The involvement of trade markets, including the private sector, was also recommended in the interests of generating economic motivations for positive changes in food hygiene behaviours. The Consultation urged that opportunities be explored among all relevant bodies, including WHO, FAO and OIE, to share information related to foodborne and zoonotic parasitic diseases and to jointly support countries in capacity-building on intervention options throughout the food value chain for effective control of foodborne parasitic diseases at the regional and country level.

2.5.5 Participatory comprehensive interventions for community empowerment

The Lawa model is a research-based integrated opisthorchiasis control model used in Khon Kaen, Thailand.^{24,25} It aims to demonstrate the impact of a comprehensive participatory community-based intervention. Thailand boasts over 30 years of national efforts to control opisthorchiasis, but experience has shown that top-down medical interventions relying on treatment of infected cases alone are not sufficient to make a sustainable impact on the prevalence of infection in highly endemic areas. The Lawa model, created in 2007, combines selective treatment of all schoolchildren and other infected individuals, intensive community and school-based health education, and disease surveillance and environmental monitoring. Community participation has been crucial in all interventions. In five years, the prevalence of infection in 13 target villages declined to less than a third of the baseline prevalence. Infected snails are no longer found and cyprinoid fish species, which are the primary second intermediate host, now show less than 1% prevalence compared to a maximum of 70% at the baseline. The key factors contributing to this success include the involvement of existing primary health care units in control activities, high-level advocacy to put liver fluke control on the national agenda and self-empowerment of affected communities. All parties help to ensure the continuity and sustainability of control activities.

In response to a question on how positive changes in social and human behaviours were measured, it was explained that anthropologists and social scientists had been involved in assessing the impacts of the model.

²⁴ Sripa B, Tangkawattana S, Sangnikul T (2017) The Lawa model: A sustainable, integrated opisthorchiasis control program using the EcoHealth approach in the Lawa Lake region of Thailand. *Parasitol Int.*66(4):346–54.

²⁵ Sripa B, Tangkawattana S, Laha T, Kaewkes S, Mallory FF, Smith JF, et al. (2015) Toward integrated opisthorchiasis control in northeast Thailand: the Lawa project. *Acta Trop.*141(Pt B):361–7.

2.6 Monitoring and evaluation, surveillance and response

2.6.1 Diagnostics currently available for FBT, taeniasis and cysticercosis

The major challenges in monitoring and evaluation (M&E) of control programmes of FBT infections, taeniasis and cysticercosis are: (i) the lack of highly sensitive and specific diagnostic tools/techniques that are also inexpensive and easy to use in the field; and (ii) the absence of any standardization of diagnostic techniques, both for humans and animals, to allow comparison of data across multiple surveys over time and space. Participants' experiences of various field and laboratory diagnostic techniques for each of the diseases in countries in the Western Pacific Region are summarized in Annex 4.

At the field level, the Kato–Katz technique for clonorchiasis, opisthorchiasis and fascioliasis, and direct sputum smear microscopy for paragonimiasis, remain the most commonly used techniques. The technique is accurate if microscopists have been well trained, but the sensitivity can be lessened by intra-specimen and day-to-day variations. The technique should be optimized by increasing the number of slides examined from a given sample. Furthermore, it is not easy to morphologically differentiate eggs of *O. viverrini* and *C. sinensis*, and to distinguish them from eggs of minute intestinal flukes. The Kato–Katz technique is also commonly used for human taeniasis but, once again, sensitivity is a problem and examination of multiple specimens taken on different days is necessary due to intermittent shedding of eggs. Besides, a polymerase chain reaction (PCR) test is required if different *Taenia* spp. are to be identified. For porcine cysticercosis, tongue palpation of pigs is an option. Sensitivity might not be high but it can provide an indication of a high burden in the community, and it is relatively easy to train people to do this.

In the laboratory setting, formalin ether concentration of stool samples can improve both sensitivity and specificity for all the diseases. Several ELISA assays have been developed for detection of antibodies or antigens in blood or urine samples for FBT infections and human/porcine cysticercosis, but there is no consensus as to the most appropriate antigen or antibody. Besides, detection of the antibody does not allow discrimination between active and past infections. For human/porcine cysticercosis, commercial kits for Ag-ELISA (antigen ELISA) and Ab-ELISA (antibody ELISA) are easily obtainable and these are highly sensitive and specific, but they are currently unable to differentiate neurocysticercoses. A further limitation is that, for porcine cysticercosis, Ab-ELISA cross-reacts with *T. hydatigena* in the Asian context.

For human taeniasis, enzyme-linked immunoelectrotransfer blot assay (EITB), copro-PCR and copro-Ag-ELISA are other available laboratory techniques. EITB and copro-PCR are highly specific and sensitive but the laboratory requires molecular capacity. Copro-Ag-ELISA is not species-specific and commercial kits are not widely available. EITB requires specific training and procurement of supplies from the United States Centers for Disease Control and Prevention (CDC) as well as molecular capacity.

With respect to taeniasis and cysticercosis, a stakeholder meeting on *T. solium* taeniasis/cysticercosis diagnostic tools was held on 17–18 December 2015 in Geneva. The meeting reviewed the existing field and laboratory diagnostic assays for human taeniasis and human/porcine cysticercosis, and agreed on the target product profiles to accelerate development of taeniasis/cysticercosis diagnostics.²⁶ Table 1 presents the types and characteristics of *T. solium* taeniasis/cysticercosis diagnostic tools to be considered as top priorities for development.

²⁶ WHO (2016) *Taenia solium* taeniasis/cysticercosis diagnostic tools, Report of a stakeholder meeting, 17–18 December 2015. Geneva: World Health Organization.

Table 1. *Taenia solium* taeniasis/cysticercosis diagnostic tools to be considered as top priorities

Species	Human		Pig
Disease	TS	CC	CC
Assay	Copro-Ag POC test	Ab/Ag POC test	Ag POC test
Additional suggestions	High Sp	Ag + Ab format;	high Sp
		Lateral-flow format;	
		inflammatory marker for NCC/CC differentiation	

CC: cysticercosis; POC: point of care; Sp: specificity; TS: taeniasis.

Source: WHO (2016) *Taenia solium* taeniasis/cysticercosis diagnostic tools, Report of a stakeholder meeting, 17-18 December 2015, Geneva.

For clinical diagnosis and monitoring of morbidity, ultrasound can be effectively used for clonorchiasis, opisthorchiasis, fascioliasis, and, to a lesser degree, paragonimiasis. Computed tomography and magnetic resonance imaging (CT/MRI) can also be used. Ultrasound and CT/MRI can also be used for diagnosing neurocysticercosis, but professional neurology capacities in endemic countries are generally low. Additionally, neurological signs, such as a perception of epilepsy, can be used as indicators of neurocysticercosis.

2.6.2 Active and passive surveillance on foodborne and zoonotic parasitic diseases

Experiences and challenges with the existing surveillance systems for foodborne and zoonotic parasitic diseases in China and Japan were presented and discussed.

In China, the current surveillance system for foodborne parasitic diseases was established in 2016. Surveillance for clonorchiasis consists of: (i) sentinel surveillance at fixed sites in 23 counties in seven highly endemic provinces (200 people per village, one village per town, five towns per county are screened with the Kato–Katz method and a questionnaire survey; 100 freshwater fish and 25 animal reservoirs – cats, dogs or pigs – are also tested in each county); and (ii) mobile surveillance in 10–15% of all counties in each province in mainland China (screening 200 people per village, one village per town, five towns per county with the Kato–Katz method); and (iii) passive surveillance using case reports in the national notifiable infectious diseases reporting system. However, clonorchiasis, taeniasis and cysticercosis are classified as “other diseases”, and reporting is not compulsory. The surveillance for taeniasis and cysticercosis is also similar to that for clonorchiasis but does not include mobile surveillance. Experience in China suggests that the current passive surveillance system will not provide an accurate picture of the prevalence of these diseases in the country unless they are considered notifiable and reported on a compulsory basis.

Liver flukes were once prevalent in Japan. At that time, surveillance of helminthiasis was conducted under the Parasitic Diseases Control Law, which was in force between 1907 and 1999. The Law provided for: (i) active surveillance in the form of surveys by prefectural institutes of health with the support of medical schools, using stool examinations and immunological skin tests; and (ii) passive surveillance in the form of reporting from health facilities. Together with human case detections, the distribution of metacercariae in fish was monitored in some endemic areas. In 1999, the Law was repealed. Foodborne helminth infections are now monitored under the Food Sanitation Act through passive detection, via reporting from health facilities, and active detection, if needed, using endoscopic and stool examination, immunological methods and PCR. According to the surveillance information, the number of reported cases of anisakiasis and other parasitic infections caused by eating raw sea fish is gradually increasing, but liver and lung fluke infections seem to have been almost eliminated without any specific interventions. However, cases of FBT infections and taeniasis continue to be detected sporadically in Japan even in recent years, as their life cycle seems to have been maintained in some wild animals.

2.6.3 Food safety surveillance on foodborne and zoonotic parasites

After the Food Safety Law was enacted in 2009, food safety surveillance in China began in 2010, and it has proven effective in identifying risk areas for further investigation and providing specific guidance towards better food safety risk management. It involves 32 provinces and 93% (2660/2865) of the counties in China. The surveillance currently covers *C. sinensis* in aquatic products and *T. solium* in meat. A variety of products are screened every year. In areas where the detection rate is high, active surveillance is conducted. Active surveillance for *C. sinensis* was carried out in Shunde county, Guangdong province in 2016. It tested cultured fish in selected ponds and retail outlets, and raw fish and fish porridge served in selected restaurants. This specific surveillance identified high infection rates among both live fish cultured in fish farms and those served raw in restaurants. Improved management of fish ponds, including banning latrines near the ponds in the fish farms, was recommended, along with stricter government regulation of restaurant food supply management.

The experience in China suggested that including foodborne and zoonotic parasites of public health concern in the food safety surveillance systems, where they existed, could be a passive yet effective means to identify risk areas or outbreaks of such diseases, and manage these.

2.7 Strategic actions and priority operational research to accelerate control of FBT infections, taeniasis and cysticercosis

2.7.1 Goals and targets

As stated in section 2.3, the goals and targets set in the NTD Roadmap for 2020 are still valid, and the priority should be to develop a proof of concept for effective control of FBT infections, particularly clonorchiasis and opisthorchiasis (for which there is sufficient epidemiological evidence to prove that they are a significant burden in the Region), and taeniasis and cysticercosis, and mobilize sufficient resources to scale up the validated strategy.

Taeniasis/cysticercosis

- Validated strategy for control and elimination of *T. solium* taeniasis/cysticercosis available
- Interventions scaled up in selected countries for *T. solium* taeniasis/cysticercosis control and elimination (by 2020)

FBT infections

- 75% of population at risk reached by preventive chemotherapy (by 2020)
- Morbidity due to FBT infections controlled in all endemic countries (by 2020)

2.7.2 Strategic actions

Preventive chemotherapy remains an important intervention, and the Consultation participants agreed that the infection prevalence threshold to start preventive chemotherapy should be reduced from 20% to 10% at community level, especially when the Kato–Katz stool examination method is used for FBT infections. In identification of the specific areas (communities or districts) where interventions are implemented, screening with a questionnaire on raw freshwater fish consumption habits for clonorchiasis and opisthorchiasis might precede the parasitological survey in the interests of cost containment. For taeniasis and cysticercosis, the following scenarios are recommended as criteria in selecting communities for interventions:

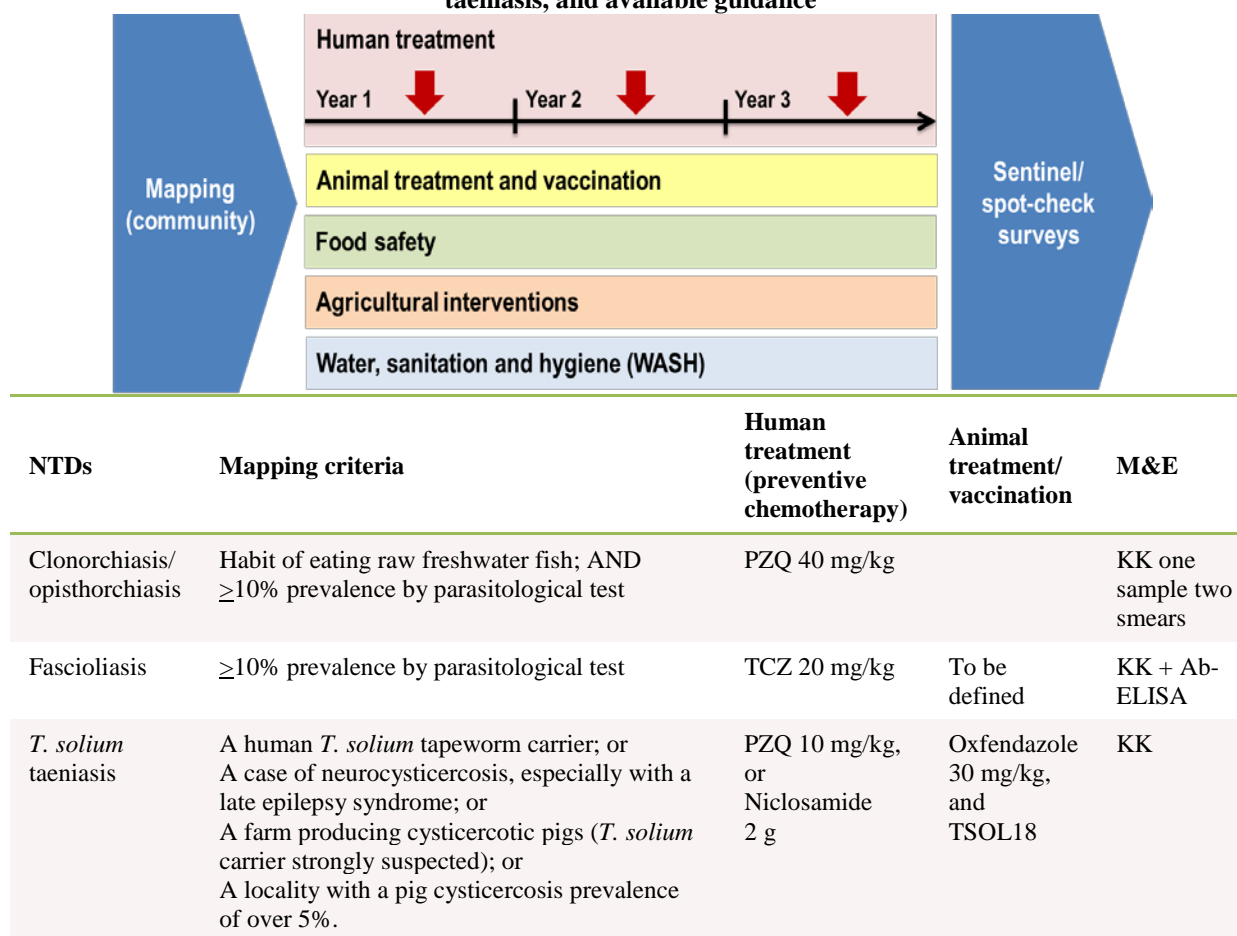
- 1) a human *T. solium* tapeworm carrier;
- 2) a case of neurocysticercosis, especially with a late epilepsy syndrome;
- 3) a farm producing cysticercotic pigs (the presence of a *T. solium* carrier is strongly suspected); or
- 4) a locality with a pig cysticercosis prevalence of over 5%.

However, the participants also agreed that reliance on preventive chemotherapy alone should be avoided because it does not sustainably reduce the prevalence of infection. Moreover, some studies suggest that repeated reinfection by liver flukes, and consequent retreatment, might increase vulnerability to cholangiocarcinoma. Because a lack of access to safe water and sanitation is the fundamental cause of the prevalence of these diseases, improving access to safe water and sanitation should be the long-term strategy. For control of clonorchiasis and opisthorchiasis, treatment of animal reservoirs is not considered a priority at present, but for control of taeniasis and cysticercosis, vaccination and treatment of all pigs (above 6 years of age for vaccination and above 1 year of age for treatment) every three months can be implemented in parallel with preventive chemotherapy for humans.

The meeting participants strongly recommended that, considering that FBT infections, taeniasis and cysticercosis are all closely related to habits relating to fish production, pig raising and the handling and ingestion of fish and pork, there be a special focus on communicating food safety risks within communities, particularly for the benefit of primary producers and consumers of such foods who typically have limited or no access to formal markets in endemic areas. Specific interventions, based on WHO and/or FAO guidelines, that primary producers (pig farmers, fisherfolk and/or fish farmers) can follow are summarized in Annex 3.

To this end, the Consultation recommended that community empowerment through the One Health approach, composed of effective risk communication, animal and human treatment, agricultural interventions, food safety, and water, sanitation and hygiene (WASH), should be the core strategy to accelerate and sustain control of FBT infections, taeniasis and cysticercosis (Fig. 2).

Fig. 2. Schematic diagram of proposed pilot programme steps for control of FBT infections and *T. solium* taeniasis, and available guidance



PZQ: praziquantel; TCZ: triclabendazole; ALB: albendazole; KK: Kato-Katz, Ab-ELISA: antibody enzyme-linked immunosorbent assay.

The One Health concept can be defined as the collaborative efforts of multiple disciplines – working locally, nationally and globally – aiming to achieve the best health for people, animals and the environment. The control of neglected zoonotic diseases requires integrated, strategic One Health approaches across sectors and disciplines. It is also essential to consider economic interests for added value, and societal aspects, recognizing that the societal value extends beyond commercial worth. Because of the complexities of the diseases in each country, country-specific strategies are essential, and there can be no “blanket” approach to control.

2.7.3 M&E, surveillance and response

Regular monitoring and impact assessment is essential to ensure that the recommended intervention package is effective in reducing the burden of the targeted diseases. There is currently no ideal diagnostic tool suitable for field use for detection of FBT infections, taeniasis and cysticercosis. Therefore, the Kato–Katz stool examination will be used as the standard technique in countries in the Western Pacific Region for regular active surveillance. To improve the outcomes and impose a standard across countries and different surveys for the purposes of data comparison, the Consultation recommended that a minimum of two stool samples be collected from each person and two slides be prepared from each stool sample. At least 200 people from among primary school-aged children and adults over 15 years of age should be tested per sentinel and/or spot-check sites. As resources permit, countries, with the support of collaborating academic and research institutes, might employ advanced diagnostic techniques such as ELISA and PCR-LAMP (loop-mediated isothermal amplification), in addition to the standardized Kato–Katz method, at sentinel and spot-check sites to generate supplementary epidemiological information. The partner agencies should also assist with diagnosis and laboratory capacity-building at all levels.

The Consultation also recommended that a mechanism be established to systematically report epidemiological and treatment data both within countries and from countries to WHO, in order to track progress and identify problems at national and WHO region levels. For this purpose, WHO should integrate reporting of FBT infections, taeniasis and cysticercosis with that of other preventive chemotherapy diseases, using the Joint Reporting Form and the Preventive Chemotherapy Epidemiological Data Reporting Form.

As a means of passive surveillance, integration of these diseases in the food safety surveillance and/or the national health information system, if such systems exist, might be considered. Establishment of standard case definitions and reporting guidelines could help improve the accuracy of case reporting through the health system.

2.7.4 Operational research

The following operational research agenda was identified as an immediate priority to generate further evidence, both to inform high-level advocacy and to further improve strategies for the control and elimination of FBT infections, taeniasis and cysticercosis:

- Retrospective study on the association between cholangiocarcinoma and a history of treatment and/or repeated infections with clonorchiasis/opisthorchiasis
- Mathematical modelling to determine the projected availability of improved sanitation coverage and number of years necessary for the implementation of other recommended interventions to interrupt transmission of FBT and taeniasis
- Cost–benefit analysis of comprehensive interventions to make economic arguments for policy-makers and donors
- Application of food surveillance for aquatic products and livestock as a way to identify high-risk areas
- Social science study to identify factors/triggers to motivate primary producers and community members to bring about change.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

The Consultation noted progress in epidemiological mapping of FBT infections, taeniasis and cysticercosis at country level in the Western Pacific Region. It identified countries that have sufficient information to accelerate control interventions, and those that urgently need to complete risk mapping.

While preventive chemotherapy had proven effective in reducing the prevalence of opisthorchiasis, clonorchiasis and taeniasis, participants recognized that multiple factors contributed to high reinfection rates immediately following preventive chemotherapy intervention, such as poor sanitation and food hygiene, the presence of animal reservoirs, and cultural food habits.

The Consultation acknowledged significant worldwide progress over the past decade in developing guidance and tools for the control and management of FBT infections, taeniasis and cysticercosis, both from the public health and food safety standpoints.

3.2 Recommendations

- 1) Community empowerment through the One Health approach, composed of effective risk communication, animal and human treatment, agricultural interventions, food safety and improved WASH, should be the core strategy to accelerate and sustain control of FBT infections, taeniasis and cysticercosis.
- 2) WHO should assist endemic countries in strengthening their capacity to perform regular M&E of interventions and associated severe adverse events for control of FBT infections, taeniasis and cysticercosis, integrated with M&E of other NTDs where possible.
- 3) A mechanism should be established to report systematically epidemiological and treatment data within countries and from countries to WHO, preferably integrated with the reporting of other NTDs targeted for control or elimination by preventive chemotherapy.
- 4) Diagnostic methods applicable to FBT infections, taeniasis and cysticercosis, both in humans and animals, should be standardized at regional and global levels, and WHO should collaborate with the WHO collaborating centres and other academic and research institutions to assist endemic countries in building capacity for quality assurance of such diagnosis.
- 5) Medicine and vaccine requirements to accelerate scale-up of preventive human and animal treatment should be urgently estimated to facilitate sustained resource mobilization.
- 6) WHO should explore more opportunities to collaborate with other relevant international agencies, such as FAO and OIE, in sharing information related to FBT infections, taeniasis and cysticercosis, and jointly supporting countries in adapting the control strategy to their context and building their capacities to intervene throughout the food value chain for effective control of foodborne parasitic diseases.

AGENDA

Objectives of the consultation:

1. To review the current burden and endemicity of foodborne trematode (FBT) infections, taeniasis and cysticercosis in the Western Pacific Region, as well as country experiences and recent research on the control of these diseases
2. To recommend strategic actions and research priorities and estimate resource needs to accelerate control of such diseases in the region
3. To identify and discuss integration opportunities with other disease control and surveillance activities that will contribute to acceleration of the control of FBT, taeniasis and cysticercosis in the Western Pacific Region

Day 1: Wednesday, 17 May 2017		
08:30 – 09:00	Registration	
Opening Session		
09:00 – 09:30	Welcome address	Dr Jong-Koo Lee, Director, JW Lee Center for Global Medicine, SNU, Republic of Korea
		WHO WPRO
	Meeting objectives	Dr Rabindra Abeyasinghe
	Self-introduction of participants and observers	Coordinator, WPRO/MVP
	Nomination of the co-chairs and rapporteur	
	Administrative announcements	Dr Aya Yajima, NTD focal point, WPRO/MVP
09:30 – 10:00	<i>Group photograph followed by coffee/tea break</i>	
Session 1: Current burden of FBT, taeniasis and cysticercosis in the Western Pacific Region		
10:00 – 10:10	Background and overview of the consultation	Dr Aya Yajima
10:10 – 10:30	WHO global overview on FBT, taeniasis and cysticercosis	Dr Bernadette Abela-Ridder, NZD focal point, WHO/HQ
	Discussion	All
10:30 – 12:30	Updates on country burden of FBT, taeniasis and cysticercosis <ul style="list-style-type: none"> ○ China ○ Republic of Korea ○ Lao People's Democratic Republic ○ Viet Nam ○ Other countries in the Western Pacific Region 	<ul style="list-style-type: none"> – Dr Men-Bao Qian, NIPD, China – Prof Sung Tae Hong, SNU, Republic of Korea – Dr Somphoe Sayasone, NIOPH, Lao People's Democratic Republic – Dr Do Trung Dung, NIMPE, Viet Nam – Dr Aya Yajima
	Discussion	All
	Lunch break	
12:30 – 13:30		

Session 2: Preventive interventions for accelerating control of FBT, taeniasis and cysticercosis		
13:30 – 15:00	2.1 Preventive chemotherapy <ul style="list-style-type: none"> ○ Preventive chemotherapy and morbidity (including cholangiocarcinoma) for FBT ○ MDA or selective treatment – lessons learnt on safety and efficacy ○ Preventive chemotherapy for prevention and control of taeniasis and cysticercosis 	<ul style="list-style-type: none"> – Dr Banchob Sripa, Khon Kaen University, Thailand – Dr Do Trung Dung – Dr Aya Yajima
	Discussion	All
Lunch break		
15:00 – 15:30		
15:30 – 17:30	2.2 One Health Interventions <ul style="list-style-type: none"> ○ Contribution of animal reservoirs in transmission of FBT, taeniasis and cysticercosis and One Health Concept ○ Updates on diagnostics, chemoprophylaxis and vaccination of animal reservoirs ○ Impacts and lessons learnt from veterinary interventions <ul style="list-style-type: none"> – Lao People’s Democratic Republic – Viet Nam 	<ul style="list-style-type: none"> – Dr Anna Okello, Federal Dept of Agriculture & Water Resources, Australia – Dr Bernadette Abela-Ridder – Dr Anna Okello – Dr Nguyen Thi Lan Anh, NIVR, Viet Nam
	Discussion	All
18:30 – 20:00	<i>Cocktail reception</i>	

Day 2: Thursday, 18 May 2017

Session 2: Preventive interventions for accelerating control of FBT, taeniasis and cysticercosis (continued)		
09:00 – 09:10	Wrap-up of Day 1	Dr Aya Yajima
09:10 – 10:30	2.3 Safe aquaculture, food production and supply <ul style="list-style-type: none"> ○ Lessons learnt from the 5 keys to safe aquaculture, food, fruits and vegetables ○ Policy options for prevention of foodborne parasitic diseases from food safety perspectives – recommendations from JEMRA to the Codex Alimentarius Commission ○ Methods, impacts and lessons learnt in countries <ul style="list-style-type: none"> – Viet Nam (FIBOZOPA) – China 	<ul style="list-style-type: none"> – Dr Iddya Karunasagar, Nitte University, India – Dr Masami Takeuchi, FAO, Thailand – Dr Bui Ngoc Thanh, RIA1, Viet Nam – Dr Dajin Yang, NCFSSRA, China
	Discussion	All
Coffee/tea break		
10:30 – 11:00		
10:30 – 12:30	2.4 Multi-disciplinary integrated interventions <ul style="list-style-type: none"> ○ Mathematical analysis of transmission dynamics of FBT and its implication for multi-disciplinary interventions ○ Impacts and lessons learnt from the integrated interventions for FBT in Thailand 	<ul style="list-style-type: none"> – Dr Peter Odermatt, Swiss TPH, Switzerland – Prof Banchob Sripa
	Discussion	All
12:30 – 13:30	<i>Lunch break</i>	

Session 3:	M&E, surveillance and response	
13:30 – 13:50	Updates on diagnostics currently available for FBT, taeniasis and cysticercosis	Dr Bernadette Aleba-Ridder
13:50 – 15:00	Surveillance and response on foodborne and zoonotic parasitic diseases <ul style="list-style-type: none"> – China – Republic of Korea – Japan 	<ul style="list-style-type: none"> – Dr Men-Bao Qian – Dr Youngmee Jee, KCDC, Republic of Korea – Dr Hiroshi Ohmae
	Discussion	All
15:00 – 15:30	<i>Coffee /tea break</i>	
Session 4:	Recommendation on programmatic actions and priority operational research	
15:30 – 16:30	Discussion: Goals, targets and milestones for accelerating control of FBT, taeniasis and cysticercosis in the Western Pacific Region	All
16:30 – 17:30	Discussion: Strategic actions for accelerating control of FBT, taeniasis and cysticercosis <ul style="list-style-type: none"> – Intervention options – Responsible parties and potential partners – Integration opportunities 	All

Day 3: Friday, 19 May 2017

Session 4:	Recommendation on programmatic actions and priority operational research (Continued)	
09:00 – 09:10	Wrap-up of Day 2	Dr Aya Yajima
09:10 – 10:00	Discussion: Strategic actions for accelerating control of FBT, taeniasis and cysticercosis (continued)	All
10:00 – 10:30	<i>Coffee/tea break</i>	
10:30 – 11:30	Discussion: Monitoring and surveillance strategy <ul style="list-style-type: none"> – Indicators – Protocols – Integration opportunities 	All
11:30 – 12:30	Discussion: Priority operational research <ul style="list-style-type: none"> – Research agenda – Potential partners 	All
12:30 – 13:30	<i>Lunch break</i>	
13:30 – 14:30	Discussion: Opportunities for resource mobilization	All
14:30 – 14:50	Conclusions and recommendations	Dr Rabi Abeyasinghe
14:50 – 15:00	Closing	Dr Jong-Koo Lee

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Annex 3. Risk-based interventions relevant to control of FBT infections and *T. solium* taeniasis

Risk factors	Prevention measures	Disease			Reference
		Opisthorchiasis/ Clonorchiasis	Fascioliasis	<i>T. solium</i> taeniasis	
Infection of human and animal hosts	Preventive chemotherapy of human in at-risk households/communities	Yes	Yes	Yes	Ov/Cs: 3, 7 FS: 7 TS: 4, 7, 9
	Vaccination of pigs			Yes	TS: 4, 9
	Drug treatment of animal hosts		Yes	Yes	TS: 4, 7, 9
Ingestion of raw or insufficiently cooked, pickled or smoked infected food products	Temperature treatment (freezing or through cooking)	Yes (freshwater fish, fish products)	Yes (aquatic vegetables; animal liver containing immature forms of parasite)	Yes (pig meat)	Ov/Cs: 2, 4, 5, 11 FS: 6, 10, 12 TS: 4, 9
	Food inspection	Yes (fish, fish products)		Yes (post mortem pig meat)	Ov/Cs: 8, 11 TS: 4, 9
	Pre-slaughter drug treatment of pigs			Yes	TS: 4, 9
	Use of clean water for washing aquatic vegetables		Yes		FS: 6, 12
	Hand hygiene during/after cooking	Yes	Yes	Yes	Ov/Cs: 1, 2 FS: 6, 12 TS: 4, 9
Contamination of fish ponds or agricultural/grazing area, pig pens or areas where pigs roam around with faeces containing eggs	Elimination of entry or use of human and animal waste (e.g. filtering of incoming water through a mesh or sand filter before entering the pond, modification of fish pond banks to prevent faecal runoff from entering ponds) or pre-treatment of such waste	Yes (fish ponds)	Yes (grazing area)	Yes (pig farm)	Ov/Cs: 1, 3, 5 FS: 6, 7, 12 TS: 4, 9
	Installation of fence to keep animals away, or contain animals	Yes (fish ponds)	Yes (grazing area)	Yes (pig farm)	Ov/Cs: 3 FS: 3, 6, 7, 12 TS: 4, 9
	Installation of proper on-farm sanitary facilities	Yes (fish ponds)	Yes (grazing area)	Yes (pig farm)	Ov/Cs: 3 TS: 4, 9

Failure to control snails in aquaculture system	Drainage and drying of the pond bed completely for at least 5 days before restocking the ponds	Yes (fish ponds)			Ov/Cs: 3
	Removal of all vegetation in ponds and from the water intake portal of ponds	Yes (fish ponds)			Ov/Cs: 1, 3
	Installation of a liner to the banks of ponds	Yes (fish ponds)			Ov/Cs: 3
	Treatment of the pond with a molluscicide that rapidly breaks down in water suspension (e.g. niclosamide) before fish stocking	Yes (fish ponds)			Ov/Cs: 3
	Biological snail control (e.g. introduction of molluscivore fish)	Yes (fish ponds)			Ov/Cs: 3

Ov: Opisthorchiasis; Cs: Clonorchiasis; FS: Fascioliasis; TS: *Taenia solium* taeniasis

*Paragonimiasis is excluded because the existing guidance for control and prevention of paragonimiasis is limited to preventive chemotherapy and risk communication.

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Annex 4. Currently available field and laboratory diagnostic techniques for programmatic use, type of specimen required and challenges in the Western Pacific Region

Diagnostics	Clonorchiasis	Opisthorchiasis	Paragonimiasis	Fascioliasis	<i>T. solium</i> taeniasis/Cysticercosis
In field setting					
Kato-Katz microscopy	Stool	Stool	Sputum (direct smear microscopy)	Stool (eggs are shed only 3 to 4 months after the exposure)	Stool (low sensitivity; need PCR for speciation; intermittent shedding of eggs)
Tongue palpation (pigs)					Pig tongue (low to moderate sensitivity but highly specific, could be an indicator for high burden; easy to teach community)
In laboratory setting					
Formaline ether concentration technique (higher sensitivity and specificity than Kato-Katz)	Stool	Stool	Stool	Stool (eggs are shed only 3 to 4 months after the exposure)	Stool (intermittent shedding of eggs)
Ag-ELISA	Blood	Blood / Urine	Blood / sputum		Human/porcine cysticercosis: Blood (cannot discriminate NCC from CC; commercial kits are easily obtainable)
Ab-ELISA (non-discriminatory for active and past infection)	Blood	Blood	Blood/cerebrospinal fluid /pleural effusion	Blood	Human/porcine cysticercosis: Blood (cannot diagnose NCC; commercial kits are easily obtainable; high sensitivity and specificity in human but cross-react with <i>T. hydatigena</i> in Asia context in pigs)
Copro-Ag-ELISA	Stool	Stool		Stool	<i>T. solium</i> taeniasis: Stool (high sensitivity and specificity; not yet commercialized)
Copro-PCR (species differentiation possible)	Stool	Stool			<i>T. solium</i> taeniasis: Stool (high sensitivity and specificity; laboratory needs molecular capacity but this is growing in Region)
Immunoblot				IgG antibody to FhSAP2	Difficult to set up and use – laboratory staff requires special training; requires supply from USCDC

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