Food-borne zoonotic trematodes: devious old flukes in an urbanized, global village

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Food-borne trematodes constitute a family of lung, liver and intestinal flukes that have parasitized mankind and domesticated animals since the distant past. In the modern global village, food-borne trematodes present a daunting challenge of infection with severe morbidity, despite being highly neglected as causes of disease. Urbanization is the population shift from rural to urban centers, as a necessity for industrialization and development. It is currently the hallmark of rapidly developing low and middle income countries and usually characterized by both poor planning and sustainability. In many communities, the population shift observed is mainly due to rural-urban migration. With urban industrialization and globalization however, immigration plays a significant role as well. The most significant effect is seen in rapid population growth, beyond the capacity of available resources. Aside from localized businesses, cuisine and cultural centers are the first and fastest growing establishments in newly emerging urban centers. In the low and middle income countries, water and food safety are most affected in this environment. The opportunity for introduction and transmission of imported water and food-borne trematode infections is particularly high in coastal cities or those emerging around major natural and man-made water bodies. A typical outcome of globalization, urbanization and immigration is a rise in the prevalence and spread of food-borne trematodiases.

Keywords: Food-borne zoonotic trematodiases; globalization; urbanization; immigration


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Introduction

The food-borne zoonotic trematodes [FZT] cause infection of the liver, lung and intestines with notably higher prevalences among populations that customarily consume raw or undercooked meat and fish [1]. A WHO workshop on FZT in Asia reported that more than 18 million people were infected in 2002 [2]. Their reemergence and distribution has also been further associated with recent increase in commercial aquaculture and the rapid population growth that comes with urbanization. The estimated current global burden of FZT is at 200 million cases with almost a billion people at risk, mainly in the tropics of the low and middle income countries (LMICs) [3, 4].

Among the trematodes described, the major species implicated in human infection include; Fasciola hepatica and F. gigantica occupying the bile ducts of mammalian hosts [5]
as well as *Clonorchis sinensis*, *Opisthorchis viverrini* and *O. felinus*, as the three highly pathogenic trematodes that cause cancer of the bile ducts [6,7]. The principal fluke commonly associated with lung infection is *Paragonimus westernmani*, among over 10 other species described. The intestinal flukes also comprise over 20 different species infecting man and animals. The main species reported in human infection however are; *Fasciolopsis buski*, *Heterophyes heterophyes* and a few reported cases of *Metagonimus yokogawai* [7].

Schistosomiasis due to different species of schistosome trematodes is the only water-borne trematode infection in humans and animals. *Schistosoma hematobium* infection may cause squamous cell carcinoma of the urinary bladder [7]. Recent studies have registered a strong index of association between development of cancer in later years and early life exposure to parasitic infections. The trematodes feature quite prominently as potential carcinogenic agents [8].

Another significant factor involved in trematode infections is the distribution of their fresh water and amphibian snail intermediate host species. These are usually found in all-year-round fresh water bodies, be they natural or man-made, with a mixed host of human and animal inhabitants in the immediate surroundings [9]. This factor also dictates a higher endemicity of the associated trematodiases among poor farming communities generally situated near large water bodies or in sub-urban and rural areas around fast emerging cities [10]. The food-borne zoonotic trematodiases constitute at least 5 of the WHO declared neglected tropical diseases (NTDs) of poverty [3].

Urbanization briefly entails a population growth, usually of mixed ethnicity, over a determinant density. The UNESCO population summit placed this at 2,000 inhabitants within a defined administrative or local unit [11]. This population growth is mainly a result of migration; emigration, from one’s locality/ country to another and usually permanently, or immigration of foreign populations or ethnic groups into a country or local administrative unit [11,12]. The population dynamics associated with globalization and urbanization or newly emerging cities are quite significant. Emergence of urban centres, especially in the LMICs, has seen over 60% of the global population moving from rural to urban areas [11, 12]. Most of these migrations are initially temporary and are mainly for business, employment, services, education or administrative purposes although less than 10% of such emigrants ever return to the rural areas [13]. Because such migration has in most cases not been well planned, the host administration/ country becomes overburdened with unplanned population growth and unexpected expenditure on the migrants.

Rapid and poorly planned urban population growth in most LMICs is associated with i) poor housing and slum growth, ii) scarcity of clean water and functional toilets as well as iii) poor water and food safety. Where such cities are located near major water bodies or in coastal regions, as is often the case, the risk of transmission of food and water-borne diseases increases significantly [14-16]. This is the case despite the better service provision and infrastructural development of urban compared to rural areas.

Broadly defined, globalization is an event that allows some degree of free transfer of capital, defined forms of goods and services beyond national boundaries. Globalization also comes with the inevitable increase in foreign immigrant populations. Today China, Japan, India and some Middle and South East Asian (SEA) countries are the leading source of expatriate technical labor to LMICs. In Africa this has led to the formation of micro ethnic townships in the major cities [11, 16]. Therefore the establishment of mini locations symbolizing the origin of the inhabitants such as ‘Chinatowns’, ‘Delhi-towns’ and small ‘Thai’ and ‘Tokyo-towns’ are common in rapidly emerging African cities.

Chinese and Asian immigrants to the United States, Canada and United Kingdom have increased overtime. By 1980 there were 384,000 Chinese immigrants to USA. This figure increased exponentially to 2,018,000 in 2013 [17, 18]. The Asian Canadians form a significant minority of the Canadian population. Most of the immigrants are from India, Sri Lanka, Pakistan and Bangladesh, Cambodia, China and Japan. By 2011 there were 5.01 million Asian Canadians [19]. Migration of Asian communities to the UK is high. The 2011 UK Census shows that there were slightly over 3 million Asian residents in the UK who are from a few select places in South Asia.

Asian communities have had a long history of association with Africa. Many African businesses and religious or cultural history is richly intermingled with aspects of Asian origin. Today Chinese immigrants to Africa are a million strong, both legal and illegal [20, 21]. The Indian and South East Asian, particularly Malaysian, Sri Lankan and Japanese communities further constitute another 2.5 million immigrants. These are inevitably located in newly emerging or rapidly growing urban centres, commercial farming and industrial areas [22, 10]. When people establish a new home in a new country they to a large extent retain their cultural practices, including religion, cuisine practices and language among other traditions.
Methods

We searched PubMed/MEDLINE resources, HINARI/PubMed, local, regional and institutional e-libraries such as NIH, CDC, WHO, East African Medical Journal, African Journals of public health, South East Asian Journal of Medicine as well as Vectors and Zoonoses for the following major keywords; “FZTs”, “Food borne trematodiases”, “Fish borne trematodiases”, “Zoonotic trematodiases”, “Liver flukes”, “clonorchiasis”, “paragonimiasis”, “heterophyiasis”, “fascioloisps”, “opisthorchiasis”, “Urbanization”, “Globalization”, “Policy and Health”, “Politics and Health”, “population and disease”, “population dynamics”, “helminthiasises”, “infection and cancer”, “trends in fish borne trematode research”, “urbanization and health”, “aquatic paratenic hosts”, “cholangiocarcinoma”, “liver flukes and cancer”, “trends in cancer research”, “Health and environment”, “lung flukes”, “intestinal flukes”, “one heath initiative” and “one heath paradigm.” We searched published literature from 2000 - 2015. Also we referenced recognized full textbook articles as well as summaries and abstracts containing discernible content. We selected references that fitted to be included in the review. We excluded non-English translated articles and papers/ publications that only focused on animal disease without a zoonotic component. We finally settled for 85 most relevant literature sources out of 420 identified through our search.

Globalization, urbanization and the spread of FBTs: African perspectives

By default, most small communities establish new homes around shopping areas, cultural or religious institutions and food centers. Foreign immigrants naturally and eventually import with them aspects of their culture including marital practices, laws on inheritance and admirable culinary practices. As such, a typical atmosphere of these townships are the foreign cuisine centers thus created [11, 23]. Cultural practices also readily accompany this development. For example sushi markets and sushi restaurants are common wherever South East Asians settle, or local vegetarian delis where Indian communities emerge and persist. In fact, cuisine has been a core tenet of cultural integration from pre-colonial times, and to date is still indicative of such historical cultural associations. Delicacies such as steak tartare, sushi, smoked or salted pork, crab juice, reptile meats and fresh lobster are found on many menus in prestigious and high class hotels even though the traditions in practice are hardly of African origin [23-25].

To date however, raw vegetable, meat and fish consumption are well noted causes of serious infection, from microbial to parasitic infections. The food and fish-borne zoonotic trematodiases have traditionally been known as common infections in China, Korea, South East Asia (SEA) and the Japanese isles [8, 26]. The association of hepatobiliary cancer and the (liver) flukes is a highly published public health concern [6, 8, 14, 27-32]. The rapid population growth and cultural integration that comes with globalization, especially in poorly planned urban centers has witnessed the importation and spread of rare or uncommon infections to communities outside the typical epidemiologic zones/ boundaries. The FZTs present an emerging scenario which is further complicated by limited local awareness on FZT, capacity to diagnose and manage these new diseases in the least developed countries.

The severe morbidity and malignancy associated with the trematodiases in communities where they have been well researched almost mirror the situation in the poorly surveyed and monitored African communities [6, 12, 14, 31, 33-35]. Although schistosomiasis, paragonimiasis and heterophyiasis have been documented on the African continent, most other liver and intestinal flukes have not received much attention and thus present a particularly high risk as Neglected Tropical Diseases (NTDs) of poverty [37, 36-37]. In this review we assess the risks of importation of food-borne trematode infections to the emerging urban centers in Africa as a result of rapid population growth, integration and associated health related dynamics. We also review literature on the impact of the trematodiases as a major component of the NTDs [6, 38, 39].

FZT- Associated Morbidity and Malignancy: The Liver Flukes

Trematode parasites have been increasingly associated with complications like recurrent cholangitis, hepatic tumors, calcification, pancreatitis and cholangiocarcinoma (CCA), particularly in infections by C. sinensis and O. viverrini. Bladder carcinoma and intestinal granulomas have been associated with Schistosome infection and hepatic fibrosis, cirrhosis as well as cholecystitis with Fasciola infection [5, 27, 29-31].

By contrast Schistosomes are unique in morphology, biology and transmission from all the other parasitic trematodes. While the public health importance of Schistosoma mansoni is high, it has also been associated with some hepatobiliary cancers. Schistosoma haematobium causes a severe disease that my lead to urinary bladder carcinoma. Schistosoma mansoni and S. haematobium occur in 53 countries of Africa, the Middle East, India and Portugal [1, 3, 40]. Anything short of a dedicated treatise on the worm and its associated disease spectrum would not accord it sufficient coverage.
As a class, the Trematodes are probably the most sinister of helminth parasites because some of them are associated with malignant complications over and above the main disease manifestations attributed to the parasite per se. The ability of trematodes to cause malignant complications is further compounded by the associated low mortality and hence they are easily neglected as a cause for public health concern. 

Southeast Asian Perspective

*Clonorchis sinensis, Opisthorchis viverrini* and *O. felineus* have been classified as a single organism by many taxonomists. Indeed, the adult flukes and parasite biology are similar, although the premature stages differ significantly to warrant the different classification. The three parasites however have one more aspect in common; a tendency to cause hepatobiliary cancers wherever they have attained endemicity. The association of these liver flukes with CCA has been so remarkable that Thailand, the leading country with reported cases of CCA has attributed most of these cases to *O. viverrini* infection. Infection rates with this trematode in Thailand are as high as 100% in the Lawa Lake basin of Northern Thailand. Indeed the International Agency for Research on Cancer (IARC) has raised these parasites to the status of ‘Group I carcinogens’ due to their definitive causal association with CCA and other hepatobiliary cancers.

The adult worms of these liver flukes, similar to the *Fasciola* species, inhabit the intra and extra-hepatic biliary system. The gravid hermaphroditic worm lays embryonated eggs containing ciliated larvae/ miracidia into the bile, which later get passed in feces into a freshwater environment. The egg is ingested by a primary intermediate host, typically a fresh water snail of any of the species of *Alocinma, Bithynia, Bulimus, Parafossarulus, Semisulcospira* and *Melanoides*. These are usually abundant in wetlands, rice fields and reservoirs with shallow waters, particularly in water bodies close to villages or towns where high fecal contamination of the waters occurs. The eggs hatch into miracidia, which penetrate the snail’s intestinal wall and invade the digestive gland where they develop into sporocysts. These will undergo asexual multiplication to form redial and finally, cercariae. The cercariae exit the snail and penetrate the skin of one of almost 20 freshwater fish of the cyprinoid species. These secondary intermediate or paratenic hosts serve as fresh water reservoirs for the parasite and, as food, they readily ‘carry’ the metacercariae to the vertebrate host. The cercariae invade the fish connective tissues, musculature and subcutaneous tissue where they encyst to form metacercaria, the infective stage of the worm when the fish are eaten by various carnivorous vertebrates.

Cats, dogs, bears, pigs, rats, monkeys and a host of other carnivorous mammals and fish-eating birds are thought to be reservoir hosts for the Clonorchid and Opisthorchid flukes, although man still remains the definitive host. When a human consumes raw or undercooked, infected fish the metacercaria survive stomach acid and digestion. The metacercariae ex cyst in the small intestine, releasing juvenile parasites. These penetrate the ampulla of Vater. They identify the common bile duct and reach the intra-hepatic bile ducts. Here they finally attain sexual maturity in about a month and begin egg laying. 

In aquaculture farming systems the main risk factors for human infections include contamination of ponds and pond environment with FZT eggs from humans, cats, dogs, pigs and fish-eating birds. Similarly, factors that promote diversity of intermediate snail hosts e.g. *Tiaridae* and *Bithynidae* contribute to the risk of acquiring FZTs. The diversity and competitive business practices of culinary perfection play a major role in the transmission of FZTs.

Other Food Borne Flukes: *Paragonimus, Heterophyes* and *Fasciolopsis*

Lung flukes belonging to the genus *Paragonimus* are common in India, Japan and Philippines (*P. westermani*), China, SEA (*P. heterotremus*), China (*P. skrjabini* complex and *P. hueitungensis*), Central and West Africa (*P. uterobilateralis* and *P. africanus*), Central and South America (*P. mexicanus*), Japan (*P. miyazakii*) and North America (*P. kellicotti*). *Paragonimus westermani* is the best known of the lung flukes and could be considered the species type in the genus *Paragonimus*.

*Paragonimus* flukes occur in humans and carnivores worldwide and cause lung, pleural, cerebral or cutaneous diseases. There are 10 *Paragonimus* species capable of infecting humans. Most paragonimiasis cases are reported from Asia and the common offending species is *P. westermani*. Rare and ectopic cerebral paragonimiasis was identified in India.

Briefly, the life cycle of *P. westermani* is as follows: the hermaphroditic adults in the lungs lay eggs which are coughed up with sputum or swallowed and excreted with feces. When the unembryonated eggs in sputum or feces reach a fresh water ecosystem and embryonate, they release miracidia which invade fresh water snails, the first intermediate host. In the snail the miracidium develops to a sporocyst and 2 redial stages followed by the infective
cercaria. The latter leaves the snail to invade a fresh water crustacean, as a second intermediate host. Humans acquire paragonimiasis when they eat raw or under-cooked crabs or crayfish infected by the metacercariae [55].

Several species of Paragonimus detected in the USA are considered to be imported. Paragonimus kelliotti is the only native species described in the USA so far. Non-native species including P. westermani are imported by travelers, vacationers and immigrants [56]. Paragonimiasis in India, Vietnam and Ecuador have been described [9, 57-58]. Consumption of raw crab extract or uncooked crabs is the main source of human infection in India. A Vietnamese review on paragonimiasis showed presence of 7 Paragonimus species, but only P. heterotremus was found to infect humans. The major African species identified is P. africana in West Africa [40].

It has been estimated that more than 50 million people in SEA including Korea, China, Thailand, Vietnam, Laos, the Philippines, Indonesia and India are infected with one of the 59 food-borne intestinal trematode species. Heterophyes heterophyes, H. nocens and Fasciolopsis buski are considered the most important intestinal trematodes [59].

Flukes in the Family Heterophyidae were the largest group mentioned with 9 genera and 22 species [60].

Fasciolopsis buski is the giant intestinal fluke of man and swine. It is an example of a trematode that is transmitted by metacercariae encysted on aquatic plants, such as water caltrop, chestnut, watercress, bamboo and hyacinth [40]. The adult F. buski reside in the human small intestine where they attach to the mucosa of the duodenum and jejunum. Eggs when passed out with stool are unembryonated. After embryonation in water in two to three weeks, the miracidium is released and develops further to the cercaria which is released in water. The cercariae develop into metacercariae and encyst on aquatic vegetation. F. buski is distributed in Asia, Bangladesh, China, India, Indonesia and Taiwan. Snails in the genera Segmentina, Hippeutis and Gyraulus are the intermediate hosts [9, 40, 53, 61]. In the human intestines the metacercaria encysts in the duodenum and attaches to the intestinal wall, grows to adulthood and begins egg laying. Intermediate hosts of F. buski are planorbid snails found in muddy ponds and streams.

Heterophyids are parasites of fish-eating animals and birds. Humans develop heterophyiasis by eating raw fish infected with metacercaria of Heterophyes heterophyes. The highest Heterophyes infection rates occur in Egypt, Iran, and the Sudan [53]. Heterophyes nocens is found in Korea and Japan. In the brackish lagoons of Egypt’s Nile Delta where Mugil cephalus fish is traditionally eaten raw, most children are infected by Heterophyes heterophyes [40]. The parasite resides in the small intestines of humans, dogs, pigs and cats.

Metagonimus yokogawai occurs primarily in the Far East, including Korea, China, Taiwan, Indonesia, Russia and Japan [62]. Although an intestinal trematode of the family Heterophyidae and human parasite, many consider man an accidental host with few published studies focused on the parasite.

The intestinal flukes are generally not considered of serious public health concern, compared with the other trematodiases, which have all been increasingly associated with serious complications as well as grade I and II carcinogenesis [6-7, 36, 39] in humans. Literature on the disease impact and distribution of this group of intestinal parasitic flukes is scanty at best and rather transient. However, this may further drive these parasites up the list of NTDs and, as with similar previously neglected diseases, spring novel findings as research into medicine and science progress. The fact remains that they are parasites (whether accidental or definitive) and their existence within a host will eventually affect the latter’s health and vitality.

Diagnosis, risk factors and treatment

Diagnosis of human trematodiases has improved significantly over the years, both at the clinical level as well as community and national surveys. The sensitive and quantitative Kato Katz technique for stool microscopy is still considered the most definitive diagnostic tool at the clinical level, when the characteristic oval, operculated eggs are seen [8, 24, 26, 28]. Radiological techniques have also been increasingly used at clinical level to view both the worms and the pathophysiologival changes they cause in affected organs and tissue [29, 32, 37]. More sensitive serological tests involving integument extract antigen, circulating antibody, recombinant antigen ELISA as well as highly specific molecular PCR techniques have been developed on several occasions and support the accurate diagnosis and speciation of the trematode flukes [30-32, 63].

Nevertheless, in regions and countries naïve to the FZTs, and particularly the LMICs, these advances in diagnostic techniques are both alien and beyond reach. The supporting infrastructure and skilled personnel to perfect these techniques are not available [3, 49]. An outbreak of FZTs in a typical SSA country would require significant foreign support to effectively diagnose and manage. Yet the treatment options for early diagnosed cases are relatively simple, cheap and available. The Benzimidazole class anthelmintic drugs Triabendazole, Albendazole and Thiabendazole have been effectively used against most intestinal and liver flukes. Combinations with Artemether and Tribendimidine or Nitazoxanide are also under assessment for the liver flukes. Praziquantel is still the drug
Table 1. summary of the features and morbidity of FZTs

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>Common infection source</th>
<th>Human parasitic species</th>
<th>Common intermediate host</th>
<th>Adjusted DALYs (Global)</th>
<th>Distribution</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clonorchiasis (liver fluke)</td>
<td>Fresh water Fish</td>
<td>Clonorchis sinensis</td>
<td>Alociona longicorinis, Parafossolarus spp. and Bithynia sp.</td>
<td>275,370 (peak SEA)</td>
<td>Asia, SEA, Europe</td>
<td>8, 24</td>
</tr>
<tr>
<td>Opisthorchiasis (liver fluke)</td>
<td>Fresh water Fish</td>
<td>Opisthorchis viverrini O. felineus</td>
<td>Alociona longicorinis, Parafossolarus spp. and Bithynia sp.</td>
<td>74,367 (peak SEA)</td>
<td>Asia, Europe</td>
<td>29, 30, 36</td>
</tr>
<tr>
<td>Paragonimiasis (lung fluke)</td>
<td>Freshwater crustaceans</td>
<td>Paragonimus westermani complex P. africana, P. mexicanus, P. kelliotti</td>
<td>Freshwater snails (Semisulcospira cpx spp)</td>
<td>196,710 (peak Asia)</td>
<td>Asia, S. America</td>
<td>50, 53, 57</td>
</tr>
<tr>
<td>Intestinal flukes</td>
<td>Freshwater plants, fish, frogs, snails, snakes, tadpoles</td>
<td>Fasciolopsis buski Heterophyes heterophyes, H. nocens Echinostoma hortense Metagonimus yokogawai, M. takahashii</td>
<td>Fresh water snails (Segmentina, Hippetus, Gyraulus) and muddy streams (Planorbis spp)</td>
<td>83,699 (peak SEA)</td>
<td>Global</td>
<td>60, 62, 71</td>
</tr>
</tbody>
</table>

Table 1 summarizes major features of food borne trematodiases.

of choice for most of the flukes and is still fairly effective, despite some recent reports of emerging resistance [24, 36, 47, 64].

However in the LMICs there is a high significance of risk factors in the acquisition of FZT including: (i) poor water health and safety, (ii) improper waste disposal and more recently (iii) increasing aquaculture and international trade. It is becoming a common occurrence to detect cases of infection in traditionally non-endemic areas. Reported cases of trematodiases among immigrants from SEA countries as well as local inhabitants who have consumed imported fish or recently visited countries in SEA are an emerging pattern worldwide [4, 32, 38, 65].

Additionally, the particular risk posed to emerging African cities, especially those situated along the coast or major water bodies should be recognized. Poor water and waste management, slum growth and inadequate food and water safety are major determinants of acquisition and spread of FBT. Laissez faire importation and customs laws as well as non-existent surveillance or awareness of these threats are added disadvantages in the LMICs [3, 14-15, 66-67]. Policy and the political incentive to prioritize these areas of public health concern have received limited priority. Neglected tropical diseases remain neglected in SSA not only because of lack of awareness and the capacity to curb them, but also because they cause less mortality compared to other diseases for example malaria, tuberculosis, HIV and amoebiasis. Hence the political will to combat the FZTs is negligible [29, 68-70].

Discussion

The zoonotic food-borne trematodiases are different because they have 2 intermediate hosts: snails and fish. Infection is acquired by consuming raw or under cooked fish and vegetables carrying the infective metacercariae. It is debated that studies of relevant snails would contribute to eliminating schistosomiasis and other snail-borne parasites. Malacology has always been a neglected research area in the interruption of trematode life cycle. The global distribution of most fresh water snail species [24, 71-73] presents a particularly high risk with the FZTs. Customs and dietary habits may have limited their distribution previously, but breaching those boundaries creates favorable environmental conditions for effective transmission. The presence of the intermediate and paratenic hosts, lax ecosystem and bio-safety regulations and laws, as well as poor health standards in emerging urban centres provide the necessary exposure for infection [110].

Adopting or changing dietary habits, population growth and movements, global trade of foodstuffs, changes in the food production systems and climate change are emerging drivers for the transmission of human food-borne trematodiases. Of late changes in food preference for ready-to-eat fresh and healthy food and novel ethnic food products is common and regarded as a healthy dietary practice particularly by the affluent class. Currently there is increased international travel, globalization of food supplies and cosmopolitan eating habits commonly present in exotic restaurants worldwide. China’s robust international trade in particular with Africa, America and Europe may result in exportation from China of fish-borne trematodiases into different countries [4, 45, 65].

The advent of the “Cancer Epidemic” on the African continent has been overwhelming; initial upward trends were first noted with the HIV/AIDS epidemic [68, 70]. The disease epidemic hit Africa hardest and the continent is still
struggling under its burden. Cancer and other non-communicable diseases are a new area of public health concern that are significantly stretching the already fragile situation. Worse still, the ability to diagnose and manage these health problems is still rudimentary or very poor in Africa and most LMICs [42, 53–59, 74]. Liver cancer has been associated with parasitic infections for a long time [53, 58, 63, 75–76]. The risks and possibilities of carcinogenesis due to parasitic trematode infections should be widely broadcast and investigated; the ease of preventing and controlling such a sinister disease source cannot be ignored, especially considering its ramifications [36–37, 51, 64].

Policy and politics, however unappealing to many scientists and researchers, play a vital role in the realization of any such schemes [10–11, 31, 33, 76–77]. The significance of political stability in the developed countries, and instability or poor policy in the LMICs is of such importance as can no longer be ignored. Zoonoses can spread even faster when there is political chaos or instability [25, 33, 68, 70, 76]. The association of disease and civil unrest is strong and dates back in time, especially with regard to epidemics and reemergence of previously controlled diseases. Interventions that have worked with HIV/AIDS and Malaria control, as well as Guinea worm and Polio eradication have involved campaigns from policy development to international political commitments. The state of affairs in LMICs is even more fragile, dependent on political systems and policy development through to implementation. With almost non-existent structures and a chronic predisposition to crisis management, LMICs and SSA in particular are stuck in an ever revolving web of reacting to unexpected emergencies with poor crisis management and no plan for sustainability [34, 78].

The recent WHO summit on the Millennium development goals (MDGs), has shifted gears to Sustainable development goals (SDGs) [77–78]. The call to incorporate and prioritize health in policy and planning, particularly in emerging and growing cities is gaining momentum as world health institutions acknowledge that sustainable growth and development are key to realizing health targets [79–83]. The NTDs have also become an area of concern in public health. Having attracted relatively low attention and priority, mostly due to the low associated disease mortality rates, the NTDs have reared the ugly head of morbidity and chronic malignancy. Health bodies the world over are actively advocating to incorporate morbidity as a major attribute of disease and particularly the NTDs [84–85]. The ‘One World: One Medicine: One Health’ approach to the modern challenges that face our highly integrated, commercialized and urbanized global village provides the most promising and comprehensive solution [5]. We need to act in a concerted effort to curb the spread of FZTs as well as manage the associated morbidity they cause.

Conclusions

The FBTs have traditionally been known as endemic to Asia, SEA and the Japanese Isles. Recent population dynamics and integration associated with urbanization and globalization has altered this perceived distribution. The role of urbanization, immigration and globalization in the occurrence of FBTs need to be better appreciated and addressed. The risk of importation and spread of the FZTs in LMICs, especially in SSA does indeed need to be revisited. Health workers and policy makers should recognize the effects of globalization, immigration and urbanization as probable activities that can quickly introduce and propagate FZTs and take appropriate measures to prevent this from happening.

Conflicting interests

The authors have declared that no conflict of interests exists.

Author contributions

Both authors contributed equally to the manuscript.

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