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Life by the river: neglected worm infection in Western Siberia and pitfalls of a one-size-fits-all control approach

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ABSTRACT

The One Health movement aims to provide integrated responses to problems that emerge at the intersections of human, animal, and ecological health. However, it risks derailment due to over-reliance on top-down global responses and generalisations that often fail to fit real-world settings. In this article, we examine the case of parasitic *Opisthorchis felineus* infection in Western Siberia and argue that understanding the local social dynamics of disease exposure and transmission, and how people live their lives in interactions with other species is crucial for making One Health work in practice. This qualitative study was conducted in preparation for developing an opisthorchiasis control programme and involved 20 in-depth interviews, participant observation, and multiple unstructured interviews in the village of Melnikovo. We explored the social dynamics of *O. felineus* transmission and designed a participatory model of these dynamics. This model attests to the specificity of transmission dynamics in Western Siberia and demonstrates the importance of understanding this public health issue as embedded in social networks and animated by a variety of locally-specific linkages between ways of life, food and health cultures, health-care systems, economies, and landscapes. Our work highlights that such participatory approaches have to be an integral part of One Health interventions if these interventions are to be effective and legitimate.

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Introduction

The One Health movement aims to provide integrated responses to problems that emerge at the intersections of human, animal, and ecological health and has gained increasing attention and support

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in recent years (Gibbs, 2014; Zinsstag, Schelling, Waltner-Toews, & Tanner, 2011). Multidisciplinarity in understanding and acting on these problems has been a key defining feature of One Health approaches (Gazzinelli, Correa-Oliveira, Yang, Boatin, & Kloos, 2012). Yet in practice the engagement between the One Health community and social science has been rather limited (Lapinski, Funk, & Moccia, 2015; Rock, Buntain, Hatfield, & Hallgrímsson, 2009). Critical voices have pointed that without social science engagement, One Health risks derailment due to a 'failure to recognize and respect a diverse range of approaches to and understandings of health, of social and cultural difference, of uneven power relations' (Craddock & Hinchliffe, 2015, p. 1). This paper contributes into a growing body of literature that aspires to move beyond top-down global responses and generalisations that often fail to fit real-world settings. Examining the case of *Opisthorchis felineus* infection in Western Siberia, we argue that understanding the local social dynamics of disease exposure and transmission, and how people live their lives in interactions with other species is crucial for making One Health work in practice.

One critique often raised with regards to the current One Health landscape concerns disproportions in how burdens of infection, control, and management are distributed. Cunningham, Scoones, and Wood (2017) note that much of the One Health discussion has concentrated on controlling the outbreaks of high-profile transboundary diseases such as avian flu, Ebola, and Zika, while the burdens of endemic zoonoses tend to remain neglected. Opisthorchiasis in Western Siberia can be viewed as such a truly neglected disease. *O. felineus* is a liver fluke that people can acquire by eating raw or undercooked fish, most often from the Cyprinidae family. The World Health Organisation (WHO) classifies opisthorchiasis, the resulting liver infection, among important emerging public health problems (2012). The major habitat of *O. felineus* in Russia is the Ob–Irtysh river basin, which runs from south to north in the Western Siberia region. The prevalence of *O. felineus* infection in Siberian people has been estimated to be up to 80%, 100–1000 times higher than in the European part of Russia (Bronshtein, 1986; Zavoikin, Zelya, Bragin, Konovalov, & Mikhailov, 1998). A more recent analysis of official medical statistics demonstrated that in the whole of Russia in 2011–2013, the average annual incidence of *O. felineus* infection was 24.7 ± 9.0 cases per 100,000 population (Fedorova et al., 2017). *O. felineus* infection may lead to hepatobiliary morbidity, such as chronic cholecystitis, chronic cholangitis, chronic pancreatitis, and stone disease (Ogorodova & Sazonov, 2016). A number of case reports from Western Siberia indicate the cancerogenic potential of *O. felineus* (Bychkov et al., 2008; Khamidullin et al., 2011).

Currently, no systematic continuous disease control programme has been developed and implemented in the region. To be successful, such a programme would have to be attentive not only to biomedical components of the disease but also to sociocultural processes that animate its transmission and to specificities of the local context where intervention is planned. The importance of such integrated approaches which go beyond biomedical focus of, for example, mass drug administration practices are illustrated by the history of opisthorchiasis control in Thailand (Sripa et al., 2015) and by the experiences with interventions for zoonotic tapeworm *Taenia solium* in Northern Lao People's Democratic Republic (Bardosh, Inthavong, Xayaheuang, & Okello, 2014).

This article contributes to exploring possibilities for and contributions of One Health collaborations involving social sciences (Coffin, Monje, Asiimwe-Karimu, Amuguni, & Odoch, 2015) and argues for a critical public health approach which incorporates local realities on the ground and engages understandings and experiences of those whose health is meant to be improved. The research reported here has been conducted in preparation for developing an integrated programme for opisthorchiasis control in Western Siberia. We explored social dynamics of *O. felineus* transmission and designed what was termed a 'participatory' model of these dynamics (Leach & Scoones, 2013). The classification of zoonotic disease modelling offered by Scoones et al. (2017) distinguishes between models of processes of disease spillover based on theoretical representations of biological mechanisms; pattern-based models employing correlations or statistical associations between empirical data; and models 'involving *participation* of those who live with disease, and who are embedded in the socio-ecologies of concern' (p. 2). Our work highlights that such participatory approaches have to be an integral part of One Health interventions if such interventions are to be effective and legitimate.

Methods

Study area

We performed this study in the Shegarsky District in Western Siberia, Russia. This district is located in the Tomsk Oblast, one of the epicentres of *O. felineus* infection (see Figure 1, online supplementary material). The Ob River, an important breeding site of the infection, encircles the district, which also contains multiple other smaller rivers, streams, and lakes. As of early 2016, the district's approximately 5000 km^2 was home to 19,358 people. Our main study site was the village Melnikovo, the administrative centre of the Shegarsky District, located 60 km away from the nearest city, Tomsk.

This village is a suitable site to explore the dynamics of *O. felineus* transmission because with its population of almost 10,000, it is a setting where elements of both rural and urban life co-exist. People live in single-family houses with garden plots and in low-rise buildings for several families. Recent analysis suggests that in Melnikovo and two nearby smaller villages, Staraya Shegarka and Naschekovo, 86.5% of households are connected to the centralised water supply system and 80% use the sewage system (Shegarski Rural Settlement Administration, 2013). Melnikovo is well-connected with the surrounding areas through the network of paved roads and has two schools (both providing primary and secondary school education) and 94 stores selling mostly food and other staple commodities. At the same time, the village residents live in close contact with nature. In season, many pick mushrooms, berries, and plants in the forest, fish, and, to a lesser extent, hunt; many households grow their own produce and keep cattle.

Fieldwork

The qualitative fieldwork for this study was conducted in June–August 2016. The study team included a sociologist, two medical doctors, a public health specialist with prior experience in qualitative research, and three epidemiologists trained in qualitative research. Our study was performed concurrently with a larger epidemiological study aimed at assessing *O. felineus* infection and the associated risk factors and morbidity.

Our study relied on several avenues of data collection to seek out multiple perspectives and divergent experiences. We conducted 20 in-depth key-informant interviews with individuals randomly selected from among those living in Melnikovo whose stool samples confirmed *O. felineus* infection and who agreed to be interviewed. Of them, four were men and 16 were women, aged 27–87. The interviews were conducted during house visits, which provided opportunities for participant observation and conversations with other household members. Epidemiologists and doctors who were members of our study team also participated in the concurrent larger epidemiological study, which allowed them to perform multiple unstructured interviews with members of many other households in Melnikovo and in other district villages and to observe cooking and eating practices, exchange of opinions regarding opisthorchiasis, and fish trade. During the visits to Melnikovo and surroundings, the study team members also spent time casually conversing with villagers, including fishermen, and were invited to share meals and join gatherings. The fieldwork was conducted in Russian and all our respondents understood Russian.

Data analysis

All key-informant interviews were recorded and transcribed. Observations and points from other interviews were written down in field reports. In the course of the study, the study team regularly reviewed and discussed the data being collected, identifying issues that required further exploration. We identified and cross-checked emerging patterns within and across different types of data and critically discussed our interpretations. The first author manually coded the data, derived analytical themes from the codes of similar content, and related each theme to the others in a conceptual scheme. The analysis was then reviewed by other team members and minor differences were reconciled. The emphasis was

placed on discovering a range of views and experiences and understanding meaning-making patterns of thinking, rather than establishing their specific prevalence. Transcripts are tagged with an interview number.

Ethical approval

This study was approved by the Ethical Committee of the Siberian State Medical University (№ 4815, 27.06.2016).

Results

Our research has demonstrated the several critical elements that, working together, drive the *O. felineus* transmission. They form a participatory model of transmission of this parasitic infection in Western Siberia (see Figure 1). This model attends to the local relationships between disease, livelihoods, and well-being and draws on the understandings and perspectives of those affected. In what follows, we analyse the elements of this model and the connections between them.

Fish for food, leisure, and community building

The first element is the popularity of locally caught river fish as an accessible source of protein and as the main component in a variety of popular dishes, including dishes from raw and undercooked fish. The process of catching and preparing fish is also a hobby and leisure activity, while selling, exchanging, and sharing fish with fellow community members supports not only economic but also social ties.

The opisthorchiasis disease and its association with the consumption of local river fish is widely known among local adults. The vast majority of adults encountered in Melnikovo and the Shegarsy District used the word opisthorchiasis and indicated its association with consumption of local fish. Children, on the other hand, were less likely to be aware of the disease. Also some respondents suggested that infection with the parasite could occur also through touching fish, drinking water where fish infected with *O. felineus* live, or contact with animals that consume fish. While there was some disagreement regarding the exact ways whereby infection occurs, eating fish was unanimously associated with opisthorchiasis by the respondents.

This common knowledge, however, is accompanied by the popularity of dishes from raw and undercooked fish caught in local rivers, including cyprinid fish, which carry the risk of acquiring *O. felineus*.

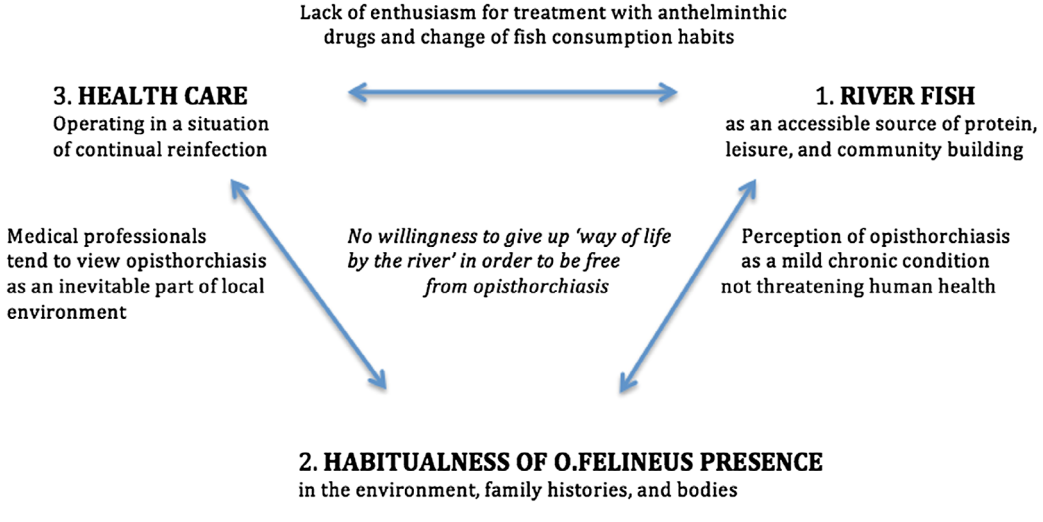

Figure 1. Participatory model of *O. felineus* transmission.

Among these dishes is frozen raw fish ('stroganina'), salted fish, and dried fish (see Figure 2, online supplementary material). Some households have their own smokehouses and enjoy smoked fish. Finally, such methods of preparing fish as frying, boiling in soup, and simmering in sour cream can also be unsafe when done at insufficient temperatures or for an insufficient amount of time. As one respondent summarised:

> Raw, fried, dried, steamed, salted. We love all kinds of fish … In my family we just cannot live without fish. (I11)

Such popularity of fish dishes, including those from raw and undercooked fish, is supported by accessibility of this nutrition source. In villages, towns, and the city of Tomsk, people can buy local fish at prices that compare favourably to prices of meat and sea fish. Not only is local river fish sold in stores, but also individual fishermen sell it in markets and to families they know.

At the same time, fish and fishing have a special significance for local communities. In many families one or more family members do fishing. Few community members identify their primary occupation as that of fisherman. Rather, those who are called fishermen tend to engage in this activity in their free time as a hobby, leisure, and way to support connections with extended family and fellow members of community. For example, when asked whether anyone does fishing in the family, one woman responded 'both husband and son fish … And also people [we] know, friends' (I6). She proceeded to explain that often the entire family goes for holidays or single-day trips together to spend time at the riverside or lakeside. During these trips they occupy themselves with fishing, cooking freshly caught fish, and sharing meals. Another respondent described how she herself likes to fish and does that together with her family regularly: 'Both daughter and son [who] also has his own small fishing rod, I think, like doing it … Just for pleasure or to simply to rest' (I16).

Such frequent fishing trips, either by groups of relatives and friends or by individuals, mean that there is always an abundance of fish being brought back to the communities. Therefore, even families where no one fishes can easily receive their share of locally caught fish, as illustrated by a respondent who answered a question about where they obtain fish:

> You know usually somebody treats us [to fish], our neighbours. We have a cow, we would give them milk and they would give us a bucket of fish. A kind of barter we have. In my family no, we do not have fishermen. (I4)

Since local fish is available, abundant, and associated with leisure and supporting family and community ties, such fish has become an indispensable part of life for many.

The Ob and other Western Siberian rivers and bodies of water are populated, apart from cyprinid fish, by other fish species such as those from Salmonidae family. In their stories, the respondents generally did not distinguish between cyprinid fish and other kinds of local river fish, with the latter being generally fewer, more burdensome, and sometimes even illegal to catch. While local non-cyprinid fish species are associated with significantly less risk of *O. felineus* infection, it is members of the Cyprinidae family, including roaches, breams, and ides, that account for the majority of catches in the area (Yurlova, Yadrenkina, Rastyazhenko, Serbina, & Glupov, 2017).

'Everybody has it': O. felineus *infection as a trait of local populations*

The popularity of locally caught river fish, including Cyprinid fish, interacts closely with the habitualness of *O. felineus* presence for local population, which is the second element that contributes to the local spread of the infection.

Just as the respondents usually correctly identified the association between opisthorchiasis and fish, they also were aware that opisthorchiasis is caused by parasitic worms that live in the liver or, as some put it more generally, 'in our organism'. Local community members are accustomed to the presence of *O. felineus* in the environment. While some of those who took part in this study suggested that being infected with the parasite could lead to unpleasant consequences mostly associated with liver damage, very few shared a sense of danger related to the infection. Underlying this acceptance of *O. felineus* infection as a normal part of life was a perception of its high prevalence among local populations. One respondent estimated that 'here every one in two people most likely has it' (I01), another suggested that 'about 90% has acquired this' (I11), while yet another respondent summed up:

> I think here, by the river, or among those who are somehow connected to the river, everyone is sick with it. (I8)

Supporting this perception of the high prevalence and relatively harmless nature of the infection are common experiences of being diagnosed with opisthorchiasis a long time ago and often, multiple times. Infection is usually diagnosed in the course of routine medical screening that tends to be regularly offered at workplace, especially to those working in state institutions, or when a person is admitted to a hospital, because screening of hospital patients for a number of parasitic diseases, including opisthorchiasis, is mandatory. Typically, in the case of *O. felineus* infection, it is up to the diagnosed individual to take action or, alternatively, refrain from doing so. Therefore, people who are not motivated to immediately seek treatment continue to accumulate instances of being diagnosed and become even less alarmed by the diagnosis. For example, one respondent narrated:

> I contracted it, probably, earlier, already in childhood. Because our whole life, we [here] like fish. So since childhood we have this invasion. I … was 17–18 years old and at some point I was undergoing medical examination and the tests showed plenty … [I learned] accidently, I do not remember was it screening or something else. So now probably I still live with it, why would it disappear? (I4)

Those who have been treated tend to become reinfected. The case of one respondent, who was treated from opisthorchiasis with effective drugs three times in the course of her life, is illustrative. About two years prior to being interviewed, she was diagnosed with opisthorchiasis for the fourth time during a workplace medical screening. When treatment was offered, the respondent refused it and explained her decision, '[Opisthorchiasis] is always there' (I6).

In addition to such personal encounters with opisthorchiasis, members of local communities are surrounded by similar experiences of people they know, and many have family histories of the disease. The following conversation illustrates a typical attitude towards opisthorchiasis that develops in this context:

> Interviewer: So you are diagnosed with opisthorchiasis?
>
> H: Yes…
>
> I: Would you like to treat it?
>
> H: No … Myself and my dad had opisthorchiasis … Nobody treated it … Dad lived to 82, I think. (I2)

Against this background, *O. felineus* infection often appears to local people to be a condition that generally does not threaten their well-being and does not require medical intervention. This attitude also tends to lead to neglecting measures for opisthorchiasis prevention. While respondents pointed out that avoiding raw and undercooked fish is important to protect oneself against contracting the parasites, few paid attention to observing this prevention measure:

> When you already have them [worms], then what's the bother for. If I did not have them, I would not eat raw fish. But when they are already there, they already there. (I5)

Some respondents explicitly added that because of the ubiquitous nature of *O. felineus,* 'no prevention is possible' (I4).

However, there is an important nuance in the understanding of opisthorchiasis. The respondents were aware of instances when the infection manifests itself in acute ways, including vomiting, fever, and pains. Some respondents had even experienced such symptoms first-hand. To reconcile these instances with their overall understanding of opisthorchiasis as a non-threatening condition characteristic of people living in the region, they tended to differentiate between the states of 'having worms' and 'having too many worms'. That is, it is assumed that many if not all people in the region live with *O. felineus* infection, which is part of life 'by the river'; infection becomes a problem only when there appears to be too many worms in the body.

When understood in this way, *O. felineus* infection becomes a mild chronic condition that requires support therapy to control the numbers of parasites, rather than measures for elimination of worms from the body and prevention of reinfection. Correspondingly, to control the numbers of *O. felineus* and support their bodies, people tend to turn to what they consider 'mild' remedies, including folk remedies and natural and herbal supplements. One respondent described the following strategy:

> It is likely that [*O. felineus* is] dangerous when there are many of them, so it is possible to try to poison them. I know many people, they eat fish, but 2–3 times a year they poison them. In such, natural, ways. Some try 'osina' [a supplement based on aspen bark], others brew different herbs. (I8)

With the use of such strategies they attempt to manage the parasitic infection. They aim at coexistence with the parasite and try to help their bodies to deal with this coexistence, without attempting to eliminate what is seen as an inevitable component of the local environment and lifestyle, as analysed in detail in the next section.

Choosing a lifestyle over parasite elimination

The third element is the local health-care system, which operates in the context of continuous reinfection fuelled by the importance of fish and the perceptions of opisthorchiasis as a non-threatening condition among the local people.

The described perceptions of *O. felineus*' ubiquitousness and its non-life-threatening nature lead to a widespread lack of enthusiasm for treatment with anthelmintic drugs, i.e. praziquantel. Treatment with praziquantel is popularly viewed as effective against parasites but toxic and damaging for the human body. Weighing risks and benefits of such treatment, most respondents took into account a high likelihood of further reinfection. In their reasoning, this likelihood would either necessitate repeated treatments with substances they consider poisonous for their bodies or make the initial treatment pointless. Consequently, in their opinion, the risks associated with repeated intake of anthelmintic drugs significantly outweigh the risks of living with the worm infection. In line with this decision-making pattern, a respondent who had been treated twice with Chloxylum (a previous generation anthelmintic agent) and then once with praziquantel explained:

> I would like to, perhaps, treat myself specifically with folk medicines. Now there are some on the basis of … aspen bark. In this way I, perhaps, would like to treat myself, but I do not want to be treated with either Chloxylum or Biltricide [trade name of praziquantel]. It is such a poison, I think. (I6)

A widely preferred approach to managing opisthorchiasis consists of two components. The first is the use of substances considered to affect *O. felineus* but be harmless to the human body to control the numbers of worms. The second component is the use of substances to support the functioning of one's body in the presence of the parasite. People may practice the first or the second component, or both at the same time.

Among substances that are thought to be effective in controlling the numbers of *O. felineus* without having a negative effect on the human body itself, the respondents named the already-mentioned aspen bark as well as dandelion roots, dried chanterelle, pinecone tea, alcohol, and also various commercially available food supplements that contain combinations of different herbs. The story of one respondent can provide an illustration to this approach of controlling numbers of parasites with methods other than anthelmintic drugs. This respondent, a lawyer, also does fishing in his free time and prepares the fish he catches. Once he felt sick, experienced fever, drowsiness, and pains, went to a hospital, and was diagnosed with opisthorchiasis. When offered treatment with praziquantel, he refused and justified his decision:

> I would not do it. I know all these cases, here by the river we all know each other, many of those who were poisoned in this way. Two people I know went through this in a positive way, and the rest – 5 years maximum and they went to a better world. Some had liver failure, others pancreatic failure, yet other had multiple failures of everything. I do not want this chemical stuff yet. Chemicals are in any way killing the body. It is better, I think, to get natural treatments … I know that my grandfather treated himself with … radish juice. He would drink it first thing in the morning and treated himself in this way. He came from the north, where they eat raw fish all the time. And he was perfectly healthy. (I8)

This respondent accepted treatment with a food supplement based on aspen bark. He was also prescribed symptomatic treatment that included several drugs registered for medical use in Russia that are meant to support liver function, normalise digestion, and relieve pain. The acute phase of infection passed and now, in the absence of symptoms bringing discomfort, this respondent considers himself healthy.

The later addition of symptomatic treatment described above belongs to the second component of the popular approach to managing opisthorchiasis, that of supporting the human body in the presence of *O. felineus*. Being generally aware that the worms may affect the liver, pancreas, and gall bladder, people often turn to what they consider 'mild' drugs (as opposed to 'harsh' praziquantel) in addition to folk, natural, and herbal supplements to support the functioning of these organs. Respondents indicated three categories of drugs registered for medical use in Russia and easily available for purchase in pharmacies without prescription that they or those they know use for this purpose: drugs meant to act as hepatoprotectors, that is, to prevent liver damage; drugs with choleretic action; and drugs with spasmolytic action. For example, a respondent who works as a nurse has been diagnosed with opisthorchiasis for many years but never proceeded to receive treatment with anthelmintic drugs:

> Have been treating myself mildly with my own methods, folk herbs … in general all the choleretic drugs. Never treatment with Biltricide. (I4)

Several respondents without medical background also reported self-medication with one or several drugs in these categories.

According to the respondents, a somewhat similar approach to treatment of opisthorchiasis may be found among some medical personnel. In Russia, treating opisthorchiasis with praziquantel is allowed only in hospitals where a patient would have to spend at least several days. Outpatient treatment with anthelmintic drugs is not allowed by the national health-care regulations. Therefore, each patient hospitalised for opisthorchiasis treatment consumes significant health facility resources. In the situation of continuous reinfection and reluctance of many infected people to adopt preventive measures such as abandoning certain fish dishes, some doctors also avoid treating opisthorchiasis with praziquantel. They also may become accustomed to *O. felineus* being an integral component of the local environment and stop seeing it as a health problem, apart from acute cases. For example, one respondent was found to have *O. felineus* infection during a routine health screening at work and did want to be treated. But she received the following response from the doctor:

> We were told that everyone lives with opisthorchiasis, everyone has opisthorchiasis … It is everywhere. It is not necessary to damage one's liver [with anthelmintic drugs], and no treatment is necessary. Such an opinion exists … among medical professionals as well. (I7)

Overall, the respondents generally described a dilemma they face in regard to opisthorchiasis. In their opinion, they must choose between their way of life 'by the river' that includes fishing and consuming variously prepared locally caught fish, and, on the other hand, elimination of *O. felineus* from their bodies. Elimination would entail taking anthelmintic drugs and then changing fish consumption habits. In the context of lack of perceived immediate danger associated with the *O. felineus* infection and the high value attributed to fish-related practices, the choice is more often than not made in favour of preserving way of life. One respondent summed up: 'I don't know about Biltricide … [to take it] it is necessary to lead another, healthy, way of life, without fish' (I6). This respondent, just like many others, was not ready to give up fish.

Discussion

This paper has explored social dynamics of *O. felineus* transmission in a large Western Siberian village. Based on the three elements described and the connections between them, we formed a participatory model of *O. felineus* transmission (Figure 1). By engaging the local context and knowledges, this model attests to the specificity of transmission dynamics in Western Siberia. In the comparatively better explored north-east Thailand, it is fish–rice economies that appear to drive the infection with *O. viverrini*, a close relative of Siberian *O. felineus*. For many north-east Thai villagers, wet-rice cultivation is the primary source of income. Flood plains with rice paddy fields provide a home for different types of cyprinid fish, making fish the primary source of animal protein and also an additional source of income for farmers. Recent studies suggest that wet-rice cultivation binds many Thais to environments favourable to the parasite and strongly influences local food cultures (Ziegler et al., 2016).

The differences between the infection transmission patterns in the two regions of Western Siberia and north-east Thailand highlight the necessity of understanding this public health issue as embedded in social networks and animated by a variety of locally-specific linkages between ways of life, food and health cultures, health-care systems, economies, and landscapes. This has important implications for designing public health interventions. With some notable exceptions such as the Lawa project in Thailand (Sripa et al., 2015), to date helminthic and zoonotic disease control programmes globally have tended to suffer from a lack of consideration for the social, cultural, political, and economic contexts of disease transmission and community responses to interventions (Allotey, Reidpath, & Pokhrel, 2010). The excessive emphasis on biomedical components, first of all on mass drug administration (MDA), with a corresponding lack of consideration for local social realities in control efforts, has been documented by a number of recent studies (Bardosh, Sambo, Sikana, Hampson, & Welburn, 2014; Parker & Allen, 2011). The approach is based on a WHO-endorsed strategy of preventive chemotherapy that provides access to effective treatment of helminthic infection, aimed at lowering the worm burden to reduce morbidity associated with the infection. Donors and decision-makers have enthusiastically accepted the preventive chemotherapy strategy and MDA for populations living in endemic areas as an easily scalable and technically effective way to end diseases affecting mostly the world's poor, a way that is expected to work anywhere, any time. Critical analysts have called such an approach 'magic bullet medicine' (Parker & Allen, 2014). Our study suggests that despite that MDA and related biomedical components of helminthic and zoonotic disease control efforts do bring encouraging results, the overall expectation of such a universal applicability is not realistic. This critique is consonant with a broader plea by social scientists to combine technological fixes or solutions to (global) health problems with adaptations to local circumstances and the involvement of those whose lives are meant to be improved (Engel, Van Hoyweghen, & Krumeich, 2014).

The model of *O. felineus* transmission we offer is necessarily partial since no model can capture entirely the complexities involved. Rather, it is to be put in dialogue with other approaches for challenging assumptions and deepening insights into the context-specific dynamics of disease transmission for truly integrated One Health research and practice (Scoones et al., 2017). Specifically, we would like to highlight two critical points to consider in designing opisthorchiasis control efforts in Western Siberia. Two important views generally characterise local understandings of opisthorchiasis: (1) that opisthorchiasis is a disease of degree, i.e. opisthorchiasis becomes a disease only when there are too many parasites in the body, and (2) that use, especially repeated use, of anthelmintic drugs is unwarranted in Western Siberia. At the first sight, these beliefs appear to be good targets for health education, since they may seem to be in need of correction. However, taking a closer look at the dynamics of opisthorchiasis revealed by other studies suggests a more cautious approach. For example, in a recent publication, Wilcox and Echaubard (2017) argue, '[s]erious hepatobiliary disease associated with liver fluke infection is observed only in cases of heavy infection', concluding that in the case of opisthorchiasis, infection is indeed not equivalent to disease. In terms of control strategies, this opens up the possibility of employing infection intensity rather than infection prevalence to guide intervention strategy (see also Echaubard, Sripa, Mallory, & Wilcox, 2016). The perceptions of Siberians reported here regarding 'regular' and 'too high' 'worm load', then, can be usefully employed as a foundation rather than an obstacle for control efforts.

Negative attitudes towards the anthelmintic drugs can potentially be problematic for an opisthorchiasis control programme. Yet, caution and careful weighing of risks and benefits of different intervention strategies is of crucial importance here as well. Researchers working in Thailand report a contrasting tendency among some Thai villagers, who believe that praziquantel can be consumed safely as many times as necessary and practice frequent prophylactic self-administration of this anthelmintic drug (Grundy-Warr et al., 2012; Ziegler et al., 2016). Availability of the drug that they consider harmless actually works to justify continuation of risky raw fish eating habits. This is worrisome in light of the possibility that, while praziquantel is a safe and appropriate treatment when used a single time, it can be a risk factor for cholangiocarcinoma when used repeatedly in people infected with *O. viverrini*, potentially playing a role in the development of the very condition the drug should prevent through eliminating

parasites (Wilcox & Echaubard, 2017). Although the data on the association between repeated use of deworming drugs and cholangiocarcinoma is not conclusive (Hanpanicha et al., 2017; Kamsa-Ard, Laopaiboon, Luvira, & Bhudhisawasdi, 2014), utmost care must be taken to avoid encouraging overuse of deworming drugs by local people in Western Siberia by the future opisthorchiasis control programme. Given the complexity of *O. felineus* transmission dynamics, the control programme must acknowledge the unique regional sociocultural circumstances, address a broad range of interconnected issues that contribute to this public health problem, and engage local views and understandings. Not doing so may damage local health and communities rather than benefit them.

Conclusion

In this article, we explored social dynamics of *O. felineus* transmission in Western Siberia in preparation for developing an integrated opisthorchiasis control programme in the region. We suggested a participatory model of these dynamics that draws on the understandings and experiences of those affected and highlights the local specificity of *O. felineus* transmission patterns in this setting. This specificity is shaped by the unique interactions between natural landscapes, health-care organisation, and cultural preferences. For an opisthorchiasis control programme to be effective and actually benefit those whose health it intends to improve, genuine engagement with realities on the ground is crucial. Participatory modelling allows for understanding the local relationships between disease, livelihoods, and well-being, all important for explaining disease transmission and making One Health interventions work in practice.

One Health approaches have been criticised for being driven by generalisations that may not fit real-life settings and placing an excessive emphasis on biomedical components (Dzingirai et al., 2017; Green, 2012). Preventive chemotherapy and MDA for tackling helminthic infections is an example of such a general approach that tends to be viewed as effective anywhere, at any time. We suggest that to avoid the pitfalls of 'magic bullet medicine' engagement with local contexts and knowledges is important. Participatory modelling in conversation with other types of data and approaches can improve effectiveness and the legitimacy of One Health interventions.

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