Journal of Evidence-Based Complementary & Alternative Medicine
2017, Vol. 22(4) 902-908

DOI: 10.1177/2156587217723497
journals.sagepub.com/home/cam
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The Battle of Worldviews: A Case Study of Liver Fluke Infection in Khon Kaen, Thailand

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Abstract

Control efforts to reduce infection from the parasitic flatworm *Opisthorchis viverrini* have progressed through understanding the epidemiology of *Opisthorchis viverrini*, antiparasitic drug developments, technological innovations, health education promoting cooking of fish, and improved hygienic defecation. Yet the problem persists. The case study method was used to examine the fundamental cause of the liver fluke infection problem. Evidence shows that the liver fluke–infected population does not care about living a long life. For them, suffering and death are simply a part of life, and expected. Thus, the cause(s) leading to death is not important. They believe morally bad actions, and predetermined fate associated with *kamma* in Buddhism, play a big role whether or not one is infected with the liver fluke. Health interventions may be made more effective if they take into account the liver fluke–infected population's worldviews about ethics, morality, life, and death. We researchers should not feel concerned only about medically determined causes of death.

Keywords

Opisthorchis viverrini, worldview, life and death, infectious disease

Received March 4, 2017. Received revised May 7, 2017. Accepted for publication June 19, 2017.

The parasitic flatworm *Opisthorchis viverrini* is a freshwater liver fluke that infects approximately 10 million people globally.[1] Of these, between 6 and 8 million people in Thailand are infected with *Opisthorchis viverrini*.[2–4] The liver fluke infection is recognized globally as one of the "emerging, neglected, and underestimated problems of world health today."[2] While many infected individuals are asymptomatic or exhibit only mild symptoms, some eventually develop cholangiocarcinoma, a cancer that initially involves the gallbladder and bile ducts and that spreads to the liver and beyond.[5] The prognosis for individuals diagnosed with cholangiocarcinoma is extremely poor—approximately 5000 cases of cholangiocarcinoma diagnosed yearly in Thailand closely matches the number of people who die each year.[6]

Thailand has not been able to reduce the level of *Opisthorchis viverrini* infection, and alarmingly high levels of cholangiocarcinoma incidence remain.[7] Control efforts have focused on understanding the biology of the parasite and its progression toward cancer, methods for early detection, and drug treatment methods. The pathobiology of opisthorchiasis and associated cholangiocarcinogenesis (eg, nitrative and oxidative DNA damage and clinical manifestations of cholangiocarcinoma) have been studied,[8] and the progression from the liver fluke infection to cancer has been well discussed in the literature.[9–11] The country has sponsored community health education on liver fluke infections intermittently since 1967 and has provided low-cost cooking pots and proper fish cooking methods.[12] Spear and colleagues investigated spatial and temporal patterns of *Opisthorchis viverrini* transmission through mathematical modeling techniques (Robert C. Spear, personal communication), as was done in the case of schistosomiasis in China.[13] The model incorporated diverse determinants of transmission dynamics (eg, sanitation practices, rainfall and flooding events, and intermediate host ecology) to simulate the transmission cycle, which can subsequently be used to assess control strategies. Despite these efforts, people continue to eat undercooked fish. In fact, effective mass parasite-control drug administration efforts may hurt more than help because reinfection after medication actually increases the risk of the cancer.[14] Personal

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behavior choices seem to be sensitive topics to talk about and are extremely hard to alter. Wilcox and Echaubard recently raised an interesting point of the complex association between *Opisthorchis viverrini* and cholangiocarcinoma, acknowledging alcohol consumption, chronic psychosocial stress, and smoking as significant risk factors that might be worth considering more than eating of undercooked fish.[15] All in all, this indicates that the existing literature is not helpful and current methods are not adequate to the challenge.

Grundy-Warr and colleagues concluded that we need interdisciplinary research programs that incorporate both "scientific and social methodologies…[within] disease prevention strategies and health education."[2] They suggest that we need to utilize qualitative methods often used in social research to really understand what they called "local knowledge" and incorporate that in scientific-based health education.

Thus, this research approaches the problem by exploring the conditions that might create and perpetuate the liver fluke infection endemic—without targeting a specific change in behavior. We investigate the liver fluke infection endemics on a philosophical level by examining how the worldviews of local villagers shape their attitudes toward life (and death) and thus about health more generally. More specifically, the research examines the worldviews, reasoning, and feelings toward life of the local villagers who consume undercooked fish. The term *worldview* represents people's "holistic and intricate picture of life, including its meaning and significance."[16] What are their hopes in life? What causes illnesses? What are the health and community problems of concern to them? Emotions are also considered here because they help people bond with their communities. Since the causes of liver fluke infection or cholangiocarcinoma (eg, genetics, environment, immune systems, host-parasite fitness) are complex and multifactorial, the worldviews of local villagers may be the more determining factors for behavior change.[17]

Methods

A pilot study was conducted on the premise that local villagers did not understand the basic science behind the infection, much less had the capacity to act on the understanding. To explore this possibility, 300 students, grades 4 through 9, in the local areas completed questionnaires. The questionnaire consisted of 12 questions (for details see Samiphak[17]) that were designed to check students' common misconceptions identified by local teachers and expert researchers in the field of liver fluke infections. Students were required to choose among 4 choices: correct, incorrect, not enough data, and don't know. Example questions included "liver fluke infection is caused by food we eat" and "lime/lemon can kill liver fluke hidden in food." Following the questionnaire, 36 students with various academic abilities were selected by their teachers for 45-minute in-depth interviews. By having real conversations with students and other local villagers, we began to better understand their beliefs and social and cultural aspects associated with eating undercooked fish.

We then developed a more intensive case study to further explore personal and spiritual dimensions about these issues because we felt this information could not be obtained simply by using survey questionnaires and rigidly structured interviews with predetermined questions. We aimed to examine the social and cultural factors involved in people actually eating undercooked fish. The case study was conducted over a 3-month period in 2013 and includes data from participant-observation, interviews, and video recordings.

Participant-Observation

The researchers' role in this study was mainly that of a participant-observer, who participated in the local villagers' everyday life while observing their experiences. To develop rapport, approximately 1 week was spent with each family. We selected 8 participants from Bann Chok Chai village (pseudonym). The village selection was driven by logistics and the practical issues of transportation and time as the host family of the first author lived there. Also, the village was known to have high prevalence of *Opisthorchis viverrini*. A convenience sample was used;[18] the participant recruitment relied on personal connections of the first author's host family. However, the first author and her host family discussed the selection beforehand to ascertain that participants varied in their background of experience (identified by occupation, age, gender, and family structures). In addition, we selected 8 participants who lived in different households, in hope of covering a wide range of thinking regarding their eating of undercooked fish.

Interviews

The interviewees were the same 8 people followed for 1 week during participant observation. This is to make coherent connections among bit and pieces of information obtained by different means. Typically, Thai people would be afraid to voice their honest opinions and they tend to accept any situations to avoid disputes and hence ruin their personal relationships with others. As we learned from the earlier pilot study, many people learned to say what they expect listeners want to hear.[17] Interviewing the same people over time is a way to learn more about what they really think and really do in real life.

Interviews took place at participants' homes, workplaces, or public open spaces where they felt relaxed. We conducted 2 rounds of 45- to 60-minute interviews. The first round was conducted during the fourth day with each participant. This provided enough time for participants and researchers to get to know each other, thus fostering the flow of conversation. The second round was conducted on the last day of each visit to discuss what we learned from them—to confirm the accuracy of observations and ensure that their ideas and concerns were being heard. This served as quality control and helped rule out possible but false rival explanations.[18] Some interviews were videotaped.

A set of interview protocols was used for the first round of interviews. Interviews began with the participants' backgrounds: who they were as individuals, and their views about life. The second part of the interview focused on liver fluke issues: their scientific knowledge and experiences, and their attitudes. The third part addressed learning both inside and outside of school, and how people and their knowledge have evolved with respect to publicly available knowledge. The final part of the interview asked participants to explain their definitions of health, their beliefs about causes of illnesses, and their abilities to recognize and interpret symptoms of liver fluke infection.

However, in reality, the interviews were nonformal and unstructured, with no script. This is a well-accepted method referred to as the Unstructured Interview. Using this method, we strategically placed the questions in the midst of our conversations and actions, so that the *interviews* seemed less intrusive and less awkward for both of us. The order of the questions thus depended on circumstances that lent

themselves to the questions. That said, not all concepts in the interview guide were asked directly; some concepts were given with a pointer, or without asking. Sometimes, their answers came under scrutiny because they contradicted words of other family members.

Setting Summary

Bann Chok Chai (pseudonym) is a small village of approximately 50 families. It is a rural community located within Ban Phai district in Khon Kaen province. In addition to households, more than half of its land area is agricultural land where people grew rice, plants and vegetables, or raised livestock (eg, cows, pigs, and hens). There were many small lagoons, and Kaeng Lawa Lake was located nearby. The local village hospital was located at the opposite end—outside the village area. People from more than 5 surrounding villages shared the same local hospital. There are 2 temples within the Bann Chok Chai village. Between 5 and 10 households sold food in their front yards or open spaces. Food varied from prepackaged traditional meals (eg, beef noodle and *pla-som*), raw vegetables and fruits, to snacks (eg, Lay's). No license was needed to open a convenience store within the village. Some stores even sold liquor.

Economically, most people were poor. The economy was based mainly on agriculture, partly on fisheries. Local villagers live in shack-like houses with outdoor kitchens. They seem to have just enough to survive: food, clothing, accommodation, and medical care. Local villagers grew their own plants and rice, raised animals for food, weaved their own clothes, had a place to stay, and had access to medical care.

The village is richly filled with cultural traditions and history. Local villagers use the northeastern dialect (Isaan language) in their everyday speech, and they speak standard Thai only if they go to the city, public schools, or the periurban areas nearby. Fish is the primary source of protein nutrition that is free and easy to find locally. Selling *pla-som* (a raw fish dish) was typical in the village and nearby markets. Eating certain undercooked fish dishes was a traditional way of living that passed from generation to generation. Those who fish would share excess fish with others—the practice carried out long before Saenna and colleagues discovered that fish sharing itself is a risk factor for the liver fluke infection.[19] Almost every household in the Bann Chok Chai village used charcoal cooking stoves for making everyday sticky rice (or sweet rice), and trash burning was typical. Hence, the smoke produced by heating and burning, along with the smell of animal manure, and muddy and moldy, puddles of water along the streets cause an unpleasant odor around the village. News and information were largely and quickly disseminated through an amplifier and 5 to 7 loudspeakers spread throughout the village—the traditional way of spreading information and addressing the community.[20]

Results and Discussion

In the earlier pilot survey with students, we discovered from the questionnaires that, irrespective of past experiences of eating undercooked fish, the students did have a *basic* understanding of the transmission pathway of *Opisthorchis viverrini*, that is, the understanding that if one eats undercooked fish that were infected with the liver fluke, one can be infected, and later develop cancer as a result. By "basic," we acknowledge the risk of oversimplification of the epidemiology of *Opisthorchis viverrini* (ie, the linear causal chain), as well as the current publicly available scientific knowledge about liver fluke at the time of conducting survey questionnaires. The fact that people recognize the link between undercooked fish and liver fluke infection is not very useful to them. This is analogous to the fact that smoking can lead to lung cancer and circulatory problems. Yet people start and continue smoking every day. In addition, we found that even prior liver fluke infection did not change people's behavior as one might expect.

However, we learn a lot more about this phenomenon from our more intensive observation and interviews with students and villagers. What we learned followed the Grundy-Warr and colleagues' suggestion that local knowledge has great potential to fuse with scientific knowledge.[2] The two seemingly contradictory views are integrated and point to the complexity *of Opisthorchis viverrini* infection.

First, even students understood that the cause-and-effect relationship between eating undercooked fish and being infected with *Opisthorchis viverrini* was not linear. The majority of students said variations of the following:

> For a person to actually have the disease [ie, the liver fluke infection], it all depends on multiple things. For instance, does he/she have enough sleep?…Some people may get used to the eating and will never get the disease; while others who never actually eat undercooked fish, can get the disease.…As I said, it all depends.

In a scientific term, the students may talk about human vulnerability factors (eg, stress-induced sleep habits). Also, a fifth-grade student also claimed, "I see my mom and dad are not infected by the liver flukes, so I followed their habit of eating raw fish." A mother was also perplexed that her parents were not also infected by the liver fluke when they always eat raw fish together with her and her children—a kindergarten girl and a sixth-grade boy.

> You know it is the same fish that we ate—same raw fish. Supposedly those fish were infected by the liver flukes, how come they were not infected; while I and my children tested positive.

In a scientific term, she may speak about biological susceptibility (tolerance) factors—genetic factors—that put her parents at ease regarding the disease. However, these students may generally talk about their views on causes of disease/illness in general that are not necessarily related to what a person eats—it is more complicated than cut-and-dried linear causality. Perhaps, they might imply the theory of *kamma*, which states that "one action brings multiple results and one result is caused by multiple actions."[21]

Second, students surprisingly mentioned about a threshold point at which the live fluke infection occurs. That is, it takes time for the liver fluke to develop. Time in this case implies either amount of exposure or total number of undercooked fish exposure times. This follows recent scientific claim, which states that infection intensity, and not simply prevalence, should be used in devising effective interventions addressing helminth infections.[15]

Table 1. Demographic Data of the Participants.

Pseudonym	Age (Years)	Gender	Primary Occupation	Marriage Status
Ballerina	60	Female	Housewife	Married
Vagabond	31	Female	Seller	Not married
Intellectual Brahmin	63	Male	Religious leader	Married
Superwoman	67	Female	Farmer	Widowed
Sweetheart	44	Female	Farmer/gardener	Married
Peace	55	Male	Local leader	Married
Humanitarian	54	Male	Teacher	Divorced
Kind-hearted nanny	60	Female	Babysitter	Married

Third, the villagers did not perceive the infection as a disease, as seen through the language used in the community. The Thai language of *Opisthorchiasis* or *pa-yard bai-mai tub* (**พยาธิใบไม้ตับ**) in no way emphasizes the infection or damage to the liver. *Pa-yard* means parasite; *bai-mai* means leaf; and *tub* means liver. Directed back-translation of this composite word implies that *Opisthorchiasis* is caused by leaf-shaped parasites, which reside in the host liver. In common usage, the villagers left out the word disease (**โรค**) that is normally put in front of the names of diseases for it to be grammatically correct. This perception is, surprisingly, much closer to the truth that disease is not synonymous with infection. Many liver fluke–infected people "never had and never will have overt signs or symptoms of disease." Symptoms only occur if there are high number of parasites accumulated in individual hosts.[22]

Relatedly, this, in turn, sheds light on the threat of mass administration of antiparasitic drugs; mild infection can be beneficial. At the low infection point, the benefit outweighs the risk of inducing cholangiocarcinoma.[23]

These examples illustrate the convergence of local knowledge derived from students and villagers, and scientific knowledge derived from laboratory scientists or researchers. Nonetheless, there is much to be known on both sides. Why one person survives the deadly disease, such as cancer, when Western medicine offers no hope? Or why one apparently dies with a simple, successful surgery? If not because of epidemic, no one actually knows what causes disease/illness. We can only conjecture own previous actions that may have caused the disease/illness, or merely look through our medical history.

It might now seem that we learned everything there was to know about the conditions that created and perpetuate the *Opisthorchis viverrini* infection in Thailand through interviewing students and local villagers. However, the concepts we put together were based mainly on our attempt to make connections among local knowledge and scientific knowledge. That is, the connections did not coherently arise from the people's own conversations. We had only started to absorb their beliefs and cultures. For instance, during a household visit, an old lady was asked if she ate undercooked fish, and the answer was "no." Yet a raw fish dish was located inside her food cabinet. We seemed to get contradictory and incoherent information, and there was often a mismatch between what they say and what they actually do. Thus, we decided to spend more time knowing the people in context, in hope that they may open up and feel more comfortable expressing their thinking.

We then did a more intensive case study, analyzing data obtained by different means: participant-observation, interviews, and video recordings. We focused on the local knowledge and the local villagers—on the deeper level of their thoughts, worldviews, and attitudes—in hope of its illustrative value for the bigger argument underlying general problems of public health research.

From the case study, basic demographic information on each of the 8 participants (age, gender, prime occupation, and marriage status) is provided in Table 1. We selected their pseudonyms drawn from northeastern cultural traditions. The participants' prime occupations varied within the common agricultural context. Participants consisted of 5 females and 3 males, *all* of whom had eaten undercooked fish. The participants were diverse in age and covered a range of background.

All 8 participants discussed death-related events without being asked. For instance, Intellectual Brahmin encouraged the interviewer to stay indoors during rainy days because a number of cattle and farmers had been killed by lightning strikes. Vagabond updated her mom about neighbors who had recently died, and Vagabond's mother told her about a toddler who died when a car driven by her uncle accidentally backed up over her in a nearby village. In fact, local villagers always greeted a person who has not seen each other for a while by asking whether his or her family members were still alive. It was a way of expressing care—and certainly not being rude in this culture.

More or less, local villagers accepted death as normal. Approximately 30 people were gathered together at Boonsong (pseudonym) place (a 56-year-old dying person suffering from cholangiocarcinoma who lived next to Ballerina's house) to send him to "heaven"—according to a middle-aged woman's words. His daughter-in-law (Boonsong's older son's wife) opted not to leave Boonsong to doctors, and thought it would be best for him to spend his last minutes at home. For her, prolonging life was not necessarily proper. The environment looked as if Boonsong had a party that evening, because people were chatting and greeting each other with a smile. Most local villagers in the scene had strength and courage to sit with Boonsong at his last minute. They were neither frightened nor showed great sorrow. This is a sign of acceptance of a peaceful cessation of life.

Seeing and experiencing frequent suffering while living, most local villagers were prepared to die at any time. Ballerina's life was a vivid example. She has been unable to walk since 2008 after fracturing her left pinky toe and foot bones. She normally remained in her special cradle all day. Her daughter would come and go throughout the day to administer her diabetes drug injections or serve her food. The smell of urine was everywhere. Once she was asked if there was one wish that she wanted come true, and she, along with other female participants, said variations of the following:

> I don't hope much. In fact, I don't expect anything in particular for myself. I only want to have enough [referring to food and money] to live each day.…*I only live day by day waiting to die.*… When that time comes, I must be done paid off my bad *kamma*. But for one wish I can have: I would want my family to be happy, and comfortable.

While the family part was understandable, participants seemed to answer this question in a calm and dispassionate way. More surprisingly, they mentioned their own death as if it would not matter much to their loved ones, and that they had no doubt that others would surely adjust to their absence.

Ballerina represents majority of people in Thailand who practice Buddhism. Buddhists believe in *kamma*. *Kamma*, in Pali, literally means action or doing. More specifically, *kamma* is referred to only intentional action, of which we create through body, speech, and mind.[24] One intentional thought counts as *kamma*, and this action has its own consequences known as "cause and effect."[25] This is similar to "one reaps what one has sown." This belief, along with the belief in the round of existence—a successive cycle of birth, old age, sickness, death, and rebirth—led local villagers to have an impression that health (or disease) could be a result of previous collective good actions (or bad actions) from preceding life. But because we do not have past-life memories and cannot know all of the past causes of an event, believing in *kamma* appears to invoke some kind of fatalism or predestination. This is because actions could happen in one's previous existence and consequences could be seen in this existence. In fact, in everyday usage, Thais are likely to denote unexplainable events, especially misfortunes, to *kamma*. This is not exactly blaming fate and destiny, but instead used to encourage acceptance. As in the case of Ballerina, she became receptive to her life situation. She lived her life as a way to paying off bad *kamma* in her previous and current life, while currently doing good things and thinking positive in hope of getting rewards in the future or in her next life.

Seeing suffering and death as normal and realizing that life and death are a part of the cycle we humans are in, local villagers did not pay attention to any particular diseases. This started to make sense: If death is expected, the cause(s) leading to death will not matter much. When the interviewer asked them about health and community problems, Superwoman and Sweetheart indicated cancer as their concerns. Yet they did not like to specify types of cancer, but instead grouping all types as "cancer"—similar to how local villagers grouped an *Opisthorchis viverrini* infection into a parasitic infection. Only when asked which cancer they were talking about, they would pause to think and try to specify cancer symptoms, or organs that were affected by that cancer. For instance, Sweetheart said, "It was cancer that eats human nervous system" (**มะเร็งกินเส้น** in local dialect). Superwoman and Sweetheart often ended the sentence with "something like that," or "some sort of X cancer," or "I don't really know medical terms."

In the local villagers' view, medically determined causes of death (eg, eating undercooked fish or smoking) were not as important as one's virtue (*kamma*). Buddhists believe in the round of existence, and that everyone's life is fair under the natural, never-failing law of justice—the theory of *kamma*. As mentioned, actions could happen in one's previous existence and consequences could be seen in one's next existence. That is, for some people, the liver fluke infection might be mainly caused by *kamma* in past lives. However, for others, the infection might be mainly caused by their own actions in these lives. Still the actions were not simply limited to eating undercooked fish. Ballerina told one of the authors that Boonsong's wife passed away a few months ago from liver cancer. Ballerina believed that that had much to do with the wife's drinking and arguing, and her morally bad actions (eg, beating up her teen son), rather than the liver fluke infection. Note: According to 1 of the 5 moral percepts in Buddhism, Buddhists should refrain from drinking alcoholic beverages as it hampers the mind that makes decisions to act in certain ways. On Boonsong's last day, every visitor, including Boonsong's father (who lived with Ballerina because of frequent fights with Boonsong), came only to forgive Boonsong of his morally bad actions—whether intended or not. This very act of forgiving confirmed that local villagers believed Boonsong's suffering before death was due to the complex working of *kamma*, and that forgiveness might exhaust the *kammic* effect somehow.

Moreover, the villagers' belief in uncertainty in life causes them to become accepting to anything that life threw at them. Consequently, they paid no concern about a particular behavior that could lead to a particular disease. Agricultural work prepared local villagers for dealing with uncertainty. According to Humanitarian, "Agricultural work makes people stay calm, be patient—knowing to wait for rain and for plants to grow… waiting for the results." They never know for certain how many animals they would get from each birth, thus how much money they will get. Yet they had a great deal of patience. Kind-hearted Nanny never complained about waiting in line at the hospital. She chose to go early at 5 AM and accepted the long waiting time. Vagabond's husband's stepfather, Loong (pseudonym), also accepted that the perception of beauty, and of a *good life*, has changed drastically in his lifetime. "Young generations like to work indoor" (eg, in offices or in factories), so they look pretty with no freckles from harsh sun exposure. Even though Ballerina and Sweetheart believed chemical fertilizers were the cause of unknown diseases in the village, including many types of cancer, they also understood the need of using chemical fertilizers for higher yields and for survival—the uncontrollable

external factors in human life. On one occasion Ballerina said, "What can we do, you know? Farmers work hard and die easily." Loong also compared a farmer in northeastern part of Thailand to an iron man "who has *iron bone*, deserves hard work," and supposedly is free from human emotions unlike other *humans* elsewhere. In the end, no one can escape sickness, old age, and death—regardless of what causes it.

That is to say, the local villagers believe that their willpower and actions to prevent diseases are not sufficient to prolong life. And even though lowering risk factors in preventive health care makes sense, this medical model for prevention leaves room for many legends surrounding unexplained diseases and illnesses. In Sweetheart's words, "For one who does not eat undercooked fish and gets the infection, all you can do is accepting it."

The findings from this research agree with Lyttleton's findings that Buddhist ideology, merit, and karmic attribution powerfully involved in people's explanations for sickness, and the belief that morally good action could lead to happy and healthy life.[20] Local villagers have their own schemas, or individual thoughts embedded in cultural life, which "shaped and [were] shaped by experience[s]."[26] Their views of uncertainty in life, of predetermined fate associated to *kamma* in Buddhism, of ethics or morality, and of life and death play a big role in their decisions to engage in the behavior.

Even though the findings are limited within a single case study, they are worth consideration, because they point to general problems of public health research in which researchers often have preconceived notions about what causes illnesses and do not fully understand and deal with people's worldviews. We probably should reconsider the public health goal of promoting health by simply prolonging life and neglecting these worldviews.

We propose the "life-based model" in place of the disease-based model of medicine in the case of *Opisthorchis viverrini* and cholangiocarcinoma. Focusing on disease alone leads to researchers fixating on linear thinking and control—eating undercooked fish causes the *Opisthorchis viverrini*. *Opisthorchis viverrini* causes liver and bile duct damage, which causes cholangiocarcinoma. To limit the spread of the disease, the infectious disease community mounts intervention programs to reduce the *Opisthorchis viverrini*–infected population. While this disease-based model promotes health and can prevent disease on a large scale, it does not deal with the fact that a disease-free body does not necessarily equate to a healthy life. The life-based model, however, may help us understand better the broader elements of our existence (life and death, health and suffering), that is, what is important in life. Our model starts with the meaning and purpose of life, and how these relate to the mind of individuals who practice certain health behaviors. In the end, environmental control, medical treatment, and health education can only be made more effective if we hold our intentions of reducing the number of new *Opisthorchis viverrini* infections more lightly, and emphasize people's worldviews. Researchers must remember that the causal chain of a problem in itself is limited. There also exist unidentified risk factors that are potentially at the root cause of many health problems. Thus, we need to take each situation as a unique event, and shift our goal slightly as things emerge. Possibly, the number of the infected populations and deaths associated to cholangiocarcinoma may simply reflect the reduced sense of community in the overall Thai populace, and to improve the situation we may need to be conscious of our and others' worldviews.

Conclusions

Regarding the liver fluke infection, the situation can obviously be improved. Better sanitary infrastructure and waste-handling practices can contribute. Educational programs should not be abandoned, but can be made more effective. One should note that education goes both ways—both the population affected by the liver fluke and the government agencies sponsoring health programs need to possess more and better information on the problem and on ways of addressing it. To advocate true community participation, researchers need to pay attention to the importance of sensitivity to community cultural and philosophical worldviews. Because development projects in Thailand commonly exist with predetermined, planned change and certain inputs, it might be best to add the understanding of the people's worldviews to local governmental and nongovernmental implementations. This qualitative value could be worth more than statistics and numbers with no meaning that is often pervasive and well-entrenched in Thai research culture. The findings potentially provide a window into future health intervention in a complex world. We researchers should not feel concerned only about medically determined causes of death (eg, eating undercooked fish or smoking). Our current list of determinants of health would be a little more complete when we consider dominant worldviews prevailing in a particular society.

Authors' Note

All adult participants provided written informed consent, and a parent or guardian of any child participant provided written informed consent on the child's behalf.

Acknowledgments

We are deeply grateful to the editor and friend Dr. Robert Lamoreaux, PhD (UCB), for his patience and support. Publication made possible in part by support from the Berkeley Research Impact Initiative (BRII) sponsored by the UC Berkeley Library.

Author Contributions

Both authors contributed sufficiently to the project. They (*a*) made substantial contributions to the concept or design of the work; or acquisition, analysis or interpretation of data; (*b*) drafted the article and revised it critically for important intellectual content; and (*c*) approved the version to be published. The authors take full responsibility for appropriate portions of the content.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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Ethical Approval

The institutional review boards of the University of California, Berkeley (Protocol ID: 2013-05-5314), and the Khon Kaen University approved the study (HE 561227).

References

1. Sithithaworn P, Yongvanit P, Duenngai K, Kiatsopit N, Pairojkul C. Roles of liver fluke infection as risk factor for cholangiocarcinoma. *J Hepatobiliary Pancreat Sci*. 2014;21:301–308.
2. Grundy-Warr C, Andrews RH, Sithithaworn P, et al. Raw attitudes, wetland cultures, life-cycles: socio-cultural dynamics relating to *Opisthorchis viverrini* in the Mekong Basin. *Parasitol Int*. 2012; 61:65–70.
3. Jongsuksuntigul P, Imsomboon T. Opisthorchiasis control in Thailand. *Acta Trop*. 2003;88:229–232.
4. Sithithaworn P, Haswell-Elkins M. Epidemiology of *Opisthorchis viverrini*. *Acta Trop*. 2003;88:187–194.
5. Sripa B, Bethony JM, Sithithaworn P, et al. Opisthorchiasis and *Opisthorchis*-associated cholangiocarcinoma in Thailand and Laos. *Acta Trop*. 2011;120:S158–S168.
6. Parkin DM. The global health burden of infection-associated cancers in the year 2002. *Int J Cancer*. 2006;118:3030–3044.
7. Sithithaworn P, Andrews RH, Van De N, et al. The current status of opisthorchiasis and clonorchiasis in the Mekong Basin. *Parasitol Int*. 2012;61:10–16.
8. Sripa B. Pathobiology of opisthorchiasis: an update. *Acta Trop*. 2003;88:209–220.
9. Harinasuta T, Riganti M, Bunnag D. Opisthorchis viverrini infection: pathogenesis and clinical features. *Arzneimittelforschung*. 1983;34(9B):1167–1169.
10. Thuwajit C, Thuwajit P, Kaewkes S, et al. Increased cell proliferation of mouse fibroblast NIH-3T3 in vitro induced by excretory/secretory product(s) from *Opisthorchis viverrini*. *Parasitology*. 2004;129:455–464.
11. Thuwajit C, Thuwajit P, Uchida K, et al. Gene expression profiling defined pathways correlated with fibroblast cell proliferation induced by Opisthorchis viverrini excretory/secretory product. *World J Gastroenterol*. 2006;12:3585–3592.
12. Upatham ES, Viyanant V. *Opisthorchis viverrini* and opisthorchiasis: a historical review and future perspective. *Acta Trop*. 2003; 88:171–176.
13. Spear RC, Zhong B, Mao Y, et al. Spatial and temporal variability in schistosome cercarial density detected by mouse bioassays in village irrigation ditches in Sichuan, China. *Am J Trop Med Hyg*. 2004;71:554–557.
14. Pinlaor S, Ma N, Hiraku Y, et al. Repeated infection with *Opisthorchis viverrini* induces accumulation of 8-nitroguanine and 8-oxo-7,8-dihydro-2′-deoxyguanine in the bile duct of hamsters via inducible nitric oxide synthase. *Carcinogenesis*. 2004; 25:1535–1542.
15. Wilcox BA, Echaubard P. Balancing biomedical and ecological perspectives in research framing of liver fluke and cholangiocarcinoma in NE Thailand. *Parasitol Int*. 2017;66:372–377.
16. Tilburt JC. The role of worldviews in health disparities education. *J Gen Intern Med*. 2010;25:178–181.
17. Samiphak S. *Liver Fluke Infection and Fish Consumption in Khon Kaen, Thailand: A Case Study on Negotiating the Middle Ground between Western Science and Eastern Culture* [PhD thesis]. University of California, Berkeley; 2014.
18. Yin R. *Case Study Research: Design and Methods*. 4th ed. London, England: Sage; 2009.
19. Saenna P, Hurst C, Echaubard P, Wilcox BA, Sripa B. Fish sharing as a risk factor for Opisthorchis viverrini infection: evidence from two villages in north-eastern Thailand. *Infect Dis Poverty*. 2017;6(1):66.
20. Lyttleton C. Health and development: knowledge systems and local practice in rural Thailand. *Health Transit Rev*. 1996;6:25–48.
21. Paonil W, Sringernyuang L. Buddhist perspectives on health and healing. *Chulalongkorn J Buddhist Stud*. 2002;1:93–105.
22. Warren KS. The control of helminths: nonreplicating infectious agents of man. *Annu Rev Public Health*. 1981;2:101–115.
23. Echaubard P, Sripa B, Mallory FF, Wilcox BA. The role of evolutionary biology in research and control of liver flukes in Southeast Asia. *Infect Genet Evol*. 2016;43:381–397.
24. Payutto PA. *Good, Evil and Beyond: Karma in the Buddha's Teaching*. Bangkok, Thailand: Buddhadhamma Foundation; 1993.
25. Ratanakul P. Health, disease, and healing: the Buddhist contribution. *Dharma World*. http://www.rk-world.org/dharmaworld/dw_2008odhealth.aspx. Published 2008. Accessed July 21, 2017.
26. McVee MB, Dunsmore K, Gavelek JR. Schema theory revisited. *Rev Educ Res*. 2005;75:531–566.