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Foodborne zoonotic trematode infections in Yen Bai, Vietnam: a situational analysis on knowledge, attitude, and practice (KAP) and risk behaviors

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Keywords

Foodborne Zoonotic Trematode Infections • Liver flukes • Intestinal flukes • Vietnam • KAP

Summary

Introduction. Foodborne Zoonotic Trematode Infections (FZTi) are neglected tropical diseases of public health concern in Vietnam. The transmission of FZTi is linked to human behavior patterns. The aims to investigate the knowledge, attitude, and practices regarding FZTi among local people.

Methods. A cross-sectional study was conducted using a mixed method, which included a baseline survey and in-depth interviews. 375 participants were interviewed face-to-face in the survey, and 27 participants had the in-depth interviews.

Results. The results showed that 36.3% passed the knowledge assessment, 86.7% passed the attitude assessment, and 24% passed the practical assessment. There were differences in average knowledge scores among gender (men higher than women,

$p = 0.006$), ethnicities (Kinh higher than Dao and Tay, $p < 0.001$), and educational level (higher education, higher knowledge score, $p < 0.001$). There were differences in the frequency of eating raw fish between men and women (men higher than women, $p < 0.001$), and in the average practice score between men and women (women higher than men, $p = 0.028$). Eating raw fish and/or undercooked fish, raw vegetables, and drinking untreated water from Thac Ba lake in Yen Bai province were identified as FZTi risk behaviors. The occurrence of these risky habits can be explained by the lack of knowledge on FZTi, poor economic conditions and typical social features of local people.

Conclusion. The current knowledge of local people in regard to safe eating practices is poor. They keep performing unsafe practices, which lead to infection with FZTi; therefore, an integrated control of FZTi is essential.

Introduction

Foodborne Zoonotic Trematode infections (FZTi) are important public health concerns, particularly in South East Asia, and are on the World Health Organization (WHO) list of neglected tropical diseases. FZTi comprises a group of parasitic infections caused by trematodes that are acquired through ingestion of food contaminated with the larval stages of a parasite [1-3]. According to the WHO, it is estimated that 200,000 illnesses and more than 7,000 deaths are caused annually by FZTi, which leads to a disease burden of over two million disability-adjusted life-years (DALYs) globally [4].

Vietnam is particularly susceptible to the development and transmission of FZTi including the following: small liver fluke infections (*Clonorchiasis/Opisthorchiasis*), small intestinal fluke infections (caused by *Haplorchis* spp., *Echinostoma* spp., *Centrocestus* spp., *Echinochasmus* spp.), large liver fluke infections (*Fascioliasis*), and lung fluke infections (*Paragonimiasis*) [5, 6]. Indeed, in this

tropical country, the life cycle of these parasites is maintained by the use of human stools for fertilizing vegetable gardens and fish ponds, and by traditional eating of raw or undercooked fish and/or vegetables. Human cases of small liver fluke infection were reported in at least 21 provinces in North and Central Vietnam [7-9], with prevalent figures ranging from 15-37% [10,11]. While small liver fluke infections are caused by *Clonorchis sinensis* in most Northern provinces, *Opisthorchis viverrini* is the common species in Central provinces of Vietnam [11]. Large liver fluke infections caused by *Fasciola gigantica* occur in 47 provinces and cities, with the highest prevalence in provinces in Central Vietnam, Central Highlands [12]. A total of 11,240 fascioliasis cases were recorded from 2006 to 2009, mainly from Central Vietnam [13]. Infections with small and large liver flukes cause inflammation of the liver, gall bladder, and pancreas, and impaired absorption of nutrients [14]. Additionally, small liver flukes are highly associated with the occurrence of cholangiocarcinoma

(CCA), a fatal cancer of the bile duct [15]. Liver flukes have complex life cycles and epidemiology, in which they exist in different stages and pass through different intermediate hosts such as snails and fishes before they are ingested by humans. The transmission is linked to human behavioral patterns that are related to methods of producing, processing, and preparing foods, particularly, habits or traditional customs of eating raw or undercooked fish and raw vegetables. In order to stop FZTi, changing the behaviors/habits of individuals and communities is important and can be achieved through health education programs. However, before any health education intervention in communities can be developed and implemented, understanding knowledge, attitude and practice regarding disease prevention among a specific community is essential.

Thac Ba Lake, one of the biggest lakes in Vietnam, is the main source of fish in Yen Bai province. It has been reported that the local population has the habit of eating raw or undercooked fish and vegetables, putting them at high risk of suffering from FZTi, particularly *C. sinensis* [16]. The present study aims to answer two research questions: (1) What are the Knowledge, Attitude, and Practice (KAP) regarding to liver fluke infection (including small and large liver flukes) of local people in Yen Bai province?, and (2) Why do people in this province show risk behaviors regarding liver fluke infection?

Methods

STUDY SITES

This study was conducted in two communes (Vu

Linh and Phuc An) in Yen Bai, which is a Northern mountainous province in Vietnam (Fig. 1). The study area was selected because of the reported habit of eating raw fish, which was 86.95% (40/46 interviewees) [17]. Vu Linh and Phuc An have a population of approximately 9,400 people that cover 2,059 households, 10 ethnic groups and 21 villages. In 2017, according to the reports of Commune Health Stations, an estimated 10-15% and 10-20% of the populations of Phuc An and Vu Linh communes, respectively, had small liver fluke infections.

STUDY DESIGN

This study was conducted from February to July 2018 and was designed as a cross-sectional study using mixed methods, including both a baseline survey and in-depth interviews.

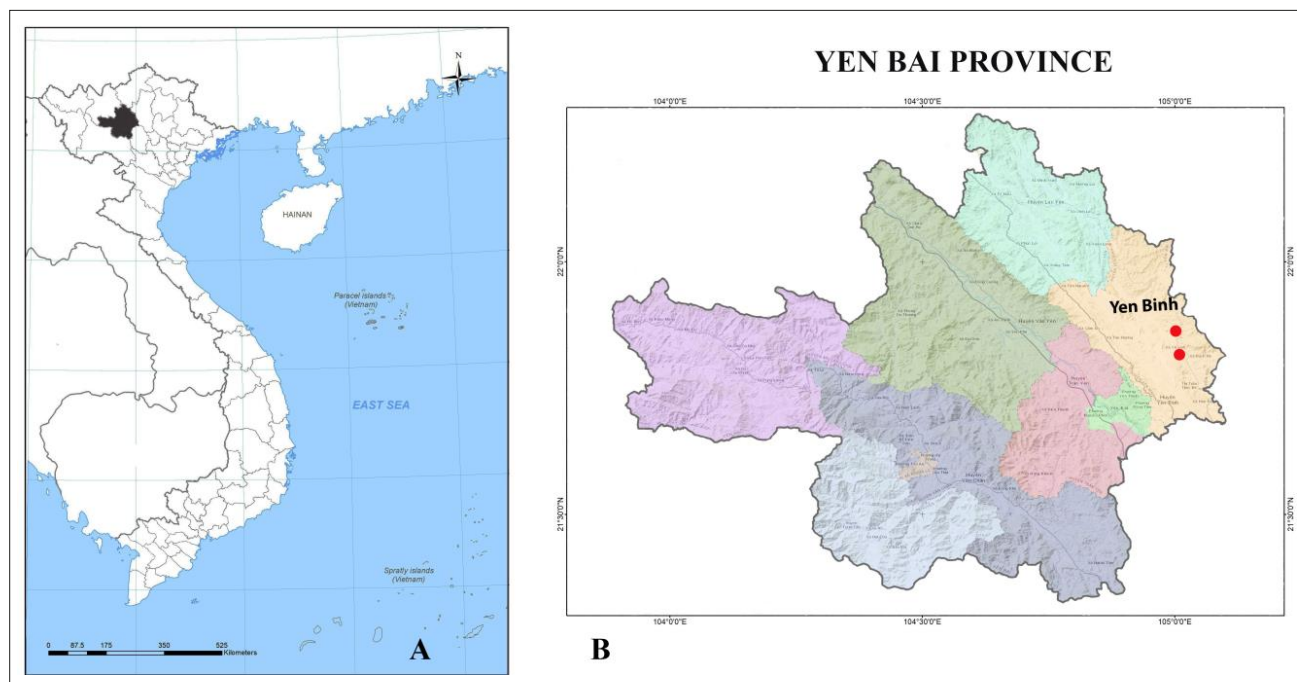
We first performed a quantitative survey on the Knowledge, Attitude, and Practice (KAP survey) of liver fluke among people in Vu Linh and Phuc An, Yen Bai, aged between 15 and 65. This survey aimed to answer the first research question. In this part, participants were invited randomly to be interviewed face-to-face by researchers with the use of a structured questionnaire.

We then performed a qualitative investigation about risk behaviors leading to getting liver fluke infection. In this part, participants were invited to an in-depth interview to provide more detailed information about eating raw fish and raw vegetables and their reasons to explain why they conducted those risk behaviors.

KNOWLEDGE, ATTITUDE, AND PRACTICE (KAP) SURVEY

A KAP survey is a quantitative approach that enables the researcher to study the Knowledge (K), Attitude (A), and

Fig. 1. A. Map of Vietnam with indication of Yen Bai province; B. Map of Yen Bai province with indications of study sites: Vu Linh and Phuc An communes in Yen Binh district.



Practice (P) of the target population. It is the first step to establish baseline data to be used in further assessments such as, selecting the most suitable intervention or assessing the changes after an intervention [18, 19]. The KAP survey in this study is a part of the “Foodborne Zoonotic Trematode Infections and Integrated Control in Vietnam project” (FOODTINC). The survey design needed to fit with other components of the project; therefore, the sample size of the KAP survey was all people selected for the parasitological part of the study [20]. The estimated sample size required for each commune, Vu Linh and Phuc An, was calculated using the following formula with 95% confidence interval, acceptable margin of error $d = 0.05$, and estimated prevalence rate of liver fluke infection $p = 0.15$ according to the annual report of 2017 of the Health Station at Phuc An commune:

$$N = \frac{z^2_{1-\alpha/2} \times p \times (1-p)}{d^2}$$

As a result, among 392 participants randomly selected in the parasitology part, 375 participants at the age of 15 to 65 years were invited to the KAP survey. Participants were invited to be face-to-face interviewed in order to obtain personal data and to determine their knowledge, attitudes and practices regarding prevention methods and risk behaviors related to the disease. The interview lasted for around 15 minutes by using the designed questionnaire on a tablet or a mobile phone. The identification numbers and answers were saved on the electrical devices when the interview ended. In order to measure the knowledge, there were three questions on general awareness, one question on causes to get a liver fluke infection, six questions on basic knowledge including, transmission, symptoms, treatment, re-infection and prevention. In order to measure the attitude of the participants, there was one question on perception of seriousness, one question on concerns, four questions on attitude towards specific habits, and two questions on attitudes towards prevention events and medication programs. In order to measure the practice of the participants, there were three questions on eating raw fish, two questions on eating raw vegetables, one question on drinking untreated water, one question on defecation hygiene (using hygienic toilets), and two questions on diagnosis and treatment.

Data were entered and managed by Kobo ToolBox software (<https://www.kobotoolbox.org/>), processed and analyzed by SPSS 16.0. By giving a score of 1 for each correct answer, the maximum scores for the Knowledge, Attitude, and Practice were 10, 8 and 6, respectively. Each individual obtained a KAP score based on their answers. We used Bloom’s cut-off point of 60% [21] to establish sufficient knowledge, positive attitude, and good practices. In other words, each participant might pass the knowledge section if his/her knowledge score was greater than 6, pass the attitude assessment if his/her attitude score was greater than 4, and pass the practice assessment if his/her practice score was greater than 3. Descriptive statistics were conducted through estimating mean, median, standard deviation (for numeric variables)

and frequencies, rates (for categorical variables). The relationship between demographic characteristics and the KAP score of individuals were tested using correlation test (between two numeric variables), Chi-square test (comparing counts of categorical responses between two independent groups), independent-samples t test (comparing means of two independent groups), and One-way ANOVA/post hoc test (comparing means of many independent groups). A p -value < 0.05 was considered to be significant.

RISK BEHAVIOR INVESTIGATION

In the Risk Behavior Investigation, in-depth interviews were organized to provide more information on characteristics of the risk behaviors including eating raw fish and/or raw vegetable and drinking untreated water from lakes/ rivers and on reasons why people show these behaviors. We used two methods to select the participants. During the KAP survey, the researchers identified people who were at risk of infection and demonstrated a risky behaviors of eating raw fish, and individuals with an existing liver fluke infection based on their fecal/blood test result performed by the another group of the FOODTINC project were invited to the in-depth interview. The second method was snowball sampling. After each in-depth interview ended, the interviewee was asked to introduce or refer to other individuals who were showing risk behaviors. Data were collected using an in depth interview guideline. The topics of the in-depth interviews were about the habits of eating raw fish, raw vegetable, and drinking untreated water from rivers/lakes, reasons, frequency and locations. Participants who reported eating raw fish were also asked about the fish species, the preparation procedure and occasions or seasons when they ate raw fish. Forty-five-minute face-to-face interviews were conducted when researchers visited participants’ house. Each interviewee was given an ID-number and his/her name was saved in a different file to ensure the confidentiality of the data. All the interviews were recorded and transcribed. In this part, the data were coded by deductive approach, which means data were analyzed based on the topics and questions given in the interview. The transcription was re-read at least three times by the researcher. A matrix including rows and columns was created in Excel Microsoft. Each row was one record of one interviewee, and each column was one label of information which was in line with interview topics/questions. Each interview record was filled in the matrix and synthesized according to topics.

RESEARCH ETHICS

The activities in the current study were under the “Foodborne Zoonotic Trematode Infections and Integrated Control in Vietnam” (FOODTINC) project, which was approved by The Science, Technology and Ethics committee at the National Institute of Malariology, Parasitology and Entomology (Decision number 113/QĐ-VSR, January 25th, 2018). The study was also approved by the Ethics Committee of the Faculty of

Behavioral, Management and Social sciences (BMS) of the University of Twente (Request number 18299). Before the field trip, the Provincial and District Health Office were informed and asked for a permission to work in the selected communes. Participants who took part in the study were informed and explained sufficiently about the aims and the contents of the research by documents that included two forms: 1) Rights and Responsibilities, and 2) Consent Form. All collected data were processed anonymously.

Results

KNOWLEDGE, ATTITUDE, PRACTICE (KAP) SURVEY

Demographic information

Among the 375 participants, 59.2% (n = 222) were female; 53.6% of participants were between 31 and 50 years old, 61.9% belonged to a minority ethnic group (Dao, Tay, Cao Lan, Nung, Muong, Pati), with Dao being more predominant (48.3%). In terms of education, 77.6% of participants were under the level of secondary school with 10.9% people not having attended school at all (n = 41). Only 2.7% of the participants had a bachelor degree (n = 10). The main occupation of participants was farmer (60.8%), and only 6.9% were government officers.

Knowledge on FZTi

Of all participants, 88.5% had heard about liver fluke (n = 332), but only 1% could name at least one type of liver fluke (small or large liver fluke) (Tab. I, II). When it comes to the way of transmission, less than half of participants gave the correct answer (49.1%, n = 184), 15.2% of all participants stated they did not know the way liver flukes are transmitted, and 24.3% of all participants had a wrong understanding on the transmission of liver fluke infections (n = 91), they believed that liver flukes can be transmitted from human to human. With regards to the symptoms of liver fluke infection, an open question was asked. A total of 44% of participants did not know the symptoms of liver fluke. Weight loss and jaundice were the two commonest symptoms that participants had listed, followed by the symptoms of decreased appetite, itch, and dyspepsia.

Of all participants, 36.3% passed the knowledge assessment by answering more than 6/10 correctly (n = 136). The correlation between the age of participants and their knowledge score was explored using correlation analysis. Results indicated that the higher the age of the participant, the lower the knowledge score he/she had. Old people highly likely had a low knowledge about liver fluke infection. There was a weak but significant negative correlation between participants' age and their knowledge score ($r = -0.165$, $p = 0.001$). There were significant differences in the average knowledge between males and females ($p = 0.006$), between ethnic groups ($p < 0.001$), and between education levels ($p < 0.001$) (Tab. I).

Attitude on FZTi

Of all the participants, 84.3% believed that being infected with liver fluke is a moderate or very serious condition (n = 316), but only 54.4% were really concerned about liver fluke infection (n = 204). The distributions of participants' attitude toward the risky and healthy behaviors of preventing liver fluke infection are presented in Table III. It is noted that only people who had heard about liver fluke infection (n = 332) were asked to give their reaction on statements regarding behaviors in avoiding liver fluke. Although 43 people (11.5%) had never heard about liver fluke infection, they were willing to take part in the communication and treatment program. A total of 99.5% of all participants were willing to take part in communication events on liver fluke infection, and they would be willing to take part in a free diagnosis program and willing to be treated if they got the disease (n = 373).

Of all participants, 86.7% passed the attitude assessment with an attitude score of more than 4 (n = 325). There was no correlation between participants' age and their attitude score ($p = 0.592$). The attitude average scores were also not associated with demographic characteristics (Tab. II).

Practice on FZTi prevention

Of all 375 participants, 54.9% reported to have eaten raw fish at least once in their life (n = 206), among which 48.1% drank alcohol while consuming raw fish (n = 99). Regarding vegetables, 91.2% of all participants reported to have eaten raw vegetables at least once in their lifetime (n = 342), and 10.4% admitted to have drunk untreated water from lakes/streams in the last three months (n = 39). Regarding to defecation hygiene, only 71.1% of participants used hygienic toilets (n = 269). The rest of the participants did not use hygienic toilets, and 8.3% of all participants did not even have a toilet in their house (n = 31), they discharged faeces freely in the environment. Regarding diagnosis and treatment, 29.3% had their faeces examined for liver fluke infections (n = 110), and 19.2% had received a fluke treatment (n = 73).

The frequencies of eating raw fish/raw vegetable are presented in Figure 2. Many people explained that they ate raw fish because it was delicious (20.5%, n = 77). Only 1.6% of participants thought it was cool and tonic for their body, and 1.6% confirmed it was their habit (n = 6). 5.6% of respondents did not like eating raw fish, but they ate it with family and friends (n = 21).

The practice of eating raw fish was significantly higher among men than women, with percentages of 61.65% and 38.35%, respectively ($p < 0.001$). There was no association between age and ethnicity with the practice of eating raw fish. Of all participants, only 24% of participants had passed the practice assessment (n = 91). There was no correlation between the age of participants and their practice score. The average practice scores by demographic characteristics are presented in Table II. The average practice score (SD) of the female group was 2.85 (0.98), which was

Tab. I. Average score in Knowledge, Attitude, and Practice by demographic characteristics of 375 participants in Yen Bai province.

Demographic characteristics	N	Knowledge score		Attitude score		Practice score	
		Mean (SD)	P-value	Mean (SD)	P-value	Mean (SD)	P-value
Total	375	4.48 (2.07)		6.55 (1.90)		2.75 (1.01)	
Gender							
Female	153	4.25 (2.13)	0.006	6.59 (2.05)	0.657	2.85 (0.98)	0.028
Male	222	4.84 (1.92)		6.50 (1.66)		2.61 (1.05)	
Ethnicity							
Kinh	143	4.96 (1.85)	< 0.001	6.71 (1.69)	0.143	2.88 (1.00)	0.379
Dao	181	4.05 (2.18)		6.38 (2.08)		2.69 (1.08)	
Tay	24	3.88 (2.25)		6.17 (2.30)		2.58 (0.65)	
Cao Lan	24	5.42 (1.32)		7.21 (0.78)		2.71 (0.81)	
Other	3	6.00 (1.00)		7.33 (0.58)		2.33 (0.58)	
Education							
No education	41	3.02 (2.17)	< 0.001	5.90 (2.44)	0.209	2.80 (0.95)	0.401
Primary school	103	3.91 (2.14)		6.56 (2.12)		2.63 (1.17)	
Secondary school	147	4.73 (1.95)		6.63 (1.82)		2.74 (0.98)	
High school	62	5.32 (1.59)		6.63 (1.44)		2.82 (0.88)	
Vocational School	12	5.75 (1.14)		7.33 (0.78)		3.08 (0.90)	
Bachelor	10	6.20 (1.03)		6.50 (1.18)		3.20 (0.79)	
Occupation							
Farmer	228	4.29 (2.08)	0.098	6.64 (1.98)	0.685	2.74 (1.04)	0.356
Worker	9	4.44 (1.94)		6.22 (2.17)		2.56 (0.88)	
Student	5	6.20 (1.64)		6.20 (1.48)		2.60 (1.14)	
Government officer	26	5.54 (1.53)		6.54 (1.39)		3.19 (0.80)	
Freelance	60	4.48 (2.11)		6.32 (1.88)		2.73 (1.06)	
Fish seller	5	7.00 (0)		8.00 (0)		4.00 (0)	
Fisherman	13	4.75 (1.48)		6.67 (0.98)		2.42 (1.08)	
Business	15	4.87 (1.77)		7.00 (1.60)		2.80 (0.86)	
Unemployed	14	4.36 (2.90)		5.64 (2.53)		2.86 (0.86)	

significantly higher than the average practice score (SD) of the male group with 2.61 (1.05) (p = 0.028). Other demographic characteristics had no association with the practice score.

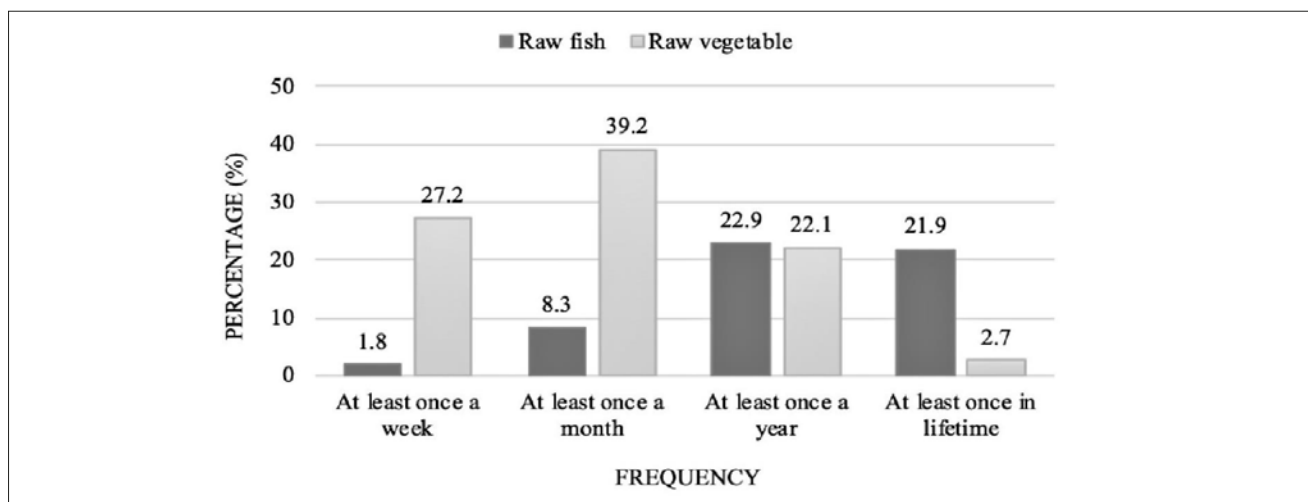
There was a significantly positive correlation between the knowledge and the attitude scores (r = 0.699, p < 0.001). There was no correlation between the knowledge score

and the practice score (r = 0.083, p = 0.109), or between the attitude score and the practice score (r = 0.081, p = 0.116).

Risk Behavior Investigation

A total of 27 people, aged between 25 and 64 years, took part in the in-depth interviews, in which 16 came from

Fig. 2. Distribution of raw fish and raw vegetable eating frequency of 375 respondents.



Tab. II. Main participants' responses to knowledge questions on liver flukes.

Question/Statements	Correct answer		
	n	%	
General awareness			
Have you ever heard about live flukes?	332	88.5	
What kinds of liver fluke do you know? (Participants were expected to name at least one type of liver fluke (small or large liver fluke))	4	1.06	
Does liver fluke affect human health?	325	86.7	
Causes			
How can people get liver fluke infection?	By eating raw fish	275	73.3
	By eating raw vegetables	158	42.1
Treatment			
Liver fluke infection can be treated by drugs	219	58.4	
Liver fluke infection cannot be treated by drugs	74	19.7	
Respondents did not know whether liver fluke infection can be treated by drugs or not	82	21.86	
Re-infection			
After patients with liver fluke infection are successfully treated, they cannot get reinfected (Participants were expected to state that this sentence is wrong)	231	61.6	
Eating infected fish always causes liver fluke infection, whether or not the fish is cooked (Participants were expected to state that this sentence is wrong)	121	32.3	
Prevention			
Liver fluke cannot be prevented (Participants were expected to state that this sentence is wrong)	218	58.1	
Symptoms			
What are the symptoms in people infected with liver fluke?	210	56.0	

Vu Linh commune and 11 from Phuc An commune. Thirteen participants were selected from the KAP survey when they were showing the habit of eating raw fish and they were open to share their story of eating raw fish. The rest of the participants were introduced by the previous interviewee in the in-depth interviews or the village health workers.

"Gỏi cá" is a popular Vietnamese name of a raw fish dish eaten by local people in Vu Linh and Phuc An, Yen Bai. Three respondents reported that the practice of eating raw fish started in the 1970s when Thac Ba Lake was created, following the construction of the Thac Ba Hydropower dam. The other respondents declared that they had seen the practice of eating raw fish for decades. Many participants reported that they had eaten raw fish since they were young. The information of eating raw fish ("Gỏi cá") is summarized in Table IV. Interviewees reported that most fish consumed raw is caught in Thac Ba Lake. The local people consider fish from Thac Ba lake fresher, cleaner, and more delicious than fish originating from the few fishponds in the area. In addition, fishes in the lake are readily available, easy to catch and are free. Ditch fish (*Hemiculter leucisculus*) and Snake-head fish (*Channa* spp.) are the fish species that are most preferred in raw fish dishes because of their firm and tasty flesh. However, the Nile Tilapia (*Oreochromis niloticus*) was the most common fish species for making raw fish because of its availability in the lake. Some people reported that other fish species such as, Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella*), Big-head carp (*Hypophthalmichthys nobilis*), Cyprinid carp (*Cultrichthys erythropterus*), Red-eyed carp (*Squaliobarbus curriculus*) were also used to

prepare raw fish dishes. Most fishermen had the habit of sharing raw fish together. After returning from fishing, they usually gather to prepare "Gỏi cá" and drink alcohol. Some of their family members, including women and children may also join and enjoy raw fish.

It was reported that raw fish was consumed mainly in the summer and autumn (April to September) which is the rainy season in North Vietnam. Local people said that during this period, fish had finished the breeding season; therefore, the fishes were firm, fishes had finished the breeding season; therefore, their flesh were firm fat, and there were no eggs inside the female fishes, which led to a better taste. This period was also reported as the annual fishing time. However, some people admitted that they may eat raw fish anytime in the year, and they did not care about the season. Regarding the population who consume raw fish, people admitted that there were not any differences between age groups among adults who ate raw fish. However, it is highly likely that men consumed more raw fish than women because raw fish eating is often associated with drinking alcohol. Fishermen or people who lived by the lakeside were highly likely to have the habit of eating raw fish.

In the study sites, people usually grow herbs and vegetables in their garden and use water from wells or from the Thac Ba lake. Raw vegetables and herbs were used as ingredients to prepare raw fish dishes. Many fishermen reported that they drink untreated water directly from Thac Ba lake during the time they go fishing.

Tab. III. Distribution of participants' attitude toward risk and health behaviors, measured with four statements.

Statement	Attitude Scale		
	Disagree	Neither agree nor disagree	Agree
To prevent liver fluke infection, I do not eat raw fish or undercooked fish anymore	4 (1.1%)	7 (1.9%)	320 (85.3%)
To prevent liver fluke infection, I do not eat raw vegetables anymore	69 (18.4%)	27 (7.2%)	235 (62.7%)
To prevent liver fluke infection, I do not defecate in a public space	1 (0.3%)	2 (0.5%)	329 (87.7%)
To prevent liver fluke infection, I do not feed fish with fresh human or animal faeces	11 (2.9%)	15 (4.0%)	306 (81.6%)

Tab. IV. Summary of information on the habit of eating raw fish in Yen Bai Province.

Interview topic	Main answers
Origin of fish	Mostly from Thac Ba lake, rarely from fish ponds
Fish species	Mainly: Ditch fish, Snake-head fish, Tilapia Other: common carp, grass carp, silver carp, squaliobarbus, cyprinid fish
Preparation procedure	Fish is washed and cleaned, and then cut into thin slices (2-3 mm). After that, it is marinated with lime juice, salt and seasoning for 15 to 30 minutes. Finally, it is mixed with fried rice powder and herbs (or raw vegetables)
Location of eating raw fish	Home or friend's home
Occasion	No special occasions, usually after people catch fresh fishes and drink alcohol together
Seasons of eating	Mainly in summer, rainy season, from April to September. Some people reported that they eat raw fish year round

REASONS OF LOCAL PEOPLE PERFORMING RISK BEHAVIORS

Habit shaped by previous generations

Firstly, it was confirmed by local people that the habit of raw fish consumption (*Gỏi cá*) is not a traditional custom or culture. Indeed, 26/27 participants declared that raw fish eating was not a traditional custom, and a few of them said that raw fish is not served at traditional festivals or on special occasions. They believed that the habit of eating raw fish appeared many years ago and was passed between generations. Therefore, eating raw fish is a habit shaped since people were young.

Consequences of poor economic conditions and cultural factors

The habit of eating raw fish was the consequence of poor economic conditions. In fact, most people are farmers without a stable income, and they produce and consume agricultural products mainly for home consumption. Therefore, fishing is a way to earn more money and to improve their daily meal. Fish has become one of the main food sources. Numerous respondents reported that the poor economic conditions made them less concerned about their health. Sometimes, fish was the only food they had, and they prepared fish in ways to be easily eaten, such as, *Gỏi cá*. Social factors also affect the habit of eating raw fish. As mentioned above, fishermen declared to share and enjoy raw fish together, and this action enabled this habit to pass from person to person. At those meals or parties, people enjoyed consuming raw fish with alcohol, and it was seen as a way for people to socialize. Another culture in Yen Bai is that people often invite their friends to try strange or delicious dishes such

as raw fish. Some people reported that they did not like or did not want to eat raw fish because of health risks, but they could not refuse the invitation from their hosts.

Lack of knowledge on liver fluke infection

One of the important reasons which leads to risk behaviors among local people is that they lack the knowledge on FZTi. Instead of knowing that eating raw fish is a bad habit, they believed that it is tonic and good for their health. Most interviewees (19/27) reported that they like eating raw fish because of the taste. Men confessed that they would still keep the habit of eating raw fish after knowing the risk of getting liver fluke infection, because they know that the disease can be treated well by drugs. While many participants were not aware of the risk of getting liver fluke infection when eating raw fish or raw vegetables, a few knew about the risks of raw fish consumption, but they kept this habit because of insufficient or wrong knowledge. As a consequence of lacking knowledge on liver fluke infection, many people underestimated its harmfulness and showed a bad attitude towards prevention.

Discussion

By applying both quantitative and qualitative research methods, we found that: (1) the knowledge regarding liver fluke infection among local people was low, with 11.5% of all participants having never heard of liver fluke, and only 36.3% passing the knowledge assessment; (2) the attitude regarding liver fluke infection and its prevention was quite positive, which was determined by 86.6% of all respondents passing the attitude assessment; and

despite the fact that many people had not heard about the disease, they were willing to join a communication or treatment program if applicable; (3) the proportion of people with good practice was low with only 24% of all participants passing the practice assessment; and (4) the habit of eating raw fish in Yen Bai was not only a consequence of a lack of knowledge but also related to economic and social factors.

The KAP scores of the participants in the current study were lower than those reported in Northeast Thailand by [22]. Although Thailand and Vietnam share many features including, the climate, the culture, and the practice of eating raw fish, overall the economic conditions are better in Thailand than in Vietnam. Thailand is one of the most developed countries in the region, with a GDP per capita of 7,806.96 USD compared to a GDP per capita of 3,416.23 USD in Vietnam (2019) [23]. Therefore, the participants in the Thai study might have had a higher education level than the participants in this study. Furthermore, differences of the study designs might also have caused differences in KAP results. For example, the knowledge of Thai participants was ranked as good if the score was above the median, which is different from the interpretation of the KAP scores in the current study [22].

We also found differences in the KAP results in people from Yen Bai and from other areas in Vietnam. The knowledge and practice results of residents in Yen Bai were lower than, in Thanh Hoa, in Central Vietnam, where 46.5% and 30.6% of the studied population passed the knowledge and practice assessments, respectively [24], and in Phu Yen, in South Vietnam, where 39.2% and 40.1% passed the knowledge and practice, respectively [25]. While only 33.3% of the studied population in Phu Yen ate raw fish, we found Yen Bai province was 54.9%. In contrast, the attitudes of people in Yen Bai were more positive than that in Thanh Hoa and Phu Yen. Indeed, most people in Yen Bai were willing to take part in communication and treatment programs. The differences among these studies may be explained by the study design and we could not confirm whether the differences among populations in the three provinces are statistically significant. Interestingly, the provinces in the three studies represent the three regions in Vietnam, *i.e.* the North, the Centre, and the South.

In the current study, the population was living in a rural mountainous area with a general low educational level. A high proportion of the population was farmer with the habit of going fishing in Thac Ba lake. The results in the risk behavior investigation showed that the practice of eating raw fish was affected by gender. Specifically, men were more likely to eat raw fish than women because men usually went fishing together, after which they would gather to drink alcohol and eat the raw fish. Women who ate raw fish mostly belonged to households in which the father, the husband or the son had a habit of eating raw fish. We also showed that men still ate raw fish even after knowing the risk of getting liver fluke infection because they know the disease may be treated with drugs. This result is in line with the findings

of a report in North Vietnam [7]. Additionally, living in villages where a tradition of sharing raw fish is common has then transmitted to a habit of eating raw fish, making this practice it more popular, which is consistent with the findings of fascioliasis in Thua Thien Hue, Vietnam [26]. The study also revealed that gender and age are factors affecting the knowledge. The average knowledge score among men was greater than that among women, and the score among younger people was greater than that among the older. This is understandable because young people are more likely to have higher education and it is much easier for them to access information via mobile phones or the internet. However, the risk behavior investigation revealed that eating raw fish was not associated with demographic characteristics such as age, ethnicity, and educational levels. This result was confirmed by the results in the KAP survey.

The findings showed that the better knowledge people have, the better attitude they display. Nevertheless, there was not enough evidence to confirm the relationship between the knowledge and the practice, and between the attitude and the practice of the population. This revealed that unsafe practices were not only caused by lack of knowledge and attitude factors, but also by other factors in the living environment. This was consistent with the results in the risk behavior investigation that showed that a habit of eating raw fish was a consequence of the poor economic conditions and social structures, which also determined a large aspect of local people's attitude.

The findings of the study contributed to filling the gap of knowledge regarding to liver fluke infection in Vietnam, and they confirmed the findings of the previous studies in different contexts. The results reflected the lack of knowledge and bad practice of residents not only in two studied communes but also all around Thac Ba lake. It is apparent that living near natural water bodies, specifically Thac Ba lake in Yen Bai, plays an important role in the context of eating raw fish and therefore getting infected with liver fluke. The lake is the origin of the raw fish eating habit, and it provides a huge source of fish, consequently it is easy for nearby residents to exploit and form habits of fishing and sharing raw fish. This study can be translated to other similar areas in which the residents live near high-density natural water bodies and eat raw fish.

Eating raw vegetables and drinking untreated water were identified as risk factors for large liver fluke infection in the Thac Ba area. This finding is similar to a fascioliasis KAP survey in Quang Nam province (Central Vietnam) [27], where all interviewees were eating raw vegetables and drinking untreated water. The attitude score for *Fasciola* prevention by not eating raw vegetable were 62.7%. This finding is surprising because Vietnamese people like to eat raw vegetables.

The results of this study must be interpreted taking into account both strengths and limitations. An important strength in the study is the use of an integrated approach with both quantitative (KAP) and qualitative methods, so the results in each part may support and complement each other. In the KAP survey, the respondents may give

different answers in different contexts although their KAP is constant. For example, respondents may have given socially desirable answers if they felt unsafe at the health station. However, the in-depth interview at home provided the participants with a comfortable and safe environment to answer the questions. The information from the qualitative part of the study can also explain the relationship among variables in the KAP. With regard to the limitations, the differences in knowledge, attitudes, and practice among different demographic characteristics that we observed were statistically significant, but the differences were small and the correlation did not show a strong relationship among variables. Moreover, the current knowledge, attitudes, and practices were described primarily through the scores, and these were given the same weight. It may be that results would be more accurate if the questions would have been given different weights in the KAP survey.

Conclusions

In conclusion, the residents in the two communes in Yen Bai, Vu Linh and Phuc An still have a poor knowledge and perform bad practices regarding to liver fluke infections. The findings suggest that the lack of knowledge is not the only reason leading to a habit of eating raw fish but that there are also economic and social factors at play. Therefore, to control FZTi in Yen Bai province, particularly in the lakeside areas, an integrated control including, health education, fish/snail habitat interventions and safe food processing is essential.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

NTTP, DDT, ML, BL, OV, DTB developed study design and research methodology. NTTP, TTBN, TIHL contributed in data collection. NTTP, MVG, MBB contributed in data analysis. NTTP, DTB contributed in manuscript's writing. NTTP, PD, MVG, MBB, DTB contributed in manuscript review and edited.

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