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Evaluation of a broadly-based control model of fascioliasis (liver fluke) in Central Vietnam

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Evaluation of a Broadly-based Control Model of Fascioliasis (Liver fluke) in Central Vietnam

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CERTIFICATION

I, Tran Minh Quy, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Public Health, in the School of Health and Society, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualification at any other academic institution.

Tran Minh Quy

ABSTRACT

Introduction:

Fascioliasis (liver fluke) is listed as one of the most important parasitic infections in humans and animals in the developing world, posing a considerable burden to human public and veterinary health globally (Mas-Coma, 2005). In Vietnam, the prevalence of fascioliasis has increased rapidly since the beginning of the 21st century and it has become a zoonosis of great public health importance, with Central Vietnam being most severely hit by the disease (Trieu, 2011). The rising prevalence of the disease has been reported in all 15 regional provinces of Vietnam, increasing from 1,500 cases during 2004-2005 to 9,985 cases in 2011 (Nguyen, 2011).

To date, comprehensive strategies for fascioliasis control are not in place, and the only control of the disease is reliance on chemotherapy with triclabendazole (TCZ), recommended by the WHO as the drug of choice for the treatment of both acute and chronic fascioliasis in humans (WHO, 2007b). However, TCZ resistance has been reported in animals and in humans (Ortiz, Scarcella, Cerna, Rosales, Cabrera, Guzman, Lamenza and Solana, 2013). Although alternative fascioliasis control measures are recommended elsewhere, no typical example has been proven to be effective in practice (Nithiuthai, Anantaphruti, Waikagul and Gajadhar, 2004; Saba and Korkmaz, 2005). Furthermore, various models of foodborne trematode infection control have been introduced and tested for their effectiveness but none of them are complete and applicable to all situations (Nguyen, Nguyen, Bui and Tran, 2011).

In the context of the unavailability of effective control measures of fascioliasis, the study of a broadly-based control model of fascioliasis in Central Vietnam was conducted to address the burden of the disease and promote the community's health. The model, selectively adapted from the trial control model of fascioliasis by Nguyen *et al*. (2011) and the intervention model by Molyneux (2006), comprised five main components: vector control, health education, improvement of local health systems, involvement of concerned bodies, and chemotherapy.

This study aims to implement and evaluate a broadly-based control model for fascioliasis in a community with high prevalence of fascioliasis in Central Vietnam

and to monitor the factors that facilitate or impede its implementation. To achieve this aim, five objectives were identified:

(1) to determine the seroprevalence of human fascioliasis by laboratory methods prior to the interventions;

(2) to describe the risk factors associated with fascioliasis infections by conducting surveys on knowledge, attitudes and practices (KAP), and undertaking household observations and snail counts;

(3) to report on the implementation of a broadly-based control model for fascioliasis infection;

(4) to evaluate the effectiveness in reducing the seroprevalence of human fascioliasis of the broadly-based control model, comparing its impact with that of a model of treatment of humans and cattle alone, and to treatment of humans only; and

(5) to explore the positive and negative factors that motivate or impede the successful implementation of the broadly-based control model for fascioliasis in Central Vietnam.

Methodology:

This thesis was a sequential explanatory mixed methods study, undertaken at three communes in two provinces of Central Vietnam. Quasi-experimental quantitative inquiry was carried out at the baseline and post-intervention stages. Adult cohorts aged from 18 years were recruited for blood surveys to identify fascioliasis seroprevalence; and other adult cohorts were selected for knowledge, attitudes and practices (KAP) surveys. In total 3,112 adults attended two blood surveys and 3,600 participated in KAP surveys. For the qualitative component, nine semi-structured interviews were conducted with stakeholders and two focus groups for 15 local health volunteers and household representatives to provide further insights into the model.

Findings:

Baseline surveys indicated a high seroprevalence of fascioliasis (7.8%) among cohorts, which categorised Central Vietnam as a meso-endemic area of the disease. High prevalence was associated with low awareness of fascioliasis as less than 50% of participants were not aware of the disease. Noticeable proportions of participants reportedly ate raw and improperly washed vegetables; and drank improperly boiled water. High proportions of the communities were without household toilets (62.5%-77.6%) and practised outdoor defecation, facilitating fascioliasis transmission in the community. Observations of household facilities also revealed unhygienic living conditions, which were found to be correlated with risks of fascioliasis transmission. Although not many lymnaeid snails as intermediate vectors were collected during the baseline survey (March to May at the beginning of summer with unsuitable weather conditions for their development), *Fasciola* larval infection in the snails indicated the capacity of disease transmission.

The broadly-based control model of fascioliasis was implemented as designed. Intervention 1 commune received all components of the intervention model with some modifications; the Intervention 2 commune received the chemotherapy for human and animal deworming activities; and only case treatment of human fascioliasis was undertaken in the Control commune.

This field-based study applied human chemotherapy for 100% of infected cases in the three cohorts and approximately 40% of animals were de-wormed in the two intervention communes. Follow-up of the human infected cases reported no side-effects seven days following D7 treatment.

Health education activities in the Intervention 1 commune included various approaches and were assisted through the participation of previously-trained staff involved in health, education, agriculture, local authority, socio-cultural, and other social organisations. The strategies applied direct health education through school activities, household visits and indirect health education via delivered leaflets, communal broadcasting systems, and construction of panels and mottos on fascioliasis control displayed in public locations.

A number of sectors, including veterinary, education and social organisations, readily participated in the fascioliasis control program. Their involvements were indicated in the campaigns launched by the health sector and were under the leadership of the local authority. Co-ordination between health and the other related sectors was identified by participants as a key element facilitating the successful implementation of the program.

To improve fascioliasis surveillance and management, communal health staff and village health volunteers in the Intervention 1 commune were trained in case detection, referral procedures to highly-advanced laboratory-based health facilities for fascioliasis case confirmation, and proper management of confirmed cases. Timely referrals of suspected cases and effective management of confirmed cases supported the importance of increasing the capacity of grass-roots health staff in fascioliasis detection and management to facilitate access to specialist health facilities.

For vector control, common practices were jointly undertaken by health and veterinary sectors during health education campaigns, including messages on grazing cattle in safe areas, feeding cattle on the upper two-thirds of the rice stubbles, avoiding dispersal of cattle waste into the environment, and mixing cattle dung with rice stubbles or drying the flattened dung in the sun. These key messages, together with the need for regular de-worming and nutrition of cattle following the guidelines of the veterinary staff, were promoted as preventing the transmission of animal fascioliasis.

The follow-up surveys indicated that the Intervention 1 commune achieved a significantly reduced prevalence of fascioliasis, an increased awareness of and practice against the disease transmission, and decreases in larvae infected snails, compared with the baseline stage. In the other two communes with lower levels of intervention coverage, the outcomes had changed but not significantly. Comparing the communes, significant changes were indicated by most of the indicators between the Intervention 1 commune and the other two communes.

The quantitative findings provided evidence to support the claim that reduced seroprevalence, and increased awareness and practice of the disease, was achieved with the implementation of a broadly-based control model of fascioliasis.

The qualitative study, undertaken following the quantitative inquiry, provided greater insight into the components of the broadly-based control model of fascioliasis in the Intervention 1 commune. The findings explored important factors that had not been adequately presented in the model. Positive factors included awareness of the disease and its risk factors to stakeholders at the system level, the important role of participants (professional, consultant, and administrative roles), and their commitment and motivation to participate in the intervention of the model through their various forms of support (provision of specific drugs, expertise and technical, and administrative support). At the household level, community representatives indicated their motivation to adopt positive behaviours and were well-informed about the disease following the interventions.

Regarding the negative factors or barriers, time constraints, technical difficulties and extreme weather events were identified as impacting on the effectiveness of the model. Vector control still remained the most difficult issue to address effectively and it was identified that stronger co-ordination between health, veterinary, and other concerned sectors was required, as was the active engagement of the community. Various time constraints were raised by local health volunteers as other challenges to implementation. Also, the lack of financial inputs was identified by participants, as helminthiasis and fascioliasis control activities were not prioritised as a national control program (www.chinhphu.vn) and thus resources had not been allocated. Finally, the occurrence of extreme weather events (flooding) affected the outcomes. As monsoon rains and flooding occur regularly in areas affected by fascioliasis, the impacts of these events should be actively considered within any control measures for fascioliasis.

The qualitative findings were incorporated into an amended broadly-based control model of fascioliasis in Central Vietnam. Coupled with the concrete model components, these results provide a holistic framework to effectively control fascioliasis in Central Vietnam and to inform other regions in the country of the initiatives.

Conclusions:

The study found that a broadly-based fascioliasis control model, which included five co-ordinated components of chemotherapy, health education, involvement of concerned bodies, improvement of surveillance and management, and vector control, can be effective in controlling fascioliasis in Central Vietnam. The mixed methods approach demonstrated the utility of undertaking qualitative research to explore the positive components and challenges to community based interventions to control vector-borne diseases. The model could feasibly inform the initiatives in other regions of the country and in other countries where vector borne diseases are prevalent.

This thesis provides important contributions both to the design and implementation of fascioliasis control strategies and to the approach to evaluation of such initiatives. The effective broadly-based control model of fascioliasis could help to reduce the socio-economic burden of the disease, and thus improve the quality of life of farming communities living in low-income rural areas who are at higher risk of infection due to unhygienic living practices. In addition, if this successful model was applied to other regions, further gains would be anticipated, contributing to the elimination of the problem of this neglected tropical disease in Vietnam.

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Finally, a special acknowledgement to my father, who inspired, supported and mentored me through my life's journey but sadly passed away before he could call his son doctor.

LIST OF ABBREVIATIONS IN ALPHABETICAL ORDER

AUD	Australian Dollar
CDC	Centres for Disease Control and Prevention
CIs	Confidence intervals
ELISA	Enzyme-linked immunosorbent assay
ENSO	El Nino-Southern Oscillation
F. gigantica	*Fasciola gigantica*
F. hepatica	*Fasciola hepatica*
FAO	Food and Agricultural Organization
FGs	Focus groups
GIs	Guided interviews
GSO	General Statistics Office of Vietnam
HDR	Higher Degree Research
IEC	Information, education and communications
IMPE-QN	Institute of Malariology-Parasitology and Entomology, Quy Nhon
KAP	Knowledge, attitudes and practices
L. natalensis	*Lymnaea natalensis*
L. swinhoei	*Lymnaea swinhoei*
L. truncatula	*Lymnaea truncatula*
L. viridis	*Lymnaea viridis*
MDA	Mass drug administration
MOH	Ministry of Heath
NIMPE	National Institute of Malariology-Parasitology and Entomology
PCMPE	Provincial Centre of Malariology-Parasitology and Entomology
SAC	School-age children
STH	Soil-transmitted helminths
TCZ	Triclabendazole
UOW	University of Wollongong
USD	US Dollar

VND	Vietnamese Dong
WB	World Bank
WCBA	Women of child-bearing age
WHO	World Health Organization

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1. INTRODUCTION

1.1 Introduction

This chapter outlines the thesis content. It commences with outlining the study's aims and objectives and a discussion of the significance of a broadly-based control model of fascioliasis (liver fluke) in a community with a high prevalence of the disease in Central Vietnam. The background of the thesis is presented to provide the rationale and structure of the thesis and the chapter concludes with an outline of the chapters of the thesis.

1.2 Thesis aim

The overall aim of the research is to implement and evaluate a broadly-based control model for fascioliasis in a community with a high prevalence of fascioliasis in Central Vietnam.

1.3 Thesis objectives

1. To determine the baseline seroprevalence of human fascioliasis by laboratory methods.
2. To describe the risk factors associated with fascioliasis infections by conducting surveys on knowledge, attitudes and practices (KAP), household observations, and snails.
3. To report on the implementation of a broadly-based control model for fascioliasis infection that includes chemotherapy, vector control, health education, surveillance and management and evaluation components, and incorporates the involvement of different sectors such as education, agriculture and social organizations.
4. To evaluate the effectiveness of the broadly-based control model in reducing the seroprevalence of human fascioliasis, comparing its impact with that of a model of treatment of humans and cattle alone, and to treatment of humans only.
5. To explore the positive and negative factors that motivate or impede the successful implementation of the broadly-based control model of fascioliasis in Central Vietnam.

1.4 Significance

Fascioliasis (liver fluke) constitutes one of the most important parasitic infections in humans and animals in the world (Mas-Coma, Valero and Bargues, 2009b), and causes tremendous impacts on human health and veterinary production (Phiri, Phiri and Monrad, 2006; Suon, Hol, Siek, McLean and Copeman, 2006; Charlier, Duchateau, Claerebout, Williams and Vercruyesse, 2007; Alawa, Adamu, Gefu, Ajanusi and Chiezey, 2010; Mezo, González-Warleta, Castro-Hermida, Muiño and Ubeira, 2011; Charlier, Van der Voort, Hogeveen and Vercruysse, 2012). From only a few cases of fascioliasis being reported in the 1980's, the incidence of the disease in Vietnam has increased rapidly since the beginning of the 21st century, making it a zoonosis of great public health importance (Nguyen, 2011). Central Vietnam has been most severely hit by fascioliasis, which is prevalent in all 15 provinces (Trieu, 2011). Recent studies (Huynh, Trieu and Nguyen, 2007; 2007a) reported the emergence of the disease in all 15 regional provinces, accounting for 93% of the total national incidence. Other studies (Nguyen, Le, Le, Luc, Nguyen, Bui, Le and Le, 2003; Nguyen, Nguyen and Bui, 2008) found human fascioliasis infection rates ranged from 5.6% to 11.1% in coastal provinces of Binh Dinh, Phu Yen and Khanh Hoa. At the Specialist Clinic of the Institute of Malariology, Parasitology and Entomology (IMPE-QN), infected patients with fascioliasis increased from 1,500 cases during 2004-2005 to 9,985 cases in 2011 alone (Trieu, 2011).

Chemotherapy with triclabendazole (TCZ) is recommended by the World Health Organization (WHO) as the drug of choice for the treatment of both acute and chronic fascioliasis in humans (WHO, 2007b). The single dose of 10mg/kg body weight for humans (12mg/kg body weight in animals) is effective against the adult flukes in the bile ducts and immature parasites migrating through the liver (WHO, 2007b; Maha, 2008). However, TCZ resistance has been reported in animals and in humans (Gaasenbeek, Moll, Cornelissen, Vellema and Borgsteede, 2001; Fairweather, 2009; Olaechea, Lovera, Larroza, Raffo and Cabrera, 2011; Gordon, Zadoks, Stevenson, Sargison and Skuce, 2012; Winkelhagen, Mank, de Vries and Soetekouw, 2012). Although other control measures such as less-toxic chemical and biological controls, environmental management and preventive education are recommended elsewhere (Nithiuthai *et al*., 2004; Saba and Korkmaz, 2005; Acosta, Cancela, Piacenza, Roche, Carmona and Tort, 2008; Rojas, Vazquez, Domenech and Robertson, 2010; Dias, Perboni, Araújo, Braga, Araujo, Puppin, Fernandes, Ramos, Bertonceli and da Silva, 2012), no intervention model has been proven to be effective in practice (WHO, 2009b).

Various models of foodborne trematode infection control have been introduced and tested for their effectiveness but none of them are complete and applicable to all situations (Lustigman, Prichard, Gazzinelli, Grant, Boatin, McCarthy and Basanez, 2012). In Vietnam, mass drug campaigns against soil-transmitted helminthiasis and fish-borne trematodiases (Nguyen, 2011) are the only management activities that have been conducted recently. Although these activities included training on information, education and communication (IEC) for health staff, changes in the prevalence of the diseases were at basic levels. Meanwhile, there were still risk behaviours among the targeted populations, such as low levels of hand washing with soap after toileting or before eating, frequent drinking of impure water, and eating of raw (contaminated) vegetables (Nguyen, 2011). In addition, no evaluations of the interventions have been conducted by either the National Institute of Malariology-Parasitology and Entomology (NIMPE) or WHO, principally because they required detailed strategies and planning for monitoring and evaluations over time, coupled with a lack of resources (a WHO official, personal communication.).

A recent study on a fascioliasis control model was conducted in two communes of the Phu Cat district in Binh Dinh province, with support provided by WHO sponsorship (Nguyen *et al*., 2011). The study aimed to assess the prevalence of fascioliasis by blood examination and exploring the risks of fascioliasis infection by knowledge, attitude and practice (KAP) surveys; to introduce the trial fascioliasis control model containing IEC for communal stakeholders and selective treatment of TCZ with infected cases; and to evaluate the effectiveness of the model by comparing the indicators with the pre-intervention stage in terms of disease prevalence and changes in community perceptions of risks. After one year of implementation, the communities' perceptions of risks increased for some factors. Awareness increased by 31.24%, attitude and practice by 21.81% and 12.51% respectively (Nguyen *et al*., 2011). However, certain sections of the communities still demonstrated risky behaviours such as drinking impure water (32.0%), eating fresh water plants (19.9%), and defecating in rice fields and sand banks (39.75%). However, they lacked an effective system of prompt diagnosis and referral of suspected patients of fascioliasis, which impeded the management of the disease at the community level. Furthermore, the study did not involve vector control as an important measure to break up the transmission of the disease. Importantly, it was noted that the co-ordination between health, education and veterinary sectors was lacking and this considerably affected the outcomes of the implementation of the model (Nguyen *et al*., 2011).

The framework of parasitic control interventions developed by Molyneux (2006) provided more comprehensive initiatives for the adaptation of some potential components to the model. These components included chemotherapy/chemoprevention; health education; water and sanitation; vector control; surveillance, diagnosis, evaluation monitoring; and involvement of other sectors (Molyneux, 2006, p. 8). Although interventions based on Molyneux's model have been applied to a variety of parasitic diseases, no examples have been reported for fascioliasis control. In addition, there are some intervention components in Molyneux's framework which could potentially have been applied to the model, but were not included in the trial model by Nguyen *et al*. (2011). They included vector control, improvement of surveillance and management of the disease, and the integration of health with other involved sectors (Molyneux, 2006).

Based on the lessons learnt from this earlier study and the lack of availability of other effective control measures of fascioliasis, the study of a broadly-based control model of fascioliasis in Central Vietnam was conducted. The model, adapted from the trial control model of fascioliasis by Nguyen *et al*. (2011) and the intervention framework by Molyneux (2006), consisted of five main components: chemotherapy; health education; the involvement of concerned bodies; the improvement of disease surveillance, management and reporting system by the local health system, and vector control. In this model, health education and chemotherapy are adopted from a previous trial on fascioliasis control in two communes of Binh Dinh province, Central Vietnam (Nguyen *et al*., 2011) and three remaining components were taken up as adaptive interventions by Molyneux (2006).

If conducted successfully, the model would contribute to reducing the morbidity of fascioliasis, and thus improve the health of communities living in the endemic areas of

Central Vietnam. In addition, the control model will inform initiatives in other regions of the country.

1.5 Background to the thesis

This thesis is based on the analysis of original data collected from surveys of population based cohorts living in three communes (Nhon Hau, Nhon Thanh and Tinh Giang) of the two Central provinces of Binh Dinh and Quang Ngai, Vietnam. The aim and objectives were developed based on the conceptual framework of a broadly-based fascioliasis control model, adapted from the model of parasitic control (Molyneux, 2006) (Appendix 2.1) and a trial control model previously conducted in two communes of Binh Dinh province (Nguyen *et al*., 2011) (Appendix 2.2).

A review of the relevant literature (Chapter 2) was completed to provide a comprehensive background on fascioliasis or liver fluke, its effects on the health of humans and animals, and the existing control measures in Vietnam as well as in the world. Also discussed in this chapter are the risk factors associated with the disease transmission. The findings from this review identified key elements important to developing a broadly-based control model of fascioliasis, and assisted to refine the thesis aims and objectives. In addition, the literature was reviewed to identify appropriate methods to monitor the prevalence of the disease, to measure risk behaviours and vector control, and to evaluate the intervention.

The study design, described in Chapter 3 as a sequential explanatory mixed methods study, comprising quantitative and qualitative data collection components, was undertaken in three phases: baseline, intervention and follow-up data collection (Table 3.1). The application of the intervention measures to each typical commune was varied and based on the different levels of intervention applied in the model.

The Intervention 1 commune received the broadly-based intervention measures including chemotherapy (treatment for all infected cases, de-worming for cattle), health education, improvement of skills and knowledge of communal health staff, co-ordination of other sectors (education, local government, social organizations and the veterinary sector), and vector control.

The Intervention 2 commune adopted the chemotherapy (treatment for humans and de-worming of cattle).

The Control commune adopted the chemotherapy for the treatment of humans only.

Evaluation of the impacts of the broadly-based control model of fascioliasis in Central Vietnam is an important opportunity to contribute new information about fascioliasis control approaches that can be undertaken in a pragmatic way with modest resources. Previous control measures, which applied treatment and health education strategies only, failed to achieve the necessary community acceptance and participation. The findings in this research will provide useful information for expansion of implementations to other regions of the country.

1.6 Arrangement of the thesis

The thesis is structured in eight chapters.

Chapter 1 introduces the purpose of the thesis, proposing that fascioliasis is a significant and growing public health problem and dealing with it adequately requires a broadly-based control model. This chapter is composed of general aims, objectives, significance, and the background to the thesis.

Chapter 2 presents a review of the literature to establish the needs for this study. It identifies that there is a burden of fascioliasis (liver fluke) worldwide and in Vietnam; explores the risk factors associated with the disease transmission; and describes existing control measures applied to helminthiasis in general and fascioliasis in Vietnam. Prior reports of implementation and evaluation of vector-borne disease control programs were also reviewed, to inform the development of the conceptual framework of a broadly-based control model of fascioliasis and the control strategies undertaken for this study.

The purpose of Chapter 3 is to describe the study design and methodology, including the selection of study sites, study objects and the time frames for data collection. The rationale for selecting the sequential mixed methods is explained as the most appropriate design for this research. The three stages of the study, baseline, implementation and follow-up, are described (Figure 3.1). A quantitative inquiry was conducted across the three stages of the research process to provide statistical confirmation of significant changes. These methods included: ELISA-based blood surveys to identify any adult human seroprevalence of fascioliasis; knowledge, attitude and practice (KAP) surveys to explore the risks associated with the disease infection; observations to assess the hygienic conditions of households; and snail surveys to evaluate the potential transmission role of this intermediate host of fascioliasis. As part of the final evaluation of the model, qualitative inquiries (interviews and focus groups) were conducted to explore the factors aiding or impeding the successful model. The study was undertaken in three communes of Binh Dinh and Quang Ngai provinces in Central Vietnam.

Chapter 4 reports the identification of the seroprevalence of fascioliasis in the study sites, and explores the risk factors associated with the disease transmission, based on the results of surveys regarding the knowledge, attitude and practices (KAP), household observations, and snail collections. The baseline findings indicated that the overall seroprevalence of fascioliasis was 7.6%, classifying Central Vietnam as a meso-endemic area of fascioliasis. KAP surveys revealed less than 50% of participating community members were aware of fascioliasis. The frequency of high-risk behaviours, as reported in the KAP survey results and observed in the daily practices of people, was high. The presence of the parasite (*Fasciola* larvae) in collected snails, though at low prevalence, supported the potential larval transmission of fascioliasis in the study areas. Relatively high prevalence and risks of fascioliasis were found in Central Vietnam, supporting the need for comprehensive intervention measures including selective treatment, health education, and multi-sectoral approaches to reduce the morbidity associated with fascioliasis and thus improve the health status of the people.

Chapter 5 describes the implementation of the broadly-based control model of fascioliasis in each commune under study. All of the components were implemented in the Intervention 1 commune, including human and animal chemotherapy, health education, involvement of concerned sectors, improvement of surveillance and management of fascioliasis, and vector control; whereas only human and animal chemotherapy were implemented in the Intervention 2 commune; and only human chemotherapy was implemented in the Control commune.

The impacts of the implementation of the broadly-based control model of fascioliasis in the studied communes are presented in Chapter 6. Comparisons to the baseline surveys and between the communes are presented, covering the seroprevalence in humans, indicators of knowledge, attitudes and practices (KAP) regarding fascioliasis and its control, observational data of household practices and facilities, and snail prevalence surveys.

Greater insights into the broadly-based control model of fascioliasis were explored using mixed qualitative methods. The findings and their analyses are presented in Chapter 7. The textual analyses from interviews and focus groups were used to explore the positive factors of system level support such as expertise technical support, specific drug provision, and local administrative support. The factors impeding the model's sustainability were identified, including time constraints, financial issues, human motivations, and natural disasters. This information was used to inform further development of the model with the view to future expansion.

In Chapter 8 the findings are pulled together in a general discussion of the outcomes of the broadly-based control model of fascioliasis. These discussed findings are followed by summative conclusions of the whole thesis and recommendations for future research.

2. LITERATURE REVIEW

2.1 Introduction

Fascioliasis (liver fluke) is a parasitic disease of great human public and veterinary health concern in many countries of the world, including Vietnam (Mas-Coma, 2004b). Central Vietnam is the area most affected by fascioliasis, with reportedly more than 200 human cases annually and categorised as a hyperendemic region (WHO, 2006a).

In order to reduce the prevalence of fascioliasis and improve the overall health status of the community at risk of the disease in Central Vietnam, it is important to understand the extent of the disease, how it is transmitted and what the risk factors associated with the disease include, and to explore what other studies have done to try to combat this type of problem. Then, based on this exploration of current combined knowledge, it will be possible to develop a model predicted to be effective against fascioliasis in Central Vietnam. Evaluation of the implementation of the model will provide important insights for wider applications to prevent this disease in the other areas of the country.

2.2 Literature search method

Analysis of the most relevant and updated literature related to the domain of fascioliasis, its impacts on human and animal health both locally and globally, and existing control measures was performed by looking at the search tools and applying both basic and advanced search features for particular databases (Aoki, Enticott and Phillips, 2013). The search strategies used chronological steps (Cleary, Hunt and Horsfall, 2009) of searching databases related to these domains, together with critiques highlighting the strengths and weaknesses of the research literature. The chapter concludes with a presentation of the main findings of the literature reviews based on three approaches: chronological, methodological and thematic (Wakefield, 2014).

A computer-based search is the most common and efficient method of searching information in most databases in this study, as it can speed up the search and significantly improve the searching strategies (Basford and Slevin, 2003). Literature was mainly retrieved from the search engines PubMed Central (PMC), MEDLINE with full text, Scopus, Google Scholar and Summon (University of Wollongong), using both a basic search (usually Summon) for most relevant contents, or advanced searches with combinations of search steps in other search engines. Advanced researches included key search terms of most relevance and with truncations “*”: fasciol*, zoonos*, parrasit*, helminth*, STH* (soil-transmitted helminthiasis), NTD* (neglected tropical diseases), risk*, control*, model*, community-based*, soci*, economy*, developing countr*, health educat*, program manag*, Vietnam*; together with the use of Boolean operators such as “OR”, “AND” and “NOT”. Inclusion criteria included time (from 1999) and full-text articles in English. Exclusion criteria comprised items not relating to developing countries, community-based approaches, and prevention or control by vaccination. National, regional and institutional e-libraries such as the World Health Organization (WHO) Library Database and publications in Vietnamese (author’s own collection of articles) with relevant information were also examined by online search or published copies.

The computer-based search yielded a total of 350 publications from Summon (n=181) PMC (n=81), Scopus (n=43), Medline (n=23) and Google Scholar (n=22). Additional publications from the WHO Library database (n=33) and Vietnamese publications (n=62) made a total of 445 preliminary items. A thorough reading was conducted to exclude abstracts only (n=81), duplicated items (n=126), and reviews/editorials (n=12). In addition, the items not meeting inclusion criteria including non-developing countries (interventions conducted in Europe) (n=8), vaccination (n=7), and non-community based (n=12) were also excluded. A total of 199 publications relevant to the inclusion criteria were identified (Figure 2.1).

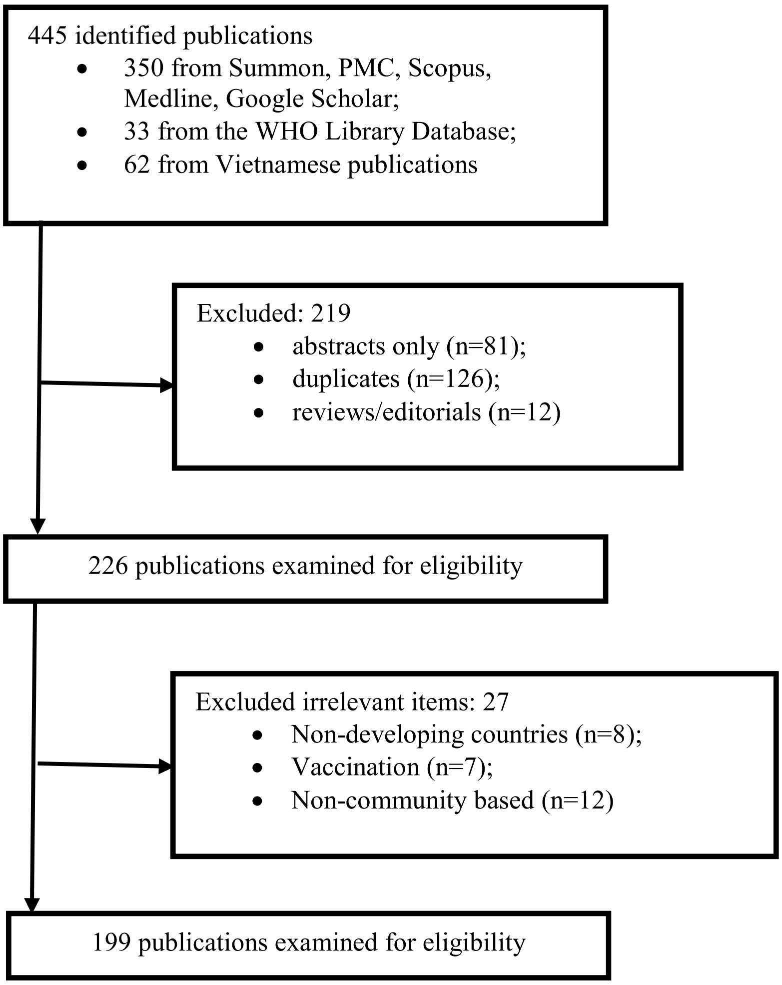

Figure 2.1 Flowchart showing the process of identifying relevant publications

2.3 Fascioliasis – an emerging/re-emerging parasitic disease as a global public health and veterinary problem

The purpose of this section is to provide the overall information concerning fascioliasis in terms of how it affects human health and livestock industries, how it is transmitted through its complex life cycle, and how the risks are associated with the disease in Central Vietnam, where it has become a major public health concern. On the basis of the risk factors being described, existing control activities of parasitic diseases including fascioliasis are examined in Vietnam and other developing countries. This information provides a foundation for the development of a broadly-based fascioliasis control model, which is discussed in the final section.

Fascioliasis is considered a secondary emerging/re-emerging zoonotic disease, defined by either new infections of humans or re-emerging ones, where there is a rapid increase in incidence of an existing infection or in a new geographical area (Molyneux, 2006; Mas-Coma, Bargues and Valero, 2014). Since the mid-1990s it has imposed negative impacts on public health systems and livestock industries worldwide (Vercruysse and Claerebout, 2001; Mas-Coma, 2005). With the annual prediction of 35,000 disability-adjusted life years (DALYs) (Fürst, Keiser and Utzinger, 2012), human fascioliasis is reportedly affecting about 180 million people and infecting from 2.4 to 17 million people in 51 countries worldwide (Keiser and Utzinger, 2009; Mas-Coma, Valero and Bargues, 2009). Recent outbreaks of human fascioliasis have made the disease a major public health problem in developing parts of the world, and is listed by WHO as a priority neglected tropical disease (NTDs) (WHO, 2007a; Maha, 2008; Chen, Guo, Chen, Ai, Xu, Jiao, Zhu, Su, Zang and Luo, 2013). In addition, various studies (Schweitzer, Braun, Deplazes and Torgerson, 2005; Charlier *et al*., 2007; Gray, Copland and Copeman, 2008; Rioux, Carmona, Acosta, Ward, Ndao, Gibbs, Bennett and Spithill, 2008; Alawa *et al*., 2010) report significant reduction or losses in milk and meat products attributed to fascioliasis. Fascioliasis is present in all continents (Mas-Coma, 2010), but the absence of detailed data from affected countries implies that prevalence is likely to be greater than the currently predicted figures, and hence may not reflect the burden and widespread transmission of the disease (WHO, 2007a).

2.3.1 Causal agents – *Fasciola* species

Fascioliasis is caused by the two food-borne species *Fasciola hepatica* (*F. hepatica*) and *Fasciola gigantica* (*F. gigantica*), which are classified as liver flukes (trematodes) and belong to the genus *Fasciolidae* (Keiser and Utzinger, 2009). Among the digenerean species, *F. hepatica* has a wide distribution in all continents (Ozturhan, Emekdaş, Sezgin, Korkmaz and Altintaş, 2009; Sakru, Korkmaz, Demirci, Kuman and Ok, 2011); whereas *F. gigantica* is restricted to the low altitudes in tropical regions of Africa, Asia, and the Middle East (Sothoeun, Davun and Copeman, 2006; Walker, Makundi, Namuba, Kassuku, Keyyu, Hoey, PrÖDohl, Stothard and Trudgett, 2008). Recent molecular tools have found the prevalence of the two fasciolids to be overlapping (Mas-Coma, 2005), possibly because they are very adaptive with lymnaeid snails as their intermediate hosts (Taraschewski, 2006). In addition, the two fasciolids can infect a wide range of final hosts, including water buffaloes, bovines, goats, sheep, and humans (Mas-Coma, 2005; A Marcos, Yi, Machicado, Andrade, Samalvides, Sánchez and Terashima, 2007).

2.3.2 Definitive and intermediate hosts

Domestic ruminants are hosts of *Fasciola spp*., including cattle, goats, sheep and other grazing mammals. These herbivorous animals act as efficient reservoirs for the parasites (Mas-Coma, Valero and Bargues, 2008a). Other studies report that wild black rats (*Rattus rattus*) (Valero, Marcos, Fons and Mas-Coma, 1998; Robinson, Colhoun, Fairweather, Brennan and Waite, 2001; Magnanou, Fons, Feliu and Morand, 2006; A Marcos *et al*., 2007), nutria – a semi-aquatic South American rodent (Ménard, Agoulon, L'Hostis, Rondelaud, Collard and Chauvin, 2001) and pigs (Valero and Mas-Coma, 2000; Valero, Darce, Panova and Mas-Coma, 2001a; Valero, Panova and Mas-Coma, 2001b) may also have important roles in transmitting fascioliasis. Humans can be definitive hosts through eating unhygienic aquatic plants or vegetables planted with contaminated water, or drinking metacercae contaminated water, or ingesting meat infected with *Fasciola* larvae. Humans then shed eggs into the environment via their faeces (Mas-Coma, 2005; Ashrafi, Valero, Massoud, Sobhani, Solaymani-Mohammadi, Conde, Khoubbane, Bargues and Mas-Coma, 2006; WHO, 2007a; Torgerson, 2013).

Fresh-water snails belonging to the lymnaeid species are recognized as intermediate hosts of *Fasciola* distribution (Maha, 2008; Carrique-Mas and Bryant, 2013). The populations of these molluscan snails are influenced by various factors such as temperature, light, vegetation, water pH, current and depth of water bodies, and snail competitive ability (Lockyer, Jones, Noble and Rollinson, 2004). The introduction of fascioliasis to new environments and geographical areas proves the marked adaptation abilities of the lymnaeid snails' parasites and the spread of the existing snail populations (Mas-Coma, 2004b). In endemic areas of Europe, South America, Africa, Asia and the Middle East, the expansion of fascioliasis transmission in recent years has been attributed to the distribution and ability of the aquatic lymnaeid snails to adapt to a wide range of environmental niches (Mas-Coma, Bargues and Valero, 2005b; Kenyon, Sargison, Skuce and Jackson, 2009; Mas-Coma *et al*., 2009b; Bargues, Artigas, Khoubbane, Ortiz, Naquira and Mas-Coma, 2012; Mramba and Abdul-Hamid, 2015).

2.3.3 Life cycle

The life cycle (http://www.cdc.gov/parasites/fasciola/biology.html) of *F. hepatica* and *F. gigantica* starts with the excretion of unembryonated eggs into the biliary ducts, which are passed through the stool of herbivores (definitive hosts) or humans (accidental hosts) into fresh-water sources (Robinson and Dalton, 2009; Fentie, Erqou, Gedefaw and Desta, 2013). The eggs are the largest among the trematodes, measured from 120-150 µm by 63-90µm (Tolan, 2011), and have an ovoid, operculate size and are yellowish-brown in colour.

Within 10-15 days at temperatures above 5^0C, optimally 15-25^0C in the water, the eggs become embryonated and release miracidia (parasites), which swim in the water and actively seek suitable intermediate hosts (snails of the family *Lymnaeidea*) to penetrate. In the snails, the parasites undergo developmental life stages including sporocysts, rediae and cercariae over a period of 5-7 weeks (Valero, Perez-Crespo, Periago, Khoubbane and Mas-Coma, 2009; Carrique-Mas and Bryant, 2013). The cercaciae are then released and encysted as metacercariae on aquatic vegetation or other surfaces.

Ruminants acquire the infection by eating vegetation containing metacercariae. Humans can accidentally become infected by ingesting metacercariae-containing freshwater plants, especially water-cress and water dandelions (Mas-Coma *et al*., 2005b). Drinking contaminated water or washing vegetables with water contaminated with metacercariae also induces infection (Mas-Coma *et al*., 2005b; Mas-Coma *et al*., 2009b; Chen *et al*., 2013). After ingestion, the low pH in the stomach provides a favourable condition for the immature metacercariae to excyst in the duodenum and migrate through the intestinal wall into the peritoneal cavity. At this stage, the newly excysted metacercariae do not feed. When they find their way into the liver parenchyma, feeding will start.

The parasites live on the liver tissues for a period of up to 5-6 weeks before eventually moving to the biliary ducts, where they develop into adults. The maturation from metacercariae into adult flukes in humans takes approximately 3 to 4 months. The adult flukes (*F. hepatica*: up to 30 mm by 13 mm; *F. gigantica*: up to 75 mm) can produce up to 25,000 eggs per day, and even in a light infection, a single animal, such as a cow, can excrete up to 50,000 eggs onto the pasture (Robinson and Dalton, 2009).

2.3.4 Recipients

Fascioliasis can affect people of all ages. In endemic areas of Bolivia, Peru and Egypt, the disease is prevalent among school-aged children (Mas-Coma, 2005; Mas-Coma *et al*., 2005b), while it is mainly predominant in adults, especially women aged 20-50 years in other countries such as Cuba and Vietnam (Nguyen, Nguyen, Dang, Doan, Le and Trieu, 2006; WHO, 2006a; Dang, 2007). Research by Esteban *et al*., (1999; 2002) found that in Andean countries women shed significantly more eggs than men. In other countries such as Egypt, the infection rate in women is significantly higher than in men (Esteban, Gonzalez, Curtale, Munoz-Antoli, Valero, Bargues, El Sayed, El Wakeel, Abdel-Wahab, Montresor, Engels, Salioli and Mas-Coma, 2003). Similar findings were reported in Vietnam, where the ratios of infection between women and men have been reported in some studies as 14:1 (Huynh *et al*., 2007; Huynh *et al*., 2007a), and in Central Vietnam, 1.67 :1 (Dang, 2007). The explanations might be related to cultural, hygienic and behavioural factors (Mas-Coma *et al*., 2005b). For example, women are more involved in agricultural work and irrigation in the rice field, and wash household items in canals, where the disease transmitting intermediate host (lymnaeid snails) breeds. In the home, women also play an important part in preparing food and handling fresh-water vegetables, which may contain *Fasciola* larvae (Mas-Coma, 2005).

2.3.5 Diagnosis and treatment

There are various diagnostic methods of fascioliasis, depending on different stages and manifestations of the disease (Aksoy, Kerimoğlu, Oto, Ergüven, Arslan, Unal, Batman and Bayraktar, 2006). The intermittent clinical signs and symptoms of fascioliasis can be confused with those of other hepatobiliary disorders, which results in delayed and difficult diagnosis of the disease (Aksoy, Kerimoglu, Oto, Erguven, Arslan, Unal, Batman and Bayraktar, 2005; Yesildag, Yildiz, Demirci, Gören and Işler, 2009).

Clinical manifestations of a typical fascioliasis case include intermittent fever, pain in the right lower quadrant, and lesions in the liver. Stool examination for egg detection is still considered a conclusive diagnosis, but this technique has low sensitivity, is unable to diagnose the disease during the incubation and acute phases, and misses all ectopic cases (WHO, 2006a). Improved diagnostic techniques include testing for eosinophilia, ultrasound, ELISA (enzyme-linked immunosorbent assay), and molecular approaches. Such approaches are becoming popular to provide fast and more accurate detection of infection (WHO, 2007b; Chen *et al*., 2013; Santana, Dalton, Camargo, Parkinson and Ndao, 2013; Behzad, Lahmi, Iranshahi and Mohammad Alizadeh, 2014).

Chemotherapy has been the main method for controlling fascioliasis for 20 years and has been predicted to remain so in the future (Fairweather, 2005; Maha, 2008; Fairweather, 2011). At present, triclabendazole (TCZ) is recommended by the WHO as the drug of choice for the treatment of both acute and chronic fascioliasis in humans (WHO, 2007b; Mas-Coma, Bargues and Valero, 2014). The single dose of 10mg/kg body weight is effective against the adult larvae in the bile ducts and on immature parasites migrating through the liver (WHO, 2007b; Maha, 2008). However, TCZ resistance has been reported in animals (Phiri, Chota and Phiri, 2007; Fairweather, 2009; Olaechea *et al*., 2011; Ortiz *et al*., 2013) and in humans (Winkelhagen *et al*., 2012). It has been recognised (Mramba and Abdul-Hamid, 2015) that resistance could potentially hamper ongoing achievement of human and animal fascioliasis control efforts. In addition, TCZ is not commercially available (Keiser et al., 2005) and is exclusively distributed by Novartis Pharma. Inc. (Basel, Switzerland); therefore, it is not widely registered and not recommended for mass drug administration (MDA) (Keiser, Engels, Büscher and Utzinger, 2005; Maha, 2008). The unavailability of the drug, specifically to treat fascioliasis, has been reported to result in outbreaks of the disease in recent years (Parkinson, O'Neill and Dalton, 2007).

2.3.6 Human fascioliasis infection in Vietnam and Central Vietnam

The first case of *F. gigantica* in Vietnam was announced in 1928 by Codvelle et al. (Nguyen and Le, 2007). Sporadic cases were reported until the late-1990s when a sudden increase in cases was reported between 1997 and 2000 (Hien, Dung, Tri, Danh and Hanh, 2001; De, Murrell, Cong, Cam, Chau, Toan and Dalsgaard, 2003). Fascioliasis raised public health concerns when the National Institute of Malariology-Parasitology and Entomology (NIMPE) reported a total incidence of 15,761 cases between 2006 and mid-2010 in 47 of 63 provinces nationwide, with the majority of the infected cases from central and southern provinces (Nguyen, 2011). The actual emergence of fascioliasis cannot be determined as the data may have come either from increasing case numbers, or improved laboratory diagnostics and reporting, or were generated from health facilities with limited capacities such as provincial general hospitals (Hien *et al*., 2001; Carrique-Mas and Bryant, 2013).

Central Vietnam, with favourable geographical and weather conditions for parasitic diseases, is the area most affected by fascioliasis (Cong, Anh, Luan, Tuan and Tuan, 2001; De *et al*., 2003; Hung, My, Hung, Quoc, The, Vien, Hien and Dung, 2003; Trieu, 2011). Recent studies (Huynh *et al*., 2007; 2007a) have reported the emergence of the disease in all 15 regional provinces, accounting for 93% of the total national incidence. Human fascioliasis infection rates have been found to range from 3.2% to 10.2% in the central provinces of Binh Dinh, Phu Yen, Gia Lai, Quang Ngai, Quang Nam and Khanh Hoa (Nguyen *et al*., 2003; Nguyen *et al*., 2008; Nguyen, Nguyen, Le and Nguyen, 2011). At the Specialist Clinic of the Institute of Malariology, Parasitology and Entomology (IMPE-QN), infected patients with fascioliasis increased from 1,500 cases during 2004-2005 to 9,985 cases in the first half of 2011 alone, with a majority of the incidence coming from central and west highland provinces (Trieu, 2011; Nguyen and Trieu, 2012).

Although the prevalence of the disease has decreased during 2012, 2013, and 2014 (3,354, 2,471, 1,741 cases, respectively) (Nguyen, 2015), the annual figures of more than 200 cases listed for Central Vietnam ranks it as a human endemic area of fascioliasis (WHO, 2007b). However, these unofficial figures are complicated because all data are generated at the IMPE-QN Clinic, and 12 of the 15 provinces of Central Vietnam did not generate reports; therefore, it is possible that under-reporting has occurred (Trieu, 2012). This high prevalence of fascioliasis warrants examination of the key risk factors for transmission, which are discussed in the following section.

2.3.7 Risk factors of fascioliasis transmission in Central Vietnam

There is a range of risk factors for fascioliasis transmission in Central Vietnam. Ecological and environmental changes, socio-cultural and behavioural factors, and the negative impacts of economic development have been found to facilitate fascioliasis transmission (Tran, Tran, Nguyen, Pham and Pham, 2001; De *et al*., 2003). Although these various risk factors behind fascioliasis have been described in other countries (Mas-Coma, 2004b; Marcos, Terashima and Gottuzzo, 2008; Mas-Coma *et al*., 2009), evidence indicates that they are under-reported in Vietnam, especially in the central region of the country. This highlights the need for the development of holistic understanding of the risk factors contributing to the burden of fascioliasis as an emerging parasitic disease.

2.3.7.1 Environmental and ecological factors

One of the most important reasons why fascioliasis is so widespread is that the liver flukes use lymnaeid snails as their intermediate hosts, and these snails have been shown to easily penetrate into new geographical areas (Mas-Coma, Funatsu and Bargues, 2001; Taraschewski, 2006). *F. hepatica* is adapted to *Lymnaea truncatula* (*L. truncatula*) in high altitudes and *F. gigantica* is more adapted to *Lymnaea natalensis* (*L. natalensis*) at lower altitudes (Mas-Coma *et al*., 2001; Walker *et al*., 2008). These snails have been proven to play an important role as potential reservoirs for fascioliasis transmission, a problem which challenges fascioliasis control measures in these areas (Mas-Coma, 2004b).

Climatic conditions (air temperature, rainfall, water conditions) have been considered to play decisive factors in fascioliasis transmission and human infection risks, with influences on the developmental stages of fasciolids and the intermediate host population (Mas-Coma, Valero and Bargues, 2009a; Bless, Schär, Khieu, Kramme, Muth, Marti and Odermatt, 2015). Human infection rates vary with seasonal changes, with high rates of infection occurring in the years with heavy rainfall, and outbreaks occurring after prolonged wet summers (Mas-Coma, 2004b). Global warming has been predicted to change the geographical distribution of various trematode species, including liver flukes (Rioux *et al*., 2008; Martínez-Valladares, Robles-Pérez, Martínez-Pérez, Cordero-Pérez, Famularo, Fernández-Pato, González-Lanza, Castañón-Ordóñez and Rojo-Vázquez, 2013). The effects of the El Nino-Southern Oscillation (ENSO) in producing prolonged droughts and floods has been found to contribute to fascioliasis outbreaks in Peru and Ecuador (Githeko, Lindsay, Confalonieri and Patz, 2000). Similar findings on the effects of ENSO on increasing fascioliasis cases in Central Vietnam also have been reported (Nguyen, Bui, Nguyen, Nguyen, Bui and Nguyen, 2005).

2.3.7.2 Behavioural and socio-cultural factors

Fascioliasis transmission is associated with unhygienic eating, drinking, cooking, outdoor defecation, and use of unprocessed human stools as fertilizer (Keiser and Utzinger, 2009; Chen *et al*., 2013). Such behavioural and socio-cultural factors were established long before fascioliasis infection emerged and are challenging to change (Keiser and Utzinger, 2005).

Consumption of water plants when they are contaminated with metacercariae facilitates the spread of human fascioliasis (Keiser and Utzinger, 2009; Hotez, Savioli and Fenwick, 2012). Changes in diets with more vegetables and less fatty foods are promoted for improved health; however, unhygienic treatment of raw vegetables before consumption may pose the risk of fascioliasis infections (Marcos *et al*., 2008). Furthermore, contaminated vegetables are transported from rural to urban areas for sale in city markets, which accelerates the transmission of the disease (Mas-Coma *et al*., 2014).

Central Vietnam is characterized by a network of small rivers, lakes and ponds close to residential areas. Farmers often use the surface water from these sources for bathing, washing household tools and cleaning animal shelters (Nguyen *et al*., 2011). The waste water is then released back into the public water sources, which poses a potential risk of fascioliasis transmission to other areas (Huynh, Trieu, Huynh, Nguyen, Ho and Nguyen, 2011). In addition, the contaminated water is used for watering vegetables such as coriander, lettuce and persicaria, which serve as ideal habitats for the fasciolids. A study by Nguyen (2007) discovered different proportions of metacercariae infection on the vegetables, with coriander containing the highest metacercariae/kg, with 1.34, and the lowest level was on persicaria which still contained 0.88 metacercariae/kg. This is a particular risk as these vegetables usually are eaten raw or with minimal cooking.

A significant number of families (39.75%) do not own water closets, especially in rural areas (Nguyen *et al*., 2011). Inappropriate human defecation on rice fields and sand banks is popular in rural areas, which perpetuates the transmission of the disease (Nguyen *et al*., 2003; Nguyen *et al*., 2011).

2.3.7.3 Economic factors

The emergence of various parasitic diseases has accompanied large-scale changes in the environment associated with economic development, which imposes considerable impacts on biodiversity and has increased contact between animal hosts, humans and pathogens (Karesh, Loh, Machalaba, Thomas, Heymann, Dobson, Lloyd-Smith, Lubroth, Dixon, Bennett, Aldrich, Harrington and Formenty, 2012). Aquacultural expansions have been rapidly promoted in the developing world to meet the increasing demands of global consumption (Subasinghe, 2005). However, the practices may result in ecologic transformation, which facilitates the emergence of diseases (Naylor, Goldburg, Primavera, Kautsky, Beveridge and Clay, 2000). It is the closeness of human habitation to freshwater bodies that poses potential risks of food-borne trematodiases, especially fascioliasis (Keiser and Utzinger, 2005; Murray and Peeler, 2005; WHO, 2010b).

In recent years in Central Vietnam, strategies of animal husbandry development such as increasing the number of herds and the importation of different breeds of cattle (often more susceptible to fascioliasis) have significantly contributed to fascioliasis transmission (Nguyen *et al*., 2011). Also, grazing cattle freely in grass fields and using fresh animal excrement to fertilize paddy fields and aquatic vegetables are common practices (Huynh *et al*., 2011; Nguyen, Le, Dao, Tran, Praet, Speybroeck, Vercruysse and Dorny, 2011). These practices facilitate the dissemination of the *Fasciola* parasites' eggs and enable the completion of their life cycle (Shuhardono, Roberts and Copeman, 2006; Nguyen *et al*., 2011). In addition, while the correlation between rates of human and animal fascioliasis has been expected at a basic level (Mas-Coma, 2005), the inter-species transmission of *Fasciola* spp. from cattle to humans is now thought to be possible, which provides further justification for the need for public health intervention (Utzinger, Brattig, Leonardo, Zhou and Bergquist, 2015).

It is important to examine the nature of fascioliasis and its affiliated risks to human and animal health, which are within the interests of the "One Health" research agenda

(Carrique-Mas and Bryant, 2013) that is discussed in detail in the following section. The disease is well recognised as a neglected tropical disease which requires priority attention (Chen *et al*., 2013); yet insufficient data are available about its burden, especially in severely-hit countries such as Vietnam (Hien *et al*., 2001). Aetiological and epidemiological studies have attempted to explore the causes and deleterious effects of fascioliasis; however, minimal progress has been reported in the fight against the disease, as treatment has been considered the only control measure of fascioliasis in the present-day context. More importantly, risk factors accompanied with environmental, ecological, socio-behavioural and economic conditions pose significant challenges to the efforts to prevent transmission of the disease in developing countries, including Vietnam.

2.4 Control of fascioliasis and other helminthiases in the developing countries and in Vietnam

The role of this section is to explore the studies of programs previously implemented in developing countries including Vietnam to combat fascioliasis. The levels of success of previous programs are also discussed so as to establish the foundation for the development of the broadly-based control of fascioliasis in Central Vietnam.

Definitions of some terms are also detailed for further understanding, for distinguishing some terms from others and to help to apply effective approaches in the context of disease control. On the basis of the definitions, attention is paid to fascioliasis as a priority neglected tropical disease and to the fundamentals concerning its control.

"Control" of diseases is defined by various authors (Molyneux, Hopkins and Zagaria, 2004, p. 5) as the "reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable level as a result of deliberate efforts; continued intervention measures are required to maintain the reduction". Accordingly, any control program or project must be cost-effective and achieve the long-term reduction at a level which is sustainable by efforts from the local community or by public or private healthcare systems (Molyneux, 2006).

Fascioliasis, a zoonosis (infection or disease naturally transmitted between people and vertebrate animals, with the latter having an essential role in maintaining the natural infection and transmitting disease to humans and animal populations) (WHO, 2005), is transmitted by consuming raw infected meat or raw vegetables contaminated with larvae. Prior to the mid-1990s the incidence of fascioliasis was low in developing countries, including Vietnam, and it was not a priority. After this date the incidence of the disease sharply increased, causing significant consternation for public health and veterinary health systems. At this time it was listed by the WHO as a priority of neglected tropical diseases (NTDs) (WHO, 2007a; Maha, 2008; Chen *et al*., 2013).

Like any other neglected zoonosis, human fascioliasis is closely related to epidemiological factors of animal fascioliasis, and thus the adoption of "One Health" approaches to survey, diagnose, monitor, manage and control the disease is beneficial both to humans and animals (WHO, 2005; Schelling and Zinsstag, 2007; Bidaisee and Macpherson, 2014). It has been acknowledged that most control interventions are on the preventive rather than the curative basis, with the fundamental principles of control including:

i) minimising the reservoir of infection among humans and animals with anthelminthics,

ii) controlling intermediate hosts where feasible, and

iii) preventing disease transmission through farming management and public health measures (WHO, 2008a; Nguyen, 2012).

The following examples, taken from several studies on fascioliasis control (Tables 2.1 and 2.2), describe the application of integrative approaches to fascioliasis control.

2.4.1 Integrated control programs of fascioliasis for humans and animals

Programs incorporating several measures to control human and animal fascioliasis have recently been reported. From 2000-2002, the Egyptian Ministry of Health and Population implemented a school-based intervention measure to control human fascioliasis, with selective treatment given to 1,280 cases from 36,000 screened schoolchildren, followed by revisits conducted by health practitioners. A reduction in the disease prevalence from 5.6 to 1.2% was reported, with the average cost of supplying personnel, laboratory and medication on an average screened child of US$

0.5, showing that such a selective approach was more cost-effective than mass distribution (less personnel and at no laboratory cost, but at US$2.33) (Curtale, Hassanein and Savioli, 2005). In the Philippines, the integrated control measures of health education, chemotherapy, surveillance and program evaluation for farmers in 16 provinces were conducted over two years to deal with high mortality and morbidity, and low dairy productivity among farming ruminants due to fascioliasis. Selective treatment of susceptible cattle was the major effective control measure. Easy access to sufficient funds and skilful techniques also were considered to significantly contribute to the successful mass treatment program. In addition, regular surveillance was implemented on improved cattle growth, coupled with evaluation of the effective control campaigns, which altogether resulted in a 48% reduction of infection among livestock (Copland and Skerratt, 2008).

These integrated programs demonstrated that good systematic treatment and follow-ups were among the effective components of the control measures to combat fascioliasis in humans and animals. However, there were gaps in these reported programs. The study in Egypt missed other high-risk groups of the Egyptian population such as women, who had significantly higher infection rates than men (Mas-Coma *et al*., 2005b). In addition, while the two-year trial resulted in a significant reduction of the fascioliasis infection rate, the long-term achievements might not be assured in the absence of a multi-sectoral approach, including "mass treatment of veterinary reservoirs, snail control, health education, promotion of hygienic habits and a definitive improvement in quality of water and sanitation in the affected areas" (Curtale et al., 2005, p. 608). The Philippines project could not ensure the long-term sustainability of the intervention activities, as it received insufficient concern from animal owners (Copland and Skerratt, 2008).

Two reports have highlighted that a range of measures should be incorporated in a broadly-based approach toward fascioliasis control.

2.4.2 Control projects and programs of fascioliasis and other helminthiases in Vietnam

Two key studies of the control activities used to combat helminthiasis and fascioliasis have been conducted in Vietnam. These disease pathogens are both neglected tropical diseases and can be considered similar in biological and epidemiological characteristics and in their likely methods of control (Hotez, Molyneux, Fenwick, Kumaresan, Sachs, Sachs and Savioli, 2007; Liese, Rosenberg and Schratz, 2010; Gabrielli, Montresor, Chitsulo, Engels and Savioli, 2011; Carrique-Mas and Bryant, 2013), and thus are discussed collectively.

It has been well acknowledged that the success of control programs targeting helminthiasis is greatly dependent on different factors, including the position of the programs in the primary health care system, the support provided, the availability of existing resources and its effectiveness in addressing the well-defined problems through proven methods (Molyneux, 2006). Various applications of integrated approaches have proven to be successful in areas with co-endemic diseases (Raso, Holmes, Singer, Tanner, N'Goran, Utzinger, Luginbühl, Adjoua, Tian-Bi, Silué, Matthys, Vounatsou, Wang and Dumas, 2004; Hotez, Ottesen, Fenwick and Molyneux, 2006), mainly involving medications provided within community-directed treatments (Hotez *et al*., 2006).

The following are instances of WHO-supported programs and projects with similar approaches applied in Vietnam.

2.4.2.1 Mass drug preventive chemotherapy campaigns for controlling helminthiases

Preventive chemotherapy has been adopted by the WHO as the main intervention for controlling most of the trematodiases, incorporating large-scale distribution of highly-effective, safety-tested medicines (WHO, 2006c). This approach has been proven effective and safe when the medicine is administered as a single-dose tablet in highly-endemic areas, where individual diagnosis is not justified. It can be conducted by non-medically trained personnel such as schoolteachers and communal volunteers (WHO, 2010b). It is acknowledged that this public health measure alone cannot assure a 100% cure rate; however, it may achieve a considerable reduction in the rate of egg production, the main indicator of helminth infections (Savioli, 2014).

Soil-transmitted helminth infections affect more than 2,000 million people worldwide, especially high-risk groups (approximately 610 million school-age children and 44 million women of child-bearing ages (WCBA) (de Silva, Brooker, Hotez, Montresor, Engels and Savioli, 2003; Haider, Humayun and Bhutta, 2009; WHO, 2011a). The

World Health Organisation (WHO) has undertaken a global campaign to provide drug coverage for a target of 75% of school-aged children (SAC) in endemic areas, and to reduce its negative impacts on women's health. As part of this campaign, mass drug administration (MDA) was launched in 35 Vietnamese provinces, with a supply of anthelminthic drugs supported by the WHO office in Vietnam (Nguyen, 2011). In 2011, about 4.8 million tablets of Albendazole (400 mg) were administered to cover nearly four million or 98% of school aged children; and more than 3.2 million doses of Albendazole were taken by almost three million women of child-bearing age in 10 provinces nationwide.

Evaluation of community perceptions about this initiative indicated high levels of satisfaction and support from students and their families, teachers, health personnel and their volunteer participation without remuneration. However, knowledge, attitude and practice (KAP) surveys found low rates of hand washing with soap after toileting or before eating, frequent drinking of impure water and eating of raw vegetables, and thus the high rates of re-infection would be anticipated. In addition, no reports on the prevalence of (soil-transmitted helminth) STH among school-aged children (SAC) and women of child-bearing ages (WCBA) were conducted after the campaigns to determine the effectiveness of the program (Nguyen, 2011).

Another WHO program targeted clonorchiasis and opisthorchiasis infections. About one million people across 24 provinces in Vietnam are infected with *Chlonosis sinensis* and *Opithorchis viverrine* from eating raw fish, a common dietary habit (NIMPE, 2007). During 2008-2009, a WHO-sponsored control model of food-borne trematodiases was implemented in four provinces in northern Vietnam, where Praziquantel (600mg) tablets were provided for 128,837 people at risk, coupled with training on information, education and communication (IEC) for health staff (Nguyen, 2011). Again, no evaluations were conducted by either NIMPE or WHO, as these would require detailed strategies and planning for monitoring and evaluations over time, and there was a lack of resources to do so (a WHO official, personal communication).

2.4.2.2 Trial model of fascioliasis control in two communes of Binh Dinh province

Chemotherapy, whether used for treatment or prevention, remains the main control measure for various helminth diseases. However, large-scale administration of currently-used anthelmintic medication over a long period of time poses inherent risks of drug resistance (Savioli, 2014); and in fact as mentioned previously (2.3.5), several cases of drug resistance have been reported in animals and in humans (Winkelhagen *et al*., 2012; Ortiz *et al*., 2013). This has raised questions on whether selective drugs are recommended for mass drug administration (Maha, 2008).

A more holistic approach was applied as an attempt to control fascioliasis in a Central province of Vietnam. Two communes of Phu Cat district were selected in a trial study of a fascioliasis control model in Binh Dinh province, with support provided by WHO sponsorship (Nguyen *et al*., 2011). The study included:

a) surveys before intervention to explore the risks of fascioliasis infection and the prevalence of fascioliasis,

b) introduction of the trial fascioliasis control model containing IEC for communal stakeholders,

c) selective treatment of infected cases with TCZ, and

d) post-intervention surveys to evaluate the effectiveness of the model (Appendix 2.2).

After one year of implementation, the perception of risks by the communities increased for some factors. Awareness increased by 31.24%, and attitudes and practices improved by 21.81% and 12.51%, respectively (Nguyen *et al*., 2011). However, certain sections of the communities still demonstrated risky behaviours such as drinking impure water (32.0%), eating fresh water plants (19.9%), and defecating in rice fields and on sand banks (39.75%). Importantly, it was noted that the co-ordination between health, education and veterinary sectors was lacking and this was identified to considerably affect the outcomes of the model (Nguyen *et al*., 2011).

In summary, control measures to combat fascioliasis and other helminthiases have focused on chemotherapy and health education only, and there has been an absence of multi-sectoral approaches. In addition, most control measures have been applied to a small area of intervention as a pilot program, not as integrated approaches, making comparisons of the effectiveness of the applied control measures difficult to undertake.

Nevertheless, helminthiasis control programmes and research studies into the diseases of interest serve as useful references for the development of a broadly-based control model of fascioliasis in Central Vietnam, which is described in the following section.

2.5 Conceptual framework of helminthiasis control and development of a broadly-based control model of fascioliasis

Review of the literature has confirmed that intervention measures to date for controlling helminth diseases and fascioliasis have focused primarily on preventive chemotherapy and integrated approaches. These measures, in certain circumstances, have achieved partial or complete success for certain diseases in given periods. However, far too little attention has been paid to adopting a more comprehensive framework that might lead to long-lasting or sustainable achievements in controlling the diseases (Peter, David, Alan, Jacob, Sonia Ehrlich, Jeffrey and Lorenzo, 2007; Gyapong, Gyapong, Yellu, Anakwah, Amofah, Bockarie and Adjei, 2010; Liese *et al*., 2010; Mas-Coma, 2010; Savioli, 2014). The following framework advocates a more holistic approach, which employs broader components and a combination of existing control measures.

2.5.1 Rationale for developing the broadly-based control model of fascioliasis in Central Vietnam

At the time this research was conducted, no comprehensive control initiatives to combat fascioliasis or other food-borne trematodiases were available in various parts of the world (Lustigman *et al*., 2012), including Vietnam, where the disease is of public health concern (Trieu, 2011; Sripa, Tangkawattana, Laha, Kaewkes, Mallory, Smith and Wilcox, 2015). The roadmap for developing a more broadly-based approach to fascioliasis control was based on intervention frameworks that had a focus on neglected tropical diseases, parasitic diseases, and trematode infections (Molyneux, 2006; Blanton, 2007; Hotez, Bottazzi, Franco-Paredes, Ault and Periago, 2008; Choffnes and Relman, 2011; Nguyen *et al*., 2011; Sripa *et al*., 2015).

Overall, ‘integrated’ was the most common approach of these disease control frameworks, achieving some level of successful outcomes in the control of the respective diseases. The most optimal model, adapted from the trial control model of fascioliasis by Nguyen et al. (2011) and the intervention framework of Molyneux (2006), comprised five main components: chemotherapy, vector control, health education, improvement of the local health system, and involvement of concerned bodies (Figure 2.2, page 35).

The term “control” of diseases was clearly defined previously in this chapter. Its primary aim is to bring the prevalence of morbidity associated with a disease of interest down to an acceptable level, with minimal disability and no mortality (Molyneux, 2006). In 2005, the WHO changed the classification of parasitic diseases from “other communicable diseases” into the more sharply focussed “neglected tropical diseases”. This shifted the paradigm of the control programs to encapsulate three requirements:

(i) attention be given to the needs of populations affected by NTDs rather than to their diseases;

(ii) interventions to deliver treatments are integrated with control measures; and

(iii) evidence-based advocacy is deployed to generate resources for control from the international community (WHO, 2010b).

To develop a control program that incorporates these three requirements, information was drawn from two key sources. A control model incorporating five components for attacking parasitic diseases was developed by Molyneux (2006), which has been applied to several parasitic diseases including soil-transmitted helminthiasis, and has demonstrated its potential relevance to fascioliasis. The second source of strategies relevant to the control model was the work of the WHO in the area of neglected tropical diseases (NTD) (2012).

Preventive chemotherapy is a public-health measure recommended to counter infection or disease by reducing transmission in populations at risks of five NTDs, including lymphatic filariasis, onchocerciasis, schistosomiasis, soil-transmitted helminthiasis and trachoma (WHO, 2010b). Promoted as the most important population-based intervention strategy to counter diseases which are often characterised by a lack of specific clinical symptoms which are sometimes unrecognised, it is considered more cost-effective than individual-based measures (WHO, 2002b). In addition, the medicines used for a variety of helminthiasis are highly safe for specifically high-risk groups in endemic areas, such as pregnant women and children from one year old (WHO, 2002c). This strategy has been applied for large-scale, easily-administered medicines which can be administered regularly, after instruction, by non-medically trained people such as schoolteachers and community volunteers in areas not within reached of the peripheral health-care system (de Silva *et al*., 2003; Urbani and Albonico, 2003; Mondadori, Ehrhardt, Anh, Cong, Sepe, Huyen and Montresor, 2006; WHO, 2006c). As a result, more than 711 million people worldwide have received preventive chemotherapy for at least one NTD as of 2010, with some people being treated with medications that provide protection against more than one disease (WHO, 2013).

However, this strategy is not anticipated to achieve global coverage. Projections of disease prevalence in the coming years, refined delivery strategies, advocacy of drug donations, the availability of health resources and the development of drug resistance following mass drug administration should be taken into account (Savioli, 2014). In addition, applying preventive chemotherapy depends greatly on the typical purposes of the treatment (universal, targeted or selective), which are based on available epidemiological data; and on the specifically recommended drugs for use as public health interventions for controlling typical diseases such as soil-transmitted helminthiasis (STH) (WHO, 2004b; Albonico, Montresor, Crompton and Savioli, 2006).

Intensified case-management mainly focuses on prompt detection, timely treatment, and good management of complications for infected cases and populations at risk (WHO, 2010b). Composed of four main approaches (intensified control, innovation, research and development, and capacity strengthening), case-management is regarded as the principal strategy for control and prevention of some NTDs without available medications for preventive chemotherapy; or those which are difficult to diagnose (under-diagnosed and misdiagnosed), treat or manage (WHO, 2005, 2013). Once patients are suspected of those diseases, they should be sent to well-equipped health facilities to reduce the duration between suspected infection, making a diagnosis and receiving treatment. Intensified control involves the periodic screening of populations at risk to detect asymptomatic diseases, so that effective treatments may be given without, or with fewer, serious side-effects. An innovative approach refers to the adaptability of the strategies to the existing national health system, with modifications when necessary. Research and development strives to improve the quality of the diagnosis and treatment with safe medicines under shorter regimens. Finally, capacity strengthening consists of efforts to maintain expertise through support from higher levels of authority or specific agencies, and actions to enhance the adaptation of the program into the local settings (WHO, 2010b, 2013).

Vector and reservoir control have recently received intensified focus as they involve the increased use of insecticides and account for more investment in controlling vector-borne diseases (accounting for 16% of all global communicable diseases that are transmitted by vectors such as insects, snails, and crustaceans) (WHO, 2008b, 2011b; van den Berg, Zaim, Yadav, Soares, Ameneshewa, Mnzava, Hii, Dash and Ejov, 2012). However, inadequate regulations and legislation regarding the use of the insecticides for public use, and a lack of sound management practices such as limited co-operation between the health and agriculture sectors, are reportedly very common in most member countries. In addition, the increasing problems of substandard, illegal or counterfeit chemicals, and the lack of facilities for the safe disposal of pesticide-related waste, have resulted in high risks of persistent and resistant vectors, and are creating negative impacts on human health and the environment (WHO, 2010b; Matthews, Tan, van den Berg, Zaim, Yadav, Soares, Hii, Ameneshewa, Mnzava, Dash and Ejov, 2011; WHO, 2011c). The presence of animal reservoirs as intermediate hosts for most zoonotic diseases also is a great impediment to intervention efforts and precludes disease control activities (Molyneux, 2006). Thus it is important that interventions use insecticides judiciously, promote multiple disease control through integrated vector management strategies, and strengthen collaboration with other sectors including agriculture, irrigation and environment for the better management of pesticide use (WHO, 2004a, 2007c).

Safe water, sanitation and hygiene have been linked to the WHO's failures in the fight against several NTDs (Prüss, Kay, Fewtrell and Bartram, 2002; WHO, 2013). Even when the incidence of infectious diseases is reduced as a result of improved sanitation and safe water, morbidity from soil transmitted helminths still exists, especially in the rural communities of low-income countries (Asaolu, Ofoezie, Odumuyiwa, Sowemimo and Ogunniyi, 2002; UNDP, 2011). Improvement of sanitation standards (preferably to higher than 90% coverage) is considered essential to reduce infection and re-infection of some STH infections (Albonico *et al*., 2006), yet achieving this depends significantly on the general socio-economic conditions of the community (Asaolu and Ofoezie, 2003). In addition, provision of a latrine is not a sound solution unless it is properly used and maintained. For example, although living in areas of sufficient latrine coverage, Senegalese children are reportedly preferring to defecate outdoors (Sow, de Vlas, Polman and Gryseels, 2004). Therefore, the associations between improved sanitation and reduced risk of diseases are currently being reviewed with a focus on the integrated delivery of improved sanitation, preventive-chemotherapy and health education as key targets to reduce NTD's prevalence (Ziegelbauer, Speich, Mäusezahl, Bos, Keiser and Utzinger, 2012; Strunz, Addiss, Stocks, Ogden, Utzinger and Freeman, 2014).

Health education is conducted to promote health, to increase hygiene awareness and to change health behaviours in the population (Albonico *et al*., 2006). Various communication strategies are applied to increase health awareness and to change behaviour, including materials such as posters, leaflets, and radio or video messages. However, there exist requirements for skills in developing these tools in understandable ways so as to compete for attention, especially in developing countries (Bull, Holt, Kreuter, Clark and Scharff, 2001; Kinzie, 2005; Whitelaw and Watson, 2005). In addition, behavioural change as a result of health education may not be achievable as it is not related directly to health awareness, and is dependent on the availability of resources over long periods of intervention, and the resources may not be effective across multiple groups such as individuals, family and community (Newson, Meijer, Pradeep, Reddy, Sidibe, Uauy, Lion, Crawford, Curtis, Elmadfa, Feunekes, Hicks, van Liere and Lowe, 2013). STH and other NTDs are associated with poverty, which often precludes the availability of hygiene facilities, despite attempts to increase a community's awareness of the safe disposal of waste (Cairncross, 2003). Therefore in the case of STH control, simple education messages are required, including promoting the use of latrines to reduce faecal contamination of the soil, individual and family hygiene such as regular hand-washing, proper food preparation to promote self-protection, and the avoidance of spreading untreated stools on vegetable gardens, to minimise the spread of infection (Guanghan, Dandan, Shaoji, Xiaojun, Zenghua and Guojun, 2000; Lansdown, Ledward, Hall, Issae, Yona, Matulu, Mweta, Kihamia, Nyandindi and Bundy, 2002)

Community participation in parasitic disease control, inspired from the Alma-Ata Declaration of 1978 to achieve "Health for All By The Year 2000" and cited in Zakus (1998), involves a higher degree of participation from communities in healthcare by utilizing the role of community leaders, encouraging healthcare activities from volunteers, and emphasizing the importance of such activities for community well-being (Molyneux, 2006). Various studies reviewing the role of community participation in vector-borne disease control have emphasized the factors contributing to successful vector-borne disease control including leadership, enthusiastic and well-motivated community, and incentives and supports from insecticide manufacturers (Israel, Schulz, Parker and Becker, 1998; Zakus and Lysack, 1998). For example, programs integrating community-based interventions in dengue fever control have proven more cost-effective than governmental vertical strategies alone (Kay and Vu, 2005; Baly, Denis, Van der Stuyft, Toledo, Boelaert, Reyes, Vanlerberghe, Ceballos, Carvajal, Maso and La Rosa, 2007).

However, challenges may inevitably occur and hinder the achievement of project goals. Changes in the program structure, such as scaling up to the national level from pilot level projects, and replacement of the long community-adherent leaderships as a result of national bureaucratic decisions, may significantly affect the continuation of disease control activities (Molyneux, 2006). In addition, community structures and their complicated social interactions in the social environment are of great importance (Israel *et al*., 1998). The WHO has recommended there should be sets of norms for community involvement in cases of population instability such as conflicts, migration, schooling and marriage (WHO, 2013). Community-based intervention strategies involving local health workers, volunteers, and social organizations can be achieved through clearly-defined shared goals and objectives, democratic leadership and the presence of community organizers; the researchers' skills and competency are also especially important (Israel *et al*., 1998; Molyneux, 2006).

Veterinary public health is promoted by the WHO as the protection of human health against zoonotic diseases and related threats requires an understanding of, and application of the veterinary sciences (WHO, 2002a). It is from the veterinary public health perspective that the concept "One Health" was developed in 2008; it is "founded on an awareness of the major opportunities that exist to protect public health through policies aimed at preventing and controlling pathogens within animal populations, at the interface between humans, animals and the environment" (IOE, 2013, p. 1).

It is well acknowledged that most zoonoses are associated with rural populations of the developing world, who are living in close proximity to animals (Doble and Fèvre, 2010; Molyneux, Sanchez, Garba, Carabin, Bassili, Chaignat, Meslin, Abushama, Willingham, Kioy, Hallaj, Keusch, McManus, Ngowi, Cleaveland, Ramos-Jimenez, Gotuzzo and Kar, 2011). These diseases are difficult to control because of the scattered smallholder livestock systems, predominantly informal market practices, and limited capacity and resources of services for disease detection or diagnosis (Schelling and Zinsstag, 2007). In addition, zoonoses are usually overlooked or forgotten (the so-called neglected zoonotic diseases) as governments pay less attention to these diseases, and the international community is more interested in newly emerging diseases with potential for pandemic spread (WHO, 2013). Therefore, the "One Health" concept places the emphasis on zoonosis detection and control from improved intersectoral collaboration, jointly planned activities among concerned bodies, and the advocacy of cost-effective transactional options for control in low-income countries (Zinsstag, 2008). In recent years, international awareness of the links between agricultural practices and health has increased and "One Health" approaches have become the most comprehensive interventions to address NTDs and fascioliasis in particular (WHO, 2013; Ashrafi, Bargues, O'Neill and Mas-Coma, 2014).

Programs targeting neglected tropical disease and parasitic disease control provide insights into understanding the approaches and strategies that encompass all components of interventions. These examples can be adapted in the development of the broadly-based control model of fascioliasis in Central Vietnam, which is discussed in the following section. However, it is important to consider the adaptability of the strategies being discussed. For example, preventive chemotherapy can be applied as a public health strategy with a single-dose, highly safe medication and used for mass drug administration, but this cannot be used for fascioliasis control due to the high risk of drug resistance reported in humans and animals. Similarly vector control using insecticides can be easily applied for insects, but they can poison living organisms or fresh water sea life when used for snail control, which is the intermediate host of fascioliasis.

2.5.2 Development of the broadly-based control model for fascioliasis in Central Vietnam

Fascioliasis is an emerging zoonosis affecting a wide range of mammalian species, including humans, worldwide. The selection of appropriate measures from the intervention approaches discussed in previous sections provides a strong foundation for the development of the broadly-based model for dealing with fascioliasis in Central Vietnam, which is discussed further in this section.

Five components in a broadly-based control model of fascioliasis in Central Vietnam were identified, including: health education and chemotherapy (adopted from previous trials of fascioliasis control models in two communes of Binh Dinh province, Central Vietnam (Nguyen *et al*., 2011), vector and reservoir control, improvement of case surveillance and management, and the involvement of other concerned sectors identified in the adaptive interventions by Molyneux (2006) and the WHO (2010b, 2013) – refer Figure 2.2, page 35. Each component is described in detail in this section, with the rationales explaining why they were selected as appropriate measures to be applied in the typical setting of Central Vietnam.

2.5.2.1 Vector and reservoir control

Fascioliasis has a complex life cycle, taking humans and ruminants as definitive hosts, and fresh water snails (lymnaeid species) as intermediate hosts (Mas-Coma, 2005; Maha, 2008; Mas-Coma *et al*., 2008a; Torgerson, 2013). Unlike other foodborne diseases, the mature forms of *Fasciola spp*. larvae (metacercariae), after being released from infected snails, float freely in water areas or stick on freshwater plants including the submerged part of rice plants (WHO, 2010b). Therefore, humans and ruminants acquire the infection by eating freshwater vegetation containing metacercariae and drinking contaminated water (Mas-Coma *et al*., 2005b; Mas-Coma *et al*., 2009b; Chen *et al*., 2013). In addition, lymnaeid snails have a wide-range distribution in various environmental niches (Mas-Coma *et al*., 2005b; Kenyon *et al*., 2009; Mas-Coma *et al*., 2009b; Bargues *et al*., 2012) and are highly adaptive to the introduction of the *Fasciola spp*. (Mas-Coma, 2004b).

The snail populations and their distribution are influenced by various biotic and abiotic factors such as temperature, light, vegetation, water pH, water current and depth, and snail competitive ability (Lockyer *et al*., 2004). Most snails die in the dry season from lack of water, except for those surviving in streams, rivers or water springs (Suhardono and Copeman, 2008). In Vietnam, *L. viridis* and *L. swinhoei* are intermediate hosts of fascioliasis (Nguyen *et al*., 2007; Dung, Doanh, Loan, Losson and Caron, 2013), often breeding in paddy fields, agricultural canals and river branches all year round (Dang and Nawa, 2005). *Fasciola* infections in snails vary by transmission seasons - low transmission in the dry season (February-August) and high transmission at the end of the raining season (September-January) (Dang and Nawa, 2005).

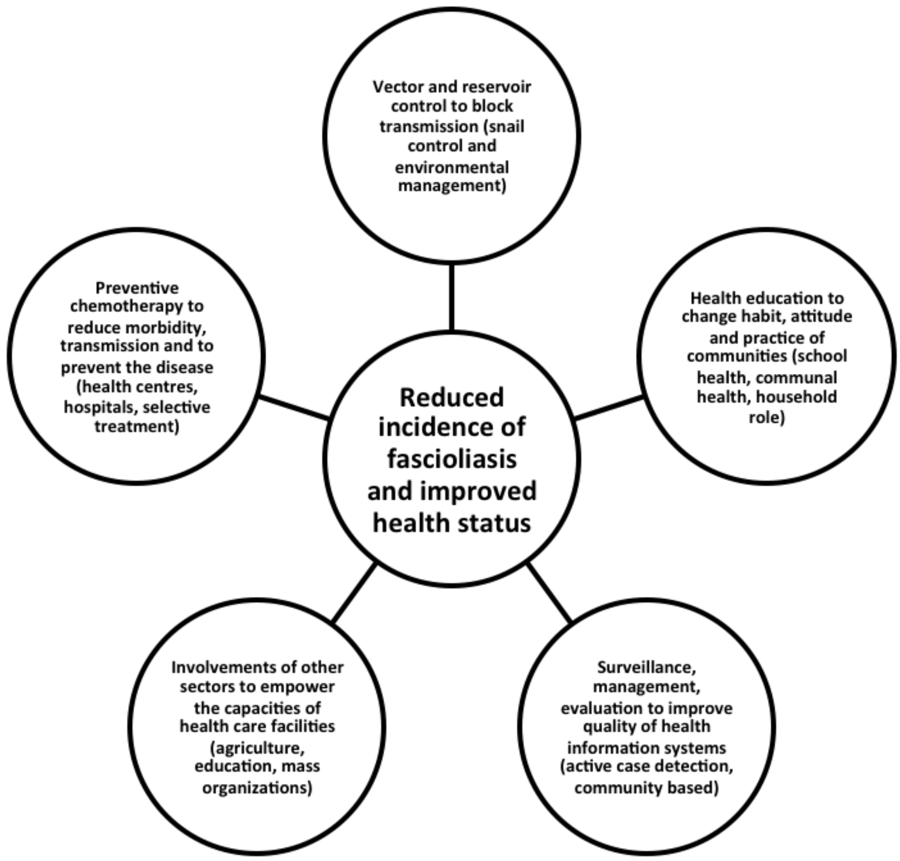

Figure 2.2 Components of interventions against fascioliasis, adapted from *Control of human parasitic diseases: context and overview* (Molyneux, 2006)

The application of snail and reservoir control measures aims to cut off the transmission of the intermediate hosts and to break the life cycle of the parasites (WHO, 1992).

As discussed in an earlier section, the application of chemical-based measures has been promoted for controlling most vector-borne diseases (WHO, 2008b, 2011b; van den Berg *et al*., 2012). Attempts have been made to apply chemical measures (molluscicides such as cypermethrin, metaldehyde and methiocarb) by aerial or hand spraying for controlling snails as the intermediate host (Velisek, Wlasow, Gomulka, Svobodova, Dobsikova, Novotny and Dudzik, 2006; Copland and Skerratt, 2008; Singh, Singh, Singh and Kumar, 2008; Singh and Singh, 2009; Santos, Ferreira, Soares and Loureiro, 2010). However, the chemicals are expensive and periodical use is required because of the rapid rate of re-population of the snails. The chemicals are not species-specific and hence may destroy the valuable aquatic non-target creatures (Sunita and Singh, 2011). In addition, increasing problems of substandard, illegal or counterfeit chemicals, and the lack of capacity of safe-disposing facilities for pesticide-related waste, have resulted in high risks of persistent and resistant vectors and negative impacts on human health and the environment (WHO, 2010b; Matthews *et al*., 2011; WHO, 2011c). Increasingly, other measures are being recommended, including the utilisation of In vitro fasciolicide activity from plant extracts such as eucalyptus leaves (Vera-Montenegro, Ibarra-Velarde, Ramírez-Avila and Munguía-Xochihua, 2008; Jeyathilakan, Abdul Basith, Murali and Anandaraj, 2012; Alvarez-Mercado, Ibarra-Velarde, Alonso-Díaz, Vera-Montenegro, Avila-Acevedo and García-Bores, 2015). Results from these studies indicated a potential for developing herbal-based medications to control liver fluke. However, these studies were conducted in laboratory settings, thus requiring further research prior to practical application (Alvarez-Mercado *et al*., 2015). In addition, the potential for fascioliasis control by utilising these plants and trees is dependent on the needs of these plants for particular topographical settings for growth (Roberts and Suhardono, 1996) and thus the measures may not be suitable in Central Vietnam.

Biological control measures of snail intermediate hosts of fascioliasis have been recommended. *Echinostoma revolutum* (*E. revolutum)* in naturally infected ducks can aggressively displace other larval flukes from their snail hosts. Based on its biological competence, the release of mixed duck faeces and bovine dungs in rice fields at the same time helps to eliminate metacercariae (mature *Fasciola* larvae), thus precluding the greatest potential source of animal infections (Suhardono, Roberts and Copeman, 2006a). Nevertheless, the measure is not possible as in reality the ducks might be stolen if kept away from houses; and the faeces of at least 5-10 ducks in a field are an additional source of schistosomes, a common infection among the poultry (Suhardono *et al*., 2006a). Releasing ducks and geese in the irrigated rice fields or aquatic bodies also has been proposed as a possible biological measure of controlling *F. gigantica* (Rai, Senai, Ahlawat and Kumar, 1996b). The birds eat snails while gleaning food on the shores of lakes or streams. However, the huge flocks of ducks required to eat snails may destroy the rice products prior to harvests and the degree of success from this control has not been measured (Copland and Skerratt, 2008).

Grazing, feeding, and environmental management are the most promising vector and reservoir control measures, which are applicable to the broadly-based control model for combatting fascioliasis in Central Vietnam.

Grazing management is acknowledged as a simple and potentially effective measure to avoid contact between *Fasciola* larvae and susceptible snails (Sargison, 2008). This measure comprises three strategies, including: preventive (putting parasite-free animals onto a clean rice pasture, or suppressing egg output by anthelmintic treatment prior to grazing a section); evasive (relying on the alternation of grazing livestock to another pasture just before the appearance of significant numbers of parasites in the original pasture); and diluting (utilising the potentially susceptible herbs in with naturally acquired immunes to parasites in order to reduce herbage infection) (Waller, 2006). The preventive strategy has been recently promoted to significantly reduce the re-infection of waterways for up to several months, as a result of the suppressive effect of the anthelmintic treatment schemes and the release of clean animals on clean pasture. However, the strategy possesses potential risks of parasitic resistance, as the parasites can survive the treatment over such a long time and develop the resistance genes (Besier, 1999). Interchange grazing between sheep and cattle has been considered a sound diluting strategy in temperate countries, based on the host specificity (e.g. a parasite species can be pathogenic in one host, but cannot infect the alternative host, or is less pathogenic in that alternative host) (Waller, 2006). Nevertheless, the interchange of cattle/sheep grazing must be achieved over a longer term, especially in tropical countries where most ruminants slowly develop natural immunity after two years of grazing; otherwise cross-infection may occur. Therefore, treatment should be applied to cattle whenever sheep are treated to reduce and eliminate contamination (Boray, 2007).

Evasive grazing is appropriate as an application for vector control in tropical countries, including Vietnam. The strategy is based on the characteristics of the free-living stages of parasites in tropical conditions, where they develop faster and are more successful by living for shorter periods than in temperate settings (Waller, 2006). The longevity of metacercariae on pasture is dependent on both moisture and temperature, with their survival rate reduced with increasing temperature, decreasing humidity and exposure to direct sunlight (Hansen and Perry, 1994). In Indonesia, metacercariae attached to submerged rice plants are found to have the longest survival (about five weeks in the aquatic temperatures of 25-30^{0}C). Therefore, the drying-out of rice fields for at least two weeks prior to harvest kills all snails and more than 90% of the metacercariae, and additional exposure of the fields for at least eight hours to direct sunlight kills almost all the viable parasites confined to the bottom third of the rice stalks (Suhardono, Roberts and Copeman, 2006b; Suhardono and Copeman, 2008).

Central Vietnam has an annual average of 275 days with temperatures above 25^{0}C (FAO, 2011). Thus is it possible to avoid infection by drying the harvested rice fields for at least two weeks prior to grazing to help kill the metacercariae attached to the rice stubbles. Furthermore, rotational grazing of cattle in alternative pastures prevents the cattle from getting auto-infection.

Most cattle raising households in Central Vietnam practice shelter-based husbandry (or zero-grazing approaches), described as an approach to animal management in which families keep livestock in enclosed and shaded areas, and feed them with fodder or straw from slacks and water (Meul, Van Passel, Fremaut and Haesaert, 2012). The practice is considered to provide a steady and important source of income for the smallholders, to increase milk productivity, and avoid diseases from the outside environment in comparison to pasture-based grazing approaches (Kristensen, Kristensen and Søegaard, 2005; Haskell, Rennie, Bowell, Bell and Lawrence, 2006; Arsenault, Tyedmers and Fredeen, 2009). However, the increased shelter-based husbandry may pose adverse effects such as lameness and leg injury (Green, Hedges, Schukken, Blowey and Packington, 2002). Good nutrition for the cattle, together with the provision of food and water, regular sanitation of the shelters, and regular application of de-worming drugs are therefore among the best practices of zero-grazing smallholders. It is also deemed important to construct trenches close to cattle shelters to store and compost the dung and waste from animals in order to prevent the disease transmission.

The optimal temperatures in Central Vietnam also provide favourable conditions for further control of fascioliasis through good management of cattle dung when used as a fertilizer. The survival of *F. gigantica* eggs in the dung is reduced as a result of high temperature when the dung is exposed to the sun (Suhardono and Copeman, 2008). In addition, mixing stored dung with carbohydrate increases the heat of the mixture through fermentation and this serves to destroy all the eggs in the dung heaps (Suhardono, Roberts and Copeman, 2006c; Cameron, Martindah, Girsang, Intong and Frank, 2008). This application is appropriate in Central Vietnam as drying dung in the sun is an easy, environmentally friendly and cost-effective measure, and dried dung can then be used or sold as fertilizer, providing economic benefits (Nguyen *et al*., 2011).

However, interventions that rely only on grazing management and animal waste treatment cannot guarantee fascioliasis control in animals. Therefore, a health education campaign combined with the health, agricultural and educational sectors should encourage health workers, farmers and students to be more involved in such measures, as discussed in the following sections.

2.5.2.2 Health education to change awareness of the community in fascioliasis control

Health education for increased health, hygiene awareness and behavioural change in the population plays an important part in any public health effort, including fascioliasis control (Albonico *et al*., 2006; Maha, 2008). The application of effective communication strategies can lead to increased community awareness (Kinzie, 2005); and long-term interventions may gradually help to change health behaviours (Newson *et al*., 2013).

In the broadly-based control model of fascioliasis in Central Vietnam, the application of educational materials such as panels, posters, leaflets and broadcasting systems was incorporated to disseminate health messages regarding fascioliasis control in the rural settings of the regions. In addition, the communication methods collectively involved a number of sectors, health, educational, agricultural and social organisations, to create positive changes in awareness and behaviour of the community towards health protection.

Health education was designed to be primarily implemented at schools and in the community with succinct messages on aspects of fascioliasis, including its life cycle, mode of transmission, damages and control measures.

The perceptions of risk and participation of school students in the health education process were designed to be an important measure to promote behavioural changes and increased health awareness of fascioliasis control. At schools, students could be educated to avoid the potential risks of fascioliasis, including not to eat raw vegetables or raw meat, or drink water from rivers or canals, but to drink boiled water, and to wash hands before meals or after toileting. Health messages could be provided through the Monday flag salutations and weekend class meeting periods. At home, students could then relay the messages on health and hygiene awareness to their families, using the education leaflets circulated at school. Students' acceptance and participation in the program could be encouraged through the involvement of the school teachers and health workers in health education message delivery and transmission.

Community participation was also identified as an important factor for achieving fascioliasis control. Messages directed to the community would include practical health education approaches to prevent fascioliasis, such as hygienic eating habits and sanitation, and proper food handling. In addition, their health awareness would also be encouraged by practical veterinary public health measures such as careful grazing management, dung treatment, nutrition and de-worming their cattle to achieve fascioliasis control. These health education messages would be co-operatively prepared and communicated via the shared efforts of the health and veterinary sectors, with the support of the local authorities, social organizations and their own children, and through the organization of community meetings, broadcasting and the delivery of health education messages. The aim of including community participation was increased awareness that their actions would not only protect their own health, but also the health of the other people in the community, based on the communal rules and norms of mutual help and support, an important aspect of Vietnamese culture (Vinh, Loan and Hien, 2007).

2.5.2.3 Improvements in the quality of surveillance and management of fascioliasis cases

Fascioliasis has been recognised as a public health concern in Central Vietnam following the sudden increase in reported cases of infection (Trieu, 2011; Nguyen and Trieu, 2012). As discussed in the previous section, unofficial figures may be the result of under-reporting, especially given the limited resourcing for monitoring and managing the disease (Trieu, 2012). Attempts to improve surveillance had been made through training sessions conducted on fascioliasis diagnosis and treatment for district and provincial medical staff in 41 provinces nationwide, together with improved diagnostic facilities at provincial and district levels (Nguyen, 2009). However, high technology laboratory facilities for diagnosing fascioliasis at the community level were not available (WHO, 2006a). Laboratory facilities for conducting diagnostic tests for fascioliasis were available only at the provincial hospitals; whereas imaging ultrasound examinations with a sensitivity of less than 15% (WHO, 2006a) were installed at district hospitals and required specific technicians (Nguyen, 2009). Lack of access to diagnostic facilities, together with the passive-case detection policy in Vietnam (MOH, 2006), had combined to impede the fascioliasis management and surveillance capacity of local health networks.

The proposed fascioliasis control model included a surveillance and management component that incorporated decentralization of treatment to the district level, adopted simplified and more inclusive case definitions, and an effective referral approach of suspected cases to upper levels within the health services (MOH, 2006). This component included training courses that were conducted on the skills and knowledge of fascioliasis diagnosis, treatment, surveillance and management. These courses were conducted for health workers, agricultural staff, local authorities and schoolteachers to support health workers in the management and surveillance of fascioliasis. The aim of the training courses was to improve the quality of surveillance and management of fascioliasis by local health care facilities. As a result, all suspected cases would be referred to relevant district or provincial hospitals; early treatment at the hospitals would be available, thus reducing hospitalization and patient costs for provincial or national health care facilities, which in turn supports the Ministry of Health's agenda (MOH, 2006).

2.5.2.4 Involvement of other sectors to empower the capacities of health care facilities

The concept of "One Health" was deemed to be applicable to the broadly-based control model for fascioliasis in Central Vietnam through multidisciplinary collaborative activities. Much of the health funding has been dedicated to some major diseases such as HIV/AIDS, tuberculosis and malaria, while fascioliasis as a zoonosis fell into the small subgroup of NTDs that did not attract much attention and hence was under-resourced (WHO, 2005, 2010c). As a zoonosis involving both human and animal health concerns, fascioliasis detection and control requires improved intersectoral collaboration, jointly planned activities among concerned bodies, and advocacy of cost-effective transactional options of control in low-income countries (Zinsstag, 2008). The "One Health" concept would be an appropriate approach to promote multidisciplinary collaborations among health, agriculture, livestock and wildlife sectors, combining their efforts to establish policies, and to increase awareness of the disease burden for the participating stakeholders and affected populations (WHO, 2013).

The human public health intervention measures involved the collective application of early detection based on simple case definitions, the surveillance and management of fascioliasis through the communal health stations and local health volunteer networks, and regular health education campaigns in collaboration with the local authorities, educational, agricultural and social organizations.

The veterinary public health intervention measures included a variety of activities to prevent infection of animals with fascioliasis, in an attempt to cut off transmission of the disease to humans. Regular de-worming for cattle would be conducted before and after the rainy season, with the active involvement of the livestock sector in collaboration with the educational and social organizations and farmers. In addition, farmers and school students would be encouraged to undertake environmental management activities, including grazing management, drying out the rice fields after harvest, drying cattle dung, and the sanitation of cattle shelters, activities which would occur under the instruction of the livestock and education sectors.

Inter-sectoral efforts would also include the participation of the education sector. At school, schoolteachers would act as health educators for students following training in fascioliasis control activities. The adoption and adaption of students' involvement in the school's activities relating to fascioliasis control would also be important, as they make up a considerable proportion of the population at risk of this infection, and may significantly contribute to its transmission. Delivery of health messages on fascioliasis control could be conducted at Monday morning flag salutations; and messages of fascioliasis control in poster and leaflet forms were useful illustrations for students at school and at their homes as well. These activities would be collectively conducted by incorporating the health, educational and agricultural sectors.

The engagement of local authorities and social organizations as stakeholders was considered a good addition for fascioliasis prevention and control. Community officials, with their important 'gate-keeping' roles (Willis, Green, Daly, Williamson and Bandyopadhyay, 2009), could facilitate increased public awareness by organizing community meetings for health education on fascioliasis control. In addition, the women's association, whose aim was to promote maternal health and family nutrition, could integrate health education on maternal health into hygienic living practices. The cultural-information sector[1] could also play an important part in transmitting health messages on fascioliasis control via the communal broadcasting system.

It is also important to emphasize the role of community participation in the broadly-based control model for fascioliasis. As discussed earlier, various community-based studies (Molyneux, 2006), have established that the leadership and enthusiasm of well-motivated communities are key factors in successful disease control programs. The community needs to perceive the risks associated with fascioliasis in humans and animals so that they can then accept to participate in any fascioliasis control activities. This understanding of the disease could be achieved through regular visits by communal health workers, volunteers and health education campaigns. In addition, the communal meetings, organized and encouraged by local authorities and leaders, could play an important role in achieving community participation, as these authoritative figures usually have important voices in the community (Israel *et al*., 1998; Molyneux, 2006).

2.5.2.5 Preventive chemotherapy

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[1] The functions and duties of the cultural-information sector are promulgated in the official letter 43/2008/TTLT-BVHTTDL-BNV by the Ministry of Culture-Sports and Tourism on co-operation with other related sectors in mutual activities on healthy living and disease control (http://www.moj.gov.vn/vbpq/Lists/Vn%20bn%20php%20lut/View_Detail.aspx?ItemID=25055)

Complete fascioliasis control as recommended by the WHO (2006c), requires preventive chemotherapy utilising safe, large-scale, easily-administered medicines (Urbani and Albonico, 2003; Mondadori *et al*., 2006). This public health intervention should comprise three key characteristics: a population-based diagnosis, population-based treatment, and implementation at regular intervals (Gabrielli *et al*., 2011). In the case of helminth infections, the population-based diagnosis is implemented to evaluate the incidence of a disease in a population (not on an individual basis) through appropriate diagnostic tests and standard questionnaires assessing pathogenic manifestations and associated risks. The population-based treatment involves large-scale administration of single-dose, safe medicines by non-medically trained personnel (schoolteachers, community volunteers). And the implementation of regular re-treatment should be assured, relying on the epidemiological characteristics of the disease and regardless of further diagnosis, yet with the required monitoring system in place (Urbani and Albonico, 2003; WHO, 2006c; Gabrielli *et al*., 2011).

Fascioliasis is typically a zoonosis with a complete life cycle requiring humans and ruminants as definitive hosts, and fresh water snails (lymnaeid species) as intermediate hosts (Mas-Coma, 2005; Maha, 2008; Mas-Coma *et al*., 2008a; Torgerson, 2013), factors that need to be taken into consideration in an intervention program. The Kato-Katz technique has been used for quantitatively detecting parasite eggs in stool samples as a simple, rapid and inexpensive method. However, the technique has been found to be of low sensitivity, unable to diagnose the disease during the incubation and acute phases, and it misses all ectopic cases (WHO, 2006a). The ELISA serological tests, though not a cost-effective technique in comparison with the stool examination method, offer the highest accuracy of diagnosis with a sensitivity and specificity of 95% and 100%, respectively, which allows for the detection of infection during incubation, acute phases and ectopic cases, thereby minimizing the rate of under-diagnosis (WHO, 2006a). Therefore, in order to conduct a population-based diagnosis for the broadly-based control model of fascioliasis in Central Vietnam, a combination of clinical examinations for symptoms and signs, laboratory tests (ELISA, eosinophilia) and imaging (ultrasound) methods would be required to confirm cases of fascioliasis (MOH, 2006). In addition, an effective system of early detection of the disease should be established with the health workers being trained on the diagnosis and management of fascioliasis.

Chemotherapy with triclabendazole (TCZ) is mentioned earlier in this chapter as the only proven control measure against fascioliasis, killing both immature and mature forms of the parasites (Fairweather, 2005; Maha, 2008). The medicine, provided by the WHO free-of-charge for countries in need (WHO, 2006a), has been proven safe with no serious adverse effects when prescribed at 10mg/kg of body weight for humans (Villegas, Engels, Mas-Coma, Gabrielli, Angles, Barrientos, Barrios, Valero, Hamed, Grueninger, Ault and Montresor, 2012). However, concerns of drug resistance on humans and animals have been reported (Fairweather, 2009; Olaechea *et al*., 2011; Winkelhagen *et al*., 2012; Ortiz *et al*., 2013). Therefore, care should be taken when using administration of the drug as the population-based measure in the model. Selective treatment for positive cases should be applied, instead of mass drug administration or targeted chemotherapy, in order to prevent risks of resistance. In addition, further diagnosis tests should be required prior to re-treatment of positive cases as a counter-resistant measure.

Preventive chemotherapy in the broadly-based control model for fascioliasis should also be applied to animal health. Previous studies (Nguyen, Tran, Le, Truong and Ngo, 2010; Nguyen *et al*., 2011) reported a very high prevalence (66.0%-72.2%) of bovine fascioliasis in Central Vietnam. Ideally, as a preventive measure, effective anthelmintics should be applied twice a year on animals. Recommended drugs for de-worming *Fasciola spp*. in ruminants include: tolzal F 1 tablet/100kg body weight, fansinex (triclabendazole) at 12mg/kg body weight, dertyl-B (niclofolan) at 6 mg/kg body weight; and these drugs can be administered interchangeably in order to prevent drug-resistance in animals (Nguyen *et al*., 2010). Supplementary vitamins such as vitamin C, B-complex or camphona can be combined to increase the immune system of the animals. In addition, the best results have been obtained when the de-worming was administered at the beginning and end of the wet seasons (Copland and Skerratt, 2008). Most importantly, multidisciplinary collaboration should be implemented to ensure the complete outcomes of the measure. Health workers, community volunteers, local authorities and social organizations should co-ordinate their information, education and communication activities to gain the active participation of farmers.

2.5.3 Evaluation framework of the broadly-based control model for fascioliasis in Central Vietnam.

This section describes the development of a framework for evaluating the broadly-based control model for fascioliasis. The aims of the evaluation are to determine the extent to which the model was implemented as planned, the impacts of the implementation on the prevalence of fascioliasis and on the presence of the snail vectors, and to identify what components of the model could be improved (CDC, 2011, p. 3-4). The section commences with a description of the program evaluation framework, presents how the framework informed the evaluation processes and describes the logic model that was developed.

This research applied the Centres for Disease Control and Prevention (CDC) Framework for Program Evaluation in Public Health, comprising a six-step process for the evaluation. These steps include: an order of engaging stakeholders, describing the program, focusing the evaluation design, gathering credible evidence, justifying conclusions, and ensuring and sharing lessons learned (CDC, 2011, p. 4).

1) Stakeholders -organisations or people with input or experience on evaluation - are required at the first step of the evaluation process. Stakeholders include people who may be involved in the program operations, are served by or benefit from the program, or are primary users of the evaluation.

2) Program descriptions detail how the objectives and operations of the program can be evaluated. In this step, stakeholders should agree on the logic model of the program, the stage of development description, and the purpose(s) of the evaluation.

3) In the third step, it is important to understand the purpose of the evaluation and the rationale for prioritization of evaluation questions, which should be addressed as being of the greatest need to the program and priority users of the evaluation.

4) In the step of planning for gathering credible evidence, acceptance should be reached on appropriate methods and credible data for evaluation results to be accepted or used.

5) Step five sets the planning for conclusions, in which the analysis and interpretation of findings should be informed and the development of conclusions and recommendations be facilitated.

6) Finally, dissemination and sharing of lessons learned is planned in the final step. The translation of evaluation results into practical applications are planned and lessons learned are meaningfully disseminated, which will facilitate ensuring use of the evaluation (CDC, 2011, p. 10).

As these steps are interdependent; they may not follow the linear sequence as discussed. However, the earlier steps should be thoroughly addressed to provide the foundation for subsequent progress (Adela Valero, Victoria Periago, Pérez-Crespo, Rodríguez, Jesús Perteguer, Gárate, González-Barberá and Mas-Coma, 2012). As the broadly-based control model for fascioliasis was a small project, with short-term outcomes being evaluated, the CDC framework was modified to address the specific context of this model.

In the broadly-based control model for fascioliasis in Central Vietnam, the stakeholders include the involved participants in the model such as regional officials (IMPE-QN), the funding source (IMPE-QN and WHO), local authorities (communal people's committee), members from concerned sectors such as health, education, agriculture (CDC, 2011), and those who directly benefit from the model, such as the communities under study and their families (Adela Valero *et al*., 2012). In this study the stakeholders were engaged in the implementation of the model, not in the planning development process as described in the CDC framework (CDC, 2011). Also, as this is a small project, an evaluation stakeholder workgroup was not established.

Developing the description of the logic model is a major focus of the evaluation process. A logic model is the visual/textual presentation of the links between inputs, activities, outputs, and intended outcomes (CDC, 2011, Figure 2, p. 13). Its aim is to provide the combined approach to integrating planning, implementation and evaluation (Hayes, Parchman and Howard, 2011). In the logic model for evaluating the broadly-based control model of fascioliasis in Central Vietnam, the inputs or resources include study materials and equipment, budgets, and human labour (these will be described in Chapter 3). The activities and outputs are the implementation of five model components, using the available resources and measures. The short-term impact comprises the changed seroprevalence, awareness and knowledge of fascioliasis; and the support, commitment, and motivation to participate in the model. The intermediate outcomes consist of sustainable factors for the model, for example prolonged community motivation in fascioliasis control activities (Figure 2.3). As this model was planned to be implemented in a one year period, the output evaluation (inputs → activities → outputs) (CDC, 2011, p. 10) is more focused than the outcome evaluation, which focuses on the outcomes (short, intermediate, and long-term impacts). However, as the implementation is progressed, the evaluation plan can and should include both process and outcome evaluation at the same time, except the long-term outcome evaluation as described in Figure 2.3.

The effectiveness of the broadly-based control model of fascioliasis in Central Vietnam is evaluated by applying the explanatory sequential mixed-methods approach as the best approach for collecting quantitative and qualitative data. Findings from the quasi-experimental quantitative studies provide credible evidence (changes in statistical indicators) for the model evaluation; whereas the exploration of qualitative mixed-method (interviews and focus groups) provides further insight into the model. During the evaluation of the model, consideration is made of the model components that need further improvement, together with other factors affecting the model components which can be further added to the refined model. Finally, the results of the model could be published, lessons learned from the implementation of the model, and the effectiveness of the broadly-based control model could inform the initiatives undertaken in other regions of the country.

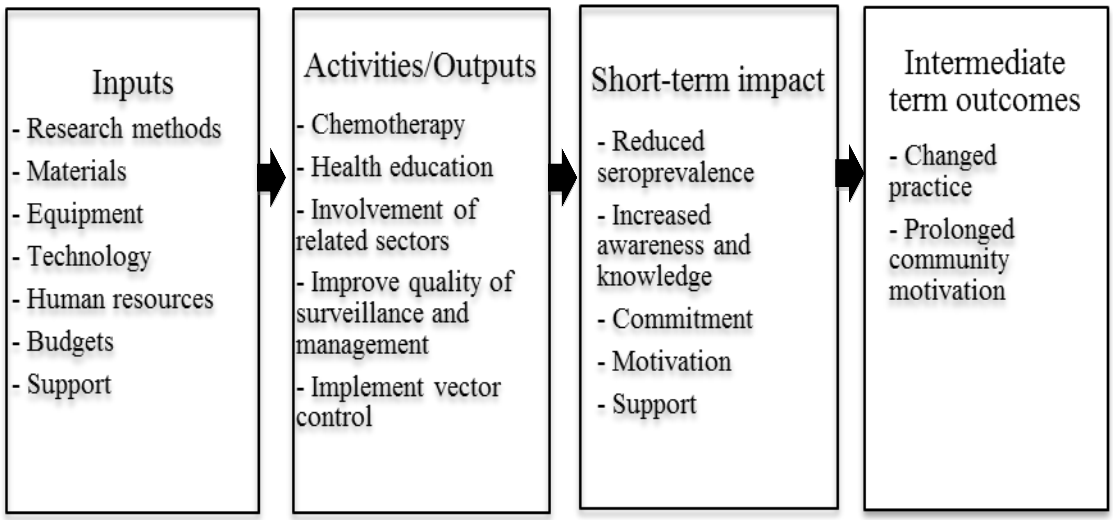

Figure 2.3 Logic model for evaluating the broadly-based control model of fascioliasis in Central Vietnam

2.6 Conclusion

Fascioliasis (liver fluke) constitutes one of the world's most important parasitic infections, causing significant impacts on human health and veterinary production. The disease has become a major public health concern in Central Vietnam as a result of ecological, environmental, behavioural, socio-cultural, and economic factors. To date, no effective control strategies are in place in the region. A more integrative approach to controlling the disease and increasing the human wellbeing of the people is advocated.

The review of the relevant literature provided the rationale for developing a broadly-based control model for fascioliasis, and a framework to evaluate the model. The proposed model, comprising five interlinked components including chemotherapy, health education, the improvement of the capacity of local health networks to undertake disease management and surveillance, the involvement of concerned sectors, and vector control, has been described in detail. The next chapter will describe the rationales for gathering, and the methods used to gather relevant data and evaluate the implementation of the proposed model.

3. STUDY DESIGN AND METHODS

3.1 Introduction

In the previous chapter, it was identified from the literature that fascioliasis is causing public health concerns in Central Vietnam with increasing incidence, together with the associated risk factors of the disease. More importantly, the review of the literature established the importance of fascioliasis control from other disease control approaches, identified potential key factors for intervention, and proposed and described an intervention model.

This chapter will outline the key methodological issues associated with the development and evaluation of a broadly-based control model of fascioliasis in Central Vietnam using a mixed method approach. The rationale of selecting this approach for the studies is explained at the beginning of this chapter, which will be followed by the description of the methodology. A brief description of the study designs, settings and cohorts is then provided, including detailed descriptions of the geographical, ethnological and socio-economic conditions relevant to fascioliasis at the study sites. Sampling techniques and the selection of appropriate tools for data collection are also discussed. Procedures for data collection, analyses and management are presented, together with the statement of approved ethical considerations. The subsequent four chapters comprise the methods, results and discussions of the four main study components, namely baseline information, intervention, outcomes and evaluation of the intervention.

3.2 Rationale for selecting mixed methods as the main study design

The increasing application of mixed methods in the social and health sciences has led to growing debate concerning the fundamental differences in the paradigms traditionally associated with quantitative and qualitative research methods (Teddlie and Tashakkori, 2009, p. 15). The differences derive from the researchers' various understandings of the nature of knowledge (epistemology) and of reality (ontology), which subsequently influence their choice of study methods, objectives and designs (Broom and Willis, 2007). Sale *et al* (2002) argued that research methods are associated with research paradigms on a one-to-one basis, and that any conflict in the propositions of the paradigms lead to disruption of the corresponding methods. However, mixed methods studies recently published provide excellent evidence of the significant contributions to addressing complex social problems made through the utilisation of both qualitative and quantitative approaches (Brett, Heimendinger, Boender, Morin and Marshall, 2002; Classen, Lopez, Winter, Awadzi, Ferree and Garvan, 2007; Farmer and Knapp, 2008; Igo, Kiewra and Bruning, 2008; Graff, 2014, p. 46).

Mixed methods research, also named by various authors as the "third methodological movement" (Teddlie and Tashakkori, 2003, p. 5) or the "third research paradigm" (Johnson and Anthony, 2004, p. 15), is defined as "the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purposes of breadth and depth of understanding and corroboration" (Johnson, Onwuegbuzie and Turner, 2007, p. 122).

The following sections will describe two mainstream paradigms with their advantages and disadvantages in designing and conducting the mixed methods design.

3.2.1 The quantitative method paradigm

Being long dominant and having remained unquestioned in the social and behavioural sciences, quantitative methods have proven considerably successful by establishing more evidence-based practice through empirical protocols and guidelines for practice (Allsop, 2013; Graff, 2014). Defined as the gathering, analysis, interpretation and presentation of numerical information (Teddlie and Tashakkori, 2009, p. 5), the quantitative method is based on positivism or post-positivism and is characterised by empirical research (Sale *et al*., 2002). The data obtained from the research are typically hypothesis driven, measurable and subjected to statistical analyses. It is claimed that such data are 'objectively' achieved and 'free of values' (Graff, 2014, p. 46). By using statistically and mathematically-based calculations, researchers establish the interpretations and draw causal inferences. In addition, as it is approached as a cumulative process, knowledge is achieved by building on previous research and continuously refining subsequent research findings (Allsop, 2013).

There are some particular advantages that make quantitative methods a more prominent contributor to knowledge in the social sciences. The methods are considered valid to explain the relationship between the independent and dependent variables on a cause-and-effect basis. In addition, quantitative methods are transparent, are demonstrable, logical, mathematical, and statistically sound. Finally, generalizability and replicability are two important strengths of the quantitative paradigm, as the findings of the research can be generalized to a large population as a result of sampling; and the research studies can be replicated by others, thus contributing to the perception of the reliability and validity of their findings (Johnson and Anthony, 2004; Allsop, 2013).

Despite the potential strengths of the quantitative methods, there are also criticisms of the paradigm. General criticism is mainly on the inappropriate application to researching social life. Critics of positivism argue that the social world is different from the natural world especially in the closely interacted activities of living beings, acting and thinking. Thus any studies on the social phenomena cannot be conducted objectively and sufficiently in the same way as can be undertaken on objects in the natural world (Rubin and Rubin, 2005; Silverman, 2011; Bryman, 2012). In addition, the research instruments are artificial and drawn on social and cultural constructions. Therefore, positivist researchers conduct the research design, implementation and interpretation of the results from their own perspectives, and not necessarily based on life as it is lived by the objects under research. The knowledge from these studies is partially subjective, interpreted, political, and ideologically driven, which may or may not be acknowledged (Rubin and Rubin, 2005; Broom and Willis, 2007).

Nevertheless, present-day quantitative research is still more realistic and objective as compared with the qualitative research, and the researchers are in favour of using quantitative methods provided a hypothesis is given to test the methods with deductive reasoning.

3.2.2 The qualitative paradigm

Rapidly developed in the 1960s and 1970s, the qualitative paradigm was used as a countermovement to quantitative research to address its critique of being too standardised in order to reflect all aspects of the social reality (Flick, Kvale, Angrosino, Barbour, Banks, Gibbs and Rapley, 2007). Although various definitions are found in the literature on the subject, the following definition by Denzin and Lincoln offers the initial, generic and complete features of qualitative research:

> "Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them." (Denzin and Lincoln, 2005, p. 3)

It is well acknowledged from the definition that qualitative research methods are different to quantitative research in philosophical assumptions, strategies of inquiry, methods of data collection, analysis and interpretation (Creswell, 2009). The following sections discuss the distinctive characteristics described as the strengths of the qualitative research methods in comparison to the quantitative methods.

A distinctive difference from the quantitative paradigm is that the qualitative paradigm is based on constructivism and interpretivism, taking realism as its philosophical foundation (Sale *et al*., 2002; Marshall and Rossman, 2006; Munhall, 2006). Instead of testing, measuring and experimenting with numerical data, qualitative research is usually concerned with meaning, by which qualitative researchers engage with the participants to understand their point of views based on multiple realities being constructed individually and socially (Willig, 2001; Graff, 2014). Moreover, whereas quantitative researchers focus on the cause-effect relationship between the independent and dependent variables, qualitative researchers believe that determining that relationship is challenging, and that the description of reality is more important. Increasingly, they investigate the entire phenomenon and examine the views of the individuals involved in the research. They are less likely to be influenced by conventional ways of thinking, and have more opportunities to create new ideas and categories to enrich their own experiences from specific social and historical contexts (Ezzy, 2002; Liehr and LoBiondo-Wood, 2006). In addition, qualitative researchers apply inductive reasoning to develop a theory from units of data; or to work from the specific or particular to the general, which provides a holistic view of phenomena to discover and understand the social and cultural features of the world (Simmons-Mackie, 2014). Finally, samples in the qualitative research are not meant to represent a large population, but they are purposeful in allowing participants to articulate and to provide meaningful information in accordance with the time and the context of the study, focussing attention on the transferability rather than the generalizability of the study results (Teddlie and Tashakkori, 2009).

Although having recognised advantages of creating insight into the knowledge about new phenomena and complex interactions by understanding the contextual issues, qualitative research is subject to criticism for its weaknesses. Some critics of constructivism (Johnson and Anthony, 2004; Saks and Allsop, 2012; Myers, 2013) indicate the lack of generalizability as the major disadvantage of qualitative research because of the small samples involved in qualitative studies, which may not be replicable and generalizable to larger settings. In addition, most of the qualitative methods are very time consuming and not cost-effective. Most qualitative studies are based on context and verbal analyses, and the research process is circular and interactive, which may be costly in terms of time (Bamberger, 2000; Simmons-Mackie, 2014). Moreover, voluminous data and time-consuming analyses may also result from a lack of focus, as research questions may be loosely designed and the theoretical issues not coherently formulated prior to data collection (Saks and Allsop, 2012). Also, biases and idiosyncrasies may be introduced when the qualitative research designs are being constructed by the researchers themselves, as the quality of the data is heavily dependent on the researchers' personal interpretations and descriptions (Anderson, 2010; Saks and Allsop, 2012).

While being critiqued as small scaled, anecdotal and lacking in scholarly rigour (Gioia, Corley and Hamilton, 2013), qualitative research has been increasingly accepted by the social scientific community as a countermovement to quantitative research. By providing insights into complex interactions of social entities, qualitative methods can be used to compensate for and replace quantitative methods in settings which are inappropriate, inaccessible, or unable to be attained using statistical measurement. More importantly, appropriately employed qualitative methods can constitute a rigorous and systematic means of discovering and understanding the world both socially and culturally.

In summary, the debates concerning whichever method should be applied in social research studies have never come to an end because the underlying differences between the quantitative and qualitative paradigms have extended beyond the philosophical and methodological standpoints (Sale *et al*., 2002). However, these differences have resulted in the increasing numbers of various books, journals, sources of literature, funding, expertise and methods from each inquiry paradigm (Sale *et al*., 2002). Despite these fundamental differences, the combination of these both methodologies can become congruent and combined into one research design, together with its purposes, benefits and barriers, which are discussed in the following section.

3.2.3 Rationales, purposes, benefits and barriers of mixed methods research

The fundamental differences between the quantitative and qualitative research methods as discussed earlier in this chapter have facilitated more advocates for combining these two paradigms into a single design to address the complex research problems. The 1980s witnessed an increasing number of studies combining quantitative and qualitative methods in the social sciences literature, which suggested that the social sciences researchers showed more flexibility in their decisions to select more appropriate study approaches (Bryman, 2006, 2012). Researchers of the social sciences identified the benefits of combining the two paradigms, including: participant enrichment, instrument fidelity, treatment integrity, and significance enhancement (Collins, Ouwuegbuzie and Sutton, 2006). In addition, they found themselves using mixed methods research to obtain greater validity (or triangulation) to their research studies from the collateral findings; to counteract the weaknesses of a single methodology as mentioned in earlier sections; to develop more powerful research instruments; and to predict and manage unexpected findings (Allsop, 2013, p. 30).

Various types of mixed methods are applied in different study designs, either with a qualitative component in a predominantly quantitative study and vice versa, or with equally weighted methods. These designs are dependent on the research questions, which place emphasis on the priority given to one or both forms and leads to different sequences of the data collection process (Graff, 2014). For example, to investigate how patient and carer groups represented their members in the policy process, Baggott *et al*. (2004) first conducted a quantitative study by questionnaire to explore the descriptive characteristics of participants, and interactions between patients and carer groups and other stakeholders. The data collected from the study were used for sampling the in-depth interviews with group leaders on cultural practices in relation to internal and external activities, and differences among groups (Baggott *et al*., 2004).

Although having the potential for increasing applicability to social sciences research, mixed methods research is still subject to a variety of complications. There can be a mismatch between the rationale for the mixed methods and how it is used in practice (Bryman, 2006). The study findings may be reported primarily with the quantitative or qualitative data, or with a much greater emphasis on one single method, while the quantitative-qualitative mixed research is intended at the foreground. Also, the findings of the studies may be presented in a parallel way, perhaps not integrated, or unable to be intertwined, indicating that the quantitative and qualitative components are weakly integrated or not integrated at all (Bryman, 2007).

However, strategies can be used to maximise the validity and thus reduce the problems of mixed methods research. In social and behavioural research, the term "triangulation" has often been applied in different methodological approaches and in the context of combining them (Erzberger and Kelle, 2003; FLick, 2006; Hall, 2008). At first, the fundamental understanding of the term is its use as a validation strategy; yet a broader understanding entails four distinguished forms: triangulation of data; researcher triangulation; theoretical triangulation; and methodological triangulation (FLick, 2006, p. 305-306). A detailed application of triangulation to maximise the validity of the studies is described in the study progress section (3.5).

In summary, mixed methods research has gained increasing attention from social sciences researchers, especially as "new ideas that are badly needed enough will be accepted" (Graff, 2014, p. 61). The fundamental differences between quantitative and qualitative domains have fostered the development of mixed methods research, as researchers discovered the advantages of mixing the two mainstream paradigms epistemologically and ontologically. There are still challenges inherent in mixed methods research, especially in the design, implementation process and interpretation of findings. However, mixed methods research offers a practical approach for targeting the research problems and questions which may differ in terms of philosophical and methodological perspectives, and has proven its potential to gain additional, in-depth information of the "third research paradigm."

3.3 Study design

According to Keele (2011), the study design is primarily dependent on the research questions, which in turn stem from the research problems and purpose statements. For this research, deciding to choose a mixed methods approach is a challenging process derived from the innate complexity of the mixed methods designs (Creswell and Plano Clark, 2011). Key principles that must be considered when designing a mixed methods study include: the decision on the type of study design; the identification of the approach to be applied; the correlation between the design and the study problems; the purpose and questions posed; and the clarity of the rationale for combining the methods (Creswell and Plano Clark, 2011). Also, there are four key decisions to be made in choosing the most appropriate mixed methods design, including: the level of interaction, the relative priority, the timing, and the procedures of mixing the strands (Creswell and Plano Clark, 2011).

As described in chapter 2, fascioliasis is an emerging human and veterinary public health problem in Vietnam and in developing countries (Mas-Coma, 2005; Nguyen, 2011), and chemotherapy is the only solution available to deal with the problem at present (Maha, 2008). In order to gain an insight into the seroprevalence of fascioliasis and its associated risks, then to develop, implement, and evaluate a broadly-based control model for the disease in Central Vietnam, it is important to explore in detail all the facets by applying corresponding research methods, including quantitative or qualitative methods, or a combination of both. Based on the rationale of selecting the most appropriate method and the research questions raised from the problems of fascioliasis, mixed methods research is deemed to be the most appropriate in this study.

Among the six major mixed methods research designs described by Creswell and Clark (2011, p. 69), the explanatory sequential design was deemed to be the most appropriate for the study of developing and evaluating the broadly-based control model for fascioliasis in Central Vietnam (Figure 3.1). In the design, the collection and analysis of quantitative data was undertaken to identify the seroprevalence of fascioliasis and associated risk factors of the disease, followed by the qualitative exploration of factors contributing to or impeding the model's effectiveness in Central Vietnam. The mixed methods data were collected and analysed in a process containing three collection stages: baseline, intervention and follow-up (Table 3.1), which aimed at addressing the research questions:

1. Is the prevalence of fascioliasis reduced, and the health status of the community improved, as the result of the introduction of the broadly-based control model for fascioliasis is introduced in Central Vietnam?

2. What factors are aiding or impeding the success of the broadly-based control model for fascioliasis in Central Vietnam? It is from the mixed methods sequential explanatory design that the qualitative data served to add more depth and breadth of information to the quantitative significant results (Creswell, Plano Clark, Gutmann and Hanson, 2003). The results obtained from the two paradigms were mixed at the interpretation phase with an attempt to explicitly explain the success of the model in Central Vietnam.

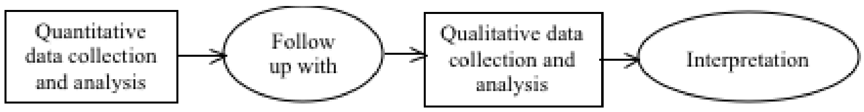

Figure 3.1 The explanatory sequential mixed methods design, adapted from Creswell & Plano Clark (2011)

3.4 Study population and sampling strategies

The study was conducted in the Nhon Hau and Nhon Thanh communes of An Nhon town (Binh Dinh province), and Tinh Giang of Son Tinh district (Quang Ngai province) in Central Vietnam (Figure 3.2). The selection of the actual communes was based on the convenience of accessibility (transport, health system facilities, and potential engagement of the local authority), and site distance (intervention communes away from the control commune).

The communes of Nhon Hau and Nhon Thanh are located in the north and northeast of An Nhon town, at the down-streams of rivers. The residential areas are intermingled by small streams and lakes. The populations of the communes are from 10,000-12,000 people, mainly involved in agricultural production such as rice cultivation, animal husbandry and handicrafts. Socio-economic conditions and behavioural characteristics, especially the free-grazing of animals and the improper treatment of animal waste, have facilitated the transmission of parasitic diseases, including fascioliasis. A majority of the community members still exhibit high-risk behaviours, such as ingesting raw vegetables and defecating outdoors, which help the *Fasciola* larva to finish their life cycle.

Located at the southwest of Son Tinh district, the Tinh Giang commune is embraced by the Tra Khuc and Giang rivers and includes 14 small streams, with three irrigational works constructed for agricultural production. There are about 10,000 people with 92.7% of them undertaking animal husbandry, rice and other farm produce cultivation as their main occupations. The proportion of poor households (average monthly income per capita less than 19 USD as promulgated by the Vietnamese government from 2011-2015-www.chinhphu.vn) accounts for approximately 15% of the whole population (GSO Vietnam, 2012). Local people still possess long-term habits of eating raw vegetables and drinking non-boiled water, which puts them at high risk of parasitic infections, especially fascioliasis. (Figure 3.2).

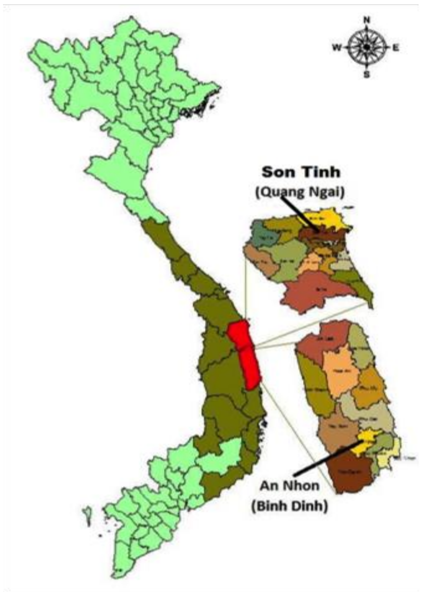

Figure 3.2 Map of Vietnam showing the study sites in Binh Dinh and Quang Ngai provinces

It is important to understand and acknowledge the sampling strategies employed in mixed methods research, especially when combining the quantitative and qualitative sampling techniques. Quantitative (probability) sampling techniques are predominantly used to obtain a sample most precisely representing the whole population under study; and qualitative (purposive) sampling techniques are mainly used to explore the most meaningful information from selected individuals or groups of participants (Graff, 2014). As discussed in the previous section, the present study applied the explanatory sequential mixed methods design, the probability and purposive sampling strategies were conducted one after another, and the procedure of quantitative sampling techniques, followed by the qualitative sampling techniques, was used, as most frequently applied in previous studies (Teddlie and Tashakkori, 2009).

3.5 Research process

The techniques and methods used for sampling, collecting and analysing data and the ethical considerations involved are now described. The application of procedures is also discussed, to increase the validity of the selected methods and techniques of data collection.

3.5.1 Quantitative study

At the start of the research, data collection was conducted to provide the overall picture of fascioliasis in Central Vietnam. Data included human blood seroprevalence, a survey of risk factors, observational data, and *Fasciola* prevalence among lymnaeid snails as intermediate hosts.

The quantitative quasi-experimental design, which applied the pre-test and post-test approach on two intervention groups and a control group (shown as intervention communes and the control commune in Table 3.1), aims to evaluate the effectiveness of interventions described in the broadly-based control model for fascioliasis (section 2.5.2, chapter 2). Although less rigorous than the experimental design, setting up and applying a quasi-experimental design is easier to do in settings which are not affected by randomization (Bonell, Hargreaves, Cousens, Ross, Hayes, Petticrew and Kirkwood, 2011). In addition, as this study is conducted in the field, the natural environments are not affected by the human-controlled laboratory or the clinical settings involved in an experimental design, which strictly require the specification of participants (Thompson and Panacek, 2006; Lennon-Dearing and Neely-Barnes, 2014, p. 12). Moreover, the quasi-experimental approach can be used in non-randomized settings, where there is difficulty in randomizing subjects by geographical distributions, and when available sample sizes are small (Harris, McGregor, Perencevich, Furuno, Zhu, Peterson and Finkelstein, 2006).

Among three common quasi-experimental design approaches as described most recently (Lennon-Dearing and Neely-Barnes, 2014), the ‘non-equivalent comparison groups’ approach was selected as being the most appropriate for this study. Accordingly, two intervention communes and a control commune were not randomly selected, but they shared similar ethnographic and socio-economic conditions as described earlier in this chapter. Therefore, the groups chosen for the study were similar enough to be comparable. In addition, as the intervention groups were not randomized and the control group chosen was a similar group, and based on the assumption that if the intervention and the control groups were similar at the pre-test, there would be a smaller likelihood that important confounding variables would differ between the groups (Harris *et al*., 2006).

However, there were still certain issues regarding the selections which might result in different outcomes (Harris *et al*., 2006). For example, the outcomes in question could change due to the occurrence of random events other than the interventions happening between the before and after surveys, which might influence the effects of the interventions. Additionally, the 'testing effect" could be introduced whereby, when repeated questions on attitudes and knowledge are asked during the later surveys, this can possibly make the participants change their views simply as a result of having been asked previously. Finally, when the study is progressing over a long period of time, the loss of participants to be involved, or who were already involved, in the study is inevitable, which poses impacts on its internal validity (Hall, 2008).

The present study attempted to apply various strategies to maximise the validity of the research. Pilot studies were conducted prior to the main studies with similar study designs, with the aim being to identify the unanticipated problems possibly affecting the main study, to test the reliability and validity of the data collection instruments, and to check the time spent on various techniques of quantitative data collection, such as questionnaire interviews, blood collection, observations and snail surveys (Hall, 2008). In addition, the use of a control group for comparisons in this study, together with the pre-test (the baseline data collection stage in this study), addressed the concerns of validity, as participants might change their responses over the time of study (Hall and Roussel, 2014). In addition, random sampling strategies were applied to select participants from within the three study communes, with additional sampling at the post-test stage, to prevent attrition and to assure the generalizability of the findings. The random selection of different cohorts from the same population at the post-test phase (the follow-up surveys in this study) aimed to reduce the problems of the occurrence of random events, re-testing and participant losses, which may occur in the quasi-experimental design (Hall, 2008).

3.5.1.1 Quantitative study design

Quantitative data collection was undertaken in three phases: baseline, intervention and follow-up, which were outlined in Table 3.1. Whereas similar measures of data collection were applied to three communes at the baseline and the follow-up stages, different levels of intervention were implemented for the communes with intended comparisons of the study outcomes. Broadly-based control measures to combat fascioliasis (including the treatment of human infected cases and de-worming of cattle, health education, integration of other involved sectors, improvement of disease management, and vector control) were applied to the Intervention 1 commune. Meanwhile, the treatment of human infected cases and the de-worming of cattle only was applied to the Intervention 2 commune; and the treatment of human cases only was applied to the Control commune (Table 3.1). If there were no differences in the outcomes among the three communes, it would be concluded that none was superior; or if no differences were observable between the Intervention 1 and 2 communes, recommendations could be made in favour of the latter intervention commune in order to save resources.

Table 3.1 Study design showing different stages of data collection

Communes[2]	Baseline data collection	Intervention	Follow-up data collection
Intervention 1 commune	+	broadly-based control model	+
Intervention 2 commune	+	treatment for humans & de-worming for cattle	+
Control commune	+	treatment for humans only	+

3.5.1.2 Sampling

This section provides the detailed descriptions of the sampling techniques, including the quantitative survey methods, attached appendices with included indicators for analyses, and the required resources. Quantitative survey methods are defined by various authors, but De Vaus (2014, p. 3) provides the most convincing definition by clearly stating two

[2] From this chapter onwards, the names of three communes under study were replaced as unanimous purposes of the study: Intervention 1 commune, Intervention 2 commune, and Control commune

typical features of a survey, including the forms of data and the methods of analysis. Based on this definition, when a survey is conducted, the collected data should be of the same characteristics so that variables such as age, gender, occupation, social classes, attitudes and behaviours can be compared; this will also help to validate the various methods of analysis (Calnan, 2012, p. 190). Therefore, in a typical quantitative method study, a range of survey approaches can be applied (Czaja and Blair, 2005). Cross-sectional surveys are the most regularly used surveys that monitor a situation at one point in time, which can be useful for measuring gross change. However, it is the longitudinal designs which study the same cohort over time that are more appropriate for understanding individual and cross-group changes (Calnan, 2012).

Quantitative surveys are associated with the deployment of various data collection tools and necessary resources which require time, money and human labour (Fink, 2003). Questionnaires are the most regularly applied tool of surveys, by which interviews of various forms can be conducted such as face-to-face, telephone, self-completed or other means (Babbie, 2008). In addition, surveys can involve qualitative data collection techniques, such as structured observations with specific activities to be recorded. In this case, quantifying the data obtained from qualitative methods helps to elicit and elaborate on the information (Calnan, 2012). Generally, survey methods are considered valuable for exploring the comparisons and differences between quantitative variables of populations, which provide the breadth and depth of a social phenomenon or a broader social picture. However, they cannot explore the meanings and perceptions of the social activities in which entities are interacting. Compensation for this can be made by integrating a qualitative approach, which allows for greater flexibility (Calnan, 2012). Further details on the strengths and weaknesses of this were discussed in each of the quantitative survey methods.

As discussed earlier in the previous section, the non-equivalent comparison groups approach was applied in this quantitative quasi-experimental design with the study groups not randomly selected. This caused concerns related to the validity of the study. However, attempts were made to minimise the problems by optimizing the sample size calculations, employing appropriate recruitment strategies, and piloting the study designs prior to conducting the main studies. In addition, as the studies were conducted in Vietnam, prior to administration, all written materials were translated into

Vietnamese and translated back into English by a separate person, to maintain the accuracy and clarity of terms.

3.5.1.2.1 Cross-sectional study for blood survey of fascioliasis prevalence

A cross-sectional study was conducted to evaluate the seroprevalence of fascioliasis in three communities. A laboratory-based blood ELISA and eosinophilia counts were undertaken, based on the guidelines for diagnosis and treatment of fascioliasis by the Ministry of Health, Vietnam (MOH, 2006), included in Appendix 3.27. The sample for this cross-sectional study was calculated using the formula for statistical methods for sample size determination espoused by Lemeshow at al. (1990, p. 1), with a known referential infection rate from a previous study conducted in Binh Dinh province (Nguyen and Le, 2007). The total population selected from each commune was 428 people, 20% or 85 more people were added to cover for potential loss or inaccessibility to ensure the desired number of participants. Hence the total population selected from each commune was 504, rounded down to 500 people (Formula 1, Appendix 3.1). As the prevalence of fascioliasis amongst children in the area had been found to be low in recent studies (Dang, 2007; Dang and To, 2010; Nguyen, 2010), adults aged from 18 were selected in this study. Further explanations are detailed in the ethical considerations section (3.5.1.4).

Recruitment, conducted one month prior to the main data collection stages, was undertaken through the random selection of representatives from household records, taken and with permission from the communal registrar's office (refer Appendix 3.2). A 5-household interval was used until the full number of participants was achieved. A total of 1,613 participants (usually householders) for the baseline and 1,500 others for the follow up stages, aged from 18 years old, were invited to attend the blood examination (refer Appendix 3.3).

Invitations with enclosed participant information sheets, explaining the purposes and contents of the survey (included in Appendices 3.2 and 3.4) were sent to the selected participants. Their agreements to participate in the survey were gained by signing the consent forms (Appendix 3.5). The blood drawings took place at the communal health offices by trained and experienced personnel at the IMPE-QN government laboratory, with procedures of phlebotomy (blood drawings) and ELISA being clearly explained to participants (Appendices 3.25 & 3.26). Participants were advised that they could take part in, or withdraw from the surveys without bearing any consequences. The blood samples were divided into two parts and treated with different laboratory haematological procedures.

The preparation of a blood slide followed the laboratory procedure of thin microscopic blood smears (Cheersbrough, 2006, p. 320). A small drop of blood was taken from the sample and placed near the frosted end of a clean microscopic slide. The thin blood smear was made by holding another slide as a spreader at a 30 degree angle and drawing it back against the drop of blood to make a film about 40-50mm in length (two thirds of the slide). Brief information about the participants including slide number, name, place and date of blood drawing were then written on the blank areas with permanent marker, and the slides were allowed to air dry (room temperature) in a dust-free area. Finally the slides were packed and transferred, together with the blood sample vials for ELISA, to the IMPE-QN laboratory for staining and counting of the eosinophils. Examined slides with eosinophilia from 8.0% provided supporting confirmation for positive results (MOH, 2006).

An ELISA was conducted to identify if a person was infected with fascioliasis. The ELISA process (Appendix 3.26), using the MOH approved test kit (Appendix 3.31), was followed and the remainder of the blood samples were treated according to the IMPE-QN guidelines on laboratory waste treatment (Appendix 3.32). Information on the participants, the same details as those given on the blood slide for eosinophilia (number, name, place and date of blood drawing), was then written on the blank areas of the vial with permanent marker. The results of the assays were calculated by dividing the optical density (OD) reading of each sample well of the plate by the cut-off value (determined by the mean OD negative controls plus 3 standard deviations). Any result from 1.0 was considered positive, and results less than 1.0 were recorded as negative (Tran and Tran, 2004).

3.5.1.2.2 Cross-sectional study for household knowledge, attitude and practice (KAP) survey on fascioliasis.

This study evaluated the adult cohorts living in the three communes in relation to their knowledge, attitudes and practices (KAP) regarding fascioliasis, which was conducted at the stages of baseline and follow-up data collection (Table 3.1). The data collection for the baseline stage lasted from March to May, 2013 and the follow-up stage from October to December 2013. These dates were the same as those of the blood survey data collection stages. As the KAP survey involved adult cohorts in three communes, an adjustment was necessary to get significant differences between the comparisons. The manual Bonferroni adjustment was used to allow for multiple comparisons to be made while assuring the overall confidence coefficient (Bland and Altman, 1995). The sample size for the study was calculated using the formula for estimating the difference between two population proportions with specified absolute precision (Two-sample situations) by Chadha (2006, pp. 60), with equal sample sizes in each pair of three comparisons. Previous levels knowledge were used as referential indicators (Nguyen *et al*., 2011) and the total number of study participants from each commune (plus 10-20% of sample in case of attrition) was 600 people (refer Formula 2, Appendix 3.1).

Recruitment, conducted one month prior to the main data collection stages, was made through the random selection of representatives from household records taken from the communal registrar's office. Accordingly, 1,800 participants (usually householders) in the baseline and 1,800 others in the follow-up stages, aged from 18 years old, were invited to attend the KAP survey, based on the randomly selected household number, with a 5-household interval until a sufficient number of participants was reached. [Note, participants for the KAP survey were invited from every second household involved with the blood survey].

Prior to the survey, invitations (Appendix 3.2) were sent to the participants together with participant information sheets (Appendix 3.6) explaining the purposes and contents of the study, before they granted their agreement to participate in the survey by signing consent forms (Appendix 3.7). The KAP surveys (Appendix 3.14) were conducted by pre-trained researchers who were involved in the field-based trials of the KAP tools prior to data collection stages. Face-to-face interviews were conducted at the householders' home, which took up to approximately 20 minutes. All the information provided by the participants was entered directly into the questionnaires and not discussed or shown to other people, and was only accessible to the research team. Participants were informed that they had the choice to participate in the KAP survey or not participate in the interview, without having any consequences to themselves. In addition, they were also advised they could receive a copy of their responses upon request. Further explanations are described in detail in the ethical considerations section (3.5.1.4).

3.5.1.2.3 Observations

Observations (Appendix 3.25) were carried out in combination with KAP surveys on a random selection of approximately 20% of the KAP participants' households in each commune to triangulate with the survey data. The availability and overall conditions of the households such as water sources, kitchen and utensils, and toilets were observed and recorded on a form. In addition, shelter structures, hygienic conditions and cattle grazing practices of local communities were observed at cattle raising households to explore the risks of fascioliasis transmission among the ruminants. Each observation took about 10 minutes, with permission obtained by oral consent from the householders. Prior to observations, researchers were trained on purposive observation techniques and completing the observation forms, which were attached to the KAP survey forms (Appendix 3.14).

3.5.1.2.4 Lymnaeid snail surveys for *Fasciola* larval infection at study sites.

Surveys of lymnaeid snails as intermediate hosts of fascioliasis were conducted by laboratory technicians from IMPE-QN at all rice fields, lakes, ponds, agricultural canals or small streams of three study sites to identify the prevalence of fascioliasis infection in the snails (Formula 3, Appendix 3.1). Paddles with a 1.5 metre-long wooden handle and nets 15 by 15cm in size were used to collect as many snails in each sampling biotope as possible (Ashrafi, Massoud, Holakouei, Mahmoodi, Joafshani, Valero, Fuentes, Khoubbane, Artigas, Bargues and Mas-Coma, 2004; Sharif, Daryani and Karimi, 2010). The collected snails were placed into plastic screw capped containers with an amount of water at the collecting sites and transferred to the laboratory of IMPE-QN. Before examination, the lymnaeid snails were morphologically identified by snail taxonomy

(Dang, 1980). Each of the snails was crushed and smeared on microscopic slides for the presence of *Fasciola* larvae (radiae and cercariae) using a microscope (40X) and with the taxonomy of *Fasciola gigantica* (*F. gigantica)* cercaria (Pham and Nguyen, 2005). The infection rate was calculated as a percentage of the total number of lymnaeid snails.

3.5.1.3 Data analysis

The quantitative data obtained from the cross-sectional descriptive studies were entered and analyzed utilizing a variety of computer-based software.

Two researchers were assigned to enter all the data into the SPSS computer-based software, and in the process of data entry, care was taken in case of errors, missing data or wrong entry in order to avoid inaccurate data analysis and interpretation (George and Mallery, 2009). In addition, comparisons between the two data versions were made to double check in terms of wrong entry or missing values. When the double checking was completed, cleaning was performed by carefully inspecting the values to identify any out-of-range data. In dealing with the missing data, two options were suggested: by eliminating the participants with missing values; or substituting with a value for all missing values in the data grid (Creswell, 2012). Current computer software packages easily allow the substitution for missing values, such as an average number for the question surveying all participants; or approximately up to 15% of missing values can be substituted without changing the overall analysis results (George and Mallery, 2009). In this study, the second option was applied to solve the missing values, which did not exceed more than 15% of the overall dataset. Missing values were replaced using the imputation function in the software package for the analysis of the dataset. In this way, the analysis of the data was not affected.

The data from the ELISA for blood samples were transferred into SPSS (Statistical Package for Social Sciences) version 19 for descriptive statistical analyses, and calculations to identify the overall prevalence of fascioliasis in the population, and the distributions of the disease according to gender, age, educational background and occupation, at the preliminary and follow-up stages, were also undertaken. In addition, comparisons were made between communities for preliminary evaluation of the overall prevalence of fascioliasis in Central Vietnam. Comparisons were also made after the intervention to evaluate any changes in prevalence. The statistical χ^2 and Fisher's exact tests were used, with statistical significances identified if the p-values were less than 0.05.

The risks of fascioliasis among three adult cohorts were evaluated using the data obtained from the knowledge, attitudes and practices (KAP) surveys in three communes. These data were entered into and analyzed using the SPSS software package, version 19. Descriptive analyses reported ethnographical characteristics and compared these between variables to explore the risks among the communities in terms of their knowledge, attitudes and practices regarding fascioliasis, its risks and management. Comparisons of changes in terms of the communities' knowledge, attitudes and practices regarding fascioliasis control were also made between the preliminary and follow-up stages, and between each of the communes under research. The Bonferroni adjustment was used to allow multiple comparisons in the two-sample situations (Chadha, 2006) in this survey, and thus significant differences from χ^2 and Fisher's exact tests were reached if the p-values were less than 0.017 (Appendix 3.1).

The data obtained from household observations were entered into the SPSS software package version 19 for evaluation of household conditions in relation to the knowledge of prevention and control of fascioliasis as reported in the KAP surveyed households. The percentages of households with observed hygienic facilities such as kitchens, gardens, cattle shelters and toilets were used to compare with the KAP survey data. The observation data also helped to explore the possible risks of fascioliasis transmission among the cattle and between cattle and humans. The infection of fascioliasis among selected lymnaeid snails provided data to evaluate the fascioliasis situation, and comparisons were made before and after the intervention measures to assess the changes over time.

3.5.1.4 Ethical considerations

A variety of ethical issues in health research have been identified and debated in the literature (Ashcroft and Wiley, 2007; Hedgecoe, 2010; Petersen, 2011), especially the three main frameworks for medical ethics including principles of ethics, rights and outcomes (Beauchamp and Childress, 2009). 'Principles of ethics' focus on the respect for autonomy, justice, avoidance of doing harm and effective uses of resources. 'Rights' concerns the provision of basic but best available health care; the prevention of harm, abuse, neglect or discrimination; the respect for freedom of information and expression; and the promotion of self-determination and social inclusion. ‘Outcomes’ aim to avoid and minimize harm and costs while promoting benefits (Beauchamp and Childress, 2009, cited in Mike and Allsop, 2013, p. 302). Although these frameworks provide standardized guidelines in conducting useful and effective health research, typical problems related to the ethical considerations are not easily answered. However, the frameworks may help to provide possible solutions to solving and reducing the ethical problems (Alderson, 2013).

Ethics approval for conducting the current research project (including quantitative and qualitative components) was obtained from the University of Wollongong HREC (Ethics number HE12/405 on March 6, 2013) (Appendix 3.20). In addition, approval was also granted by the IMPE-QN Medical Ethics Committee (Ref. number 364/CV-VSR) on October 4, 2012 (Appendix 3.30). The quantitative research component in the current research incorporated a number of solutions to reduce the problems of ethical issues.

Informed consent

All participants in the blood tests and KAP surveys were informed of the details of the studies via information sheets (Appendices 3.3 & 3.5), which explained the purposes, contents, data collection methods, and possible risks or constraints they might face. Participants were informed that they had the right not to participate in the studies and that they could withdraw at any time of the study process. In addition, they were informed that they had the right to know about the findings of the research they were involved in, including the results of the blood tests or their perceived risk of fascioliasis; and to be properly treated and followed up free-of-charge if they were found to be positive with the disease (Appendix 3.28). Furthermore, they were entitled to the application of preventive measures in case of adverse reactions occurring from the drug therapy (Appendix 3.29). Finally, participants were assured that the best efforts had been made to prevent possible harm to their health while maximizing the benefits of the research in which they were involved. For example, for participants attending the ELISA blood tests there was the potential for adverse effects associated with venipuncture, which might cause harm to their health both physically and mentally. Therefore, only laboratory technicians who were trained and experienced personnel at the IMPE-QN government laboratory were involved in taking blood samples. In addition, while performing the phlebotomy, these staff knew how to make the participants feel at ease and not feel embarrassed as a result of the venipuncture (Appendix 3.27). All participants attending the blood tests and KAP surveys agreed with the information sheets and signed the consent forms (Appendices 3.4 & 3.6).

Confidentiality, privacy and anonymity

All participants involved in the quantitative studies were given assurances of confidentiality, privacy and anonymity. In the blood test surveys for fascioliasis prevalence, the participants' names were coded as a number when written on the blood sample tubes for laboratory examinations, which could not be improperly identifiable. If found to be positive, they were invited by the research team via local health volunteers to the communal health station, where they received treatment and were followed up by the assigned medical doctor. The follow-up of their post-treatment health conditions, including possible adverse reactions from the medication, was reported in the follow-up forms (Appendix 3.29), which were kept confidential and accessible only to the research team. All of the treatment records were kept in the secured filing cabinet at the IMPE-QN. For the KAP surveys, all of the questionnaires were without personal identifiable information and were numbered before being completed. After the data entry, the completed questionnaires were kept in a locked filing cabinet and were only retrieved by the responsible researchers.

Incentives, payback, and maintaining goodwill

Small incentives were used to encourage the participants to be involved in the interviews and to partially compensate them for their time spent with the researcher (Padgett, 2012). Dependent on the ethical and financial issues of the research, the allocated monetary payments should fit in the contemporary situations: if participants are paid too little, the incentive value is lost; if they are paid too much, researchers are at risk of purchasing co-operation from the participants (Padgett, 2012, p. 87). In these quantitative surveys, a monetary payment equivalent to 0.5AUD was paid to participants attending the blood tests and a similar amount was paid to participants who participated in the KAP survey, which was an amount based on the Vietnamese government's norms of financial support in health research activities.

As mentioned in the informed consent section, participants who were identified as infected with fascioliasis by the laboratory blood tests were treated and followed up with medication free of charge. If there were any adverse effects during the treatment and follow-up, prompt measures were applied to minimize potential harm to these participants.

3.5.2 Qualitative Study

By selecting an explanatory sequential design as the appropriate mixed method research in the current study, the researcher aimed to undertake qualitative research following the quantitative research so as to provide insights into factors influencing the model's effectiveness. Understanding the factors aiding or impeding the effectiveness of the broadly-based fascioliasis model would lead to making adjustments to the model. The positive awareness of fascioliasis, the perceptions, the motivation and roles of stakeholders and household representatives regarding the control measures would be explored through qualitative mixed data collection methods. These methods would include semi-structured in-depth interviews with key informants (local authorities, officials from the health sector from central to communal levels, and local staff in agricultural, educational and social associations) and focus group discussions with health volunteers and household representatives. Procedures for data collection and data analysis will be discussed in the following sections, together with the strategies to increase the rigour of the methods and the ethical considerations.

3.5.2.1 Rationale behind qualitative research sampling

This section describes the rationale for selecting the most appropriate samples for qualitative research, which were conducted at the Intervention 1 commune (the commune receiving broadly-based intervention measures for fascioliasis control) (Table 3.1).

Sampling in qualitative research is subjectively dependent on the purpose of the study, the choices and trustworthiness of useful data, and the availability of sources including funds and time (Krueger and Casey, 2000; Patton, 2002). It is important to identify the sample size based on the following significant criteria, including: (a) the scope of the research project; (b) the types of subjects to be studied; (c) the usefulness of the data gathered; and (d) the research design (Patton, 2002; Marshall and Rossman, 2006; Munhall, 2006).

There are a variety of qualitative sampling strategies, but four major approaches including:

a) convenience sampling (individuals volunteering their time to participate in the study),

b) snowball sampling (participants referring others to take part in the study),

c) purposive sampling (the researcher's intentional choice of individuals or groups of people to help with the study), and

d) theoretical sampling (necessary groups chosen on the basis of theoretical significance for the purpose of analysing categories emerging from the data) (Patton, 2002; Polit and Beck, 2012).

Considered a popular non-probability sampling approach (requiring non-random sampling of participants from the overall population without ensuring that everyone has an equal chance of being included in the study) (Macnee, 2004, p. 123; Keele, 2011, p. 25), purposive sample has the advantage of "actively seeking to enrich the data by including participants who have a particular kind of experience, characteristic, or understanding to share" (Macnee, 2004, p. 122).

Among the major qualitative sampling strategies, this research chose purposive sampling as the most appropriate approach because the researcher deliberately and purposely selected individuals or groups of stakeholders to be involved in the interviews and group discussions (Table 3.2). These selections were based on various factors, including what was known or not known about the topic of study by the interviewees (Bowers, House and Owens, 2011). The overall aim of the qualitative study components was to provide further insight into the successful implementation of the broadly-based control model of fascioliasis in Central Vietnam.

Drawing the samples from the population deliberately and purposively, the researcher aimed to explore the overall picture of fascioliasis, the risk perceptions and motivations of experts, local officials and volunteers to be involved in fascioliasis control activities. For the interviews with stakeholders who were experts in the field of fascioliasis control and prevention, such as local officials and heads of involved organizations, maximum variation (or heterogeneous) sampling was conducted to achieve a broad range of variation in the factors contributing to the successful implementation of the control modelVietnam. These informants would provide different perspectives on the issues related to the prevalence of fascioliasis, associated risk factors of the disease, and their roles in the development of the model. In the focus group component of this research, homogeneous sampling was used to select small groups sharing similar characteristics, such as a group containing health volunteers and another group comprising household representatives. These selections helped the researcher to facilitate the groups to be comfortable to share ideas.

The following section discusses the strategies employed to increase the rigour of the interviews and focus groups.

3.5.2.2 In-depth interviews

As one of the most common methods of data collection, interviews are used “to explore the views, experiences, beliefs and motivations of individual participants on specific matters” (Gill, Stewart, Treasure and Chadwick, 2008, p. 292). Usually, interviews are carried out on a one-to-one basis (Sanderlowski, 2002), though they may also be conducted as a small group (Silverman, 2000; Patton, 2002). Typically there are three fundamental types of research interviews: structured, semi-structured and unstructured, and each type is used depending on the different purposes of the data collection (Gill *et al*., 2008). In healthcare research for instance, semi-structured (or in-depth) interviews are most frequently used because they contain several key questions that help to explore the commonly known areas of the health issues, while also allowing both participants and interviewers to diverge in order to pursue an idea or response in more detail (Britten, 1999).

In this current qualitative research, semi-structured interviews were conducted to explore the support provided by, and the risk perceptions, motivations and roles of the stakeholders in the Intervention 1 commune in relation to the implementation of the fascioliasis control model. This qualitative data collection approach also provided the participants with some background information of the disease they were to talk about, as an aid to both researchers and participants.

3.5.2.2.1 Developing in-depth interview guides for the broadly-based control model for fascioliasis in Central Vietnam

It is of the first importance for the interview process to develop the interview schedule based on the structure of the interview, the nature of the research, the aims or objectives of the study and the usefulness of the collected data (Patton, 2002; Marshall and Rossman, 2006; Munhall, 2006). The schedule should be composed of an outline of contents relevant to the research and on which interview questions are based, with the aim of yielding as much information about the study as possible while achieving the aims and objectives of the study (Gill *et al*., 2008). An appropriate number of questions should be ensured to avoid overly long interviews, unwieldy guides and compromised data (King and Horrocks, 2010). In addition, it is important to pre-test or pilot the interview schedule on several respondents prior to actual data collection (Pontin, 2000; Berg, 2009). This activity can be conducted with other researchers in the team or people familiar with the research in order to confirm whether the interview schedule is clear, understandable and can address the research questions (Gill *et al*., 2008). Any poorly understood questions can be refined from analysing the pilot interviews (Ryan, Coughlan and Cronin, 2009).

Depending on the topic, the objectives of the research and the nature of the relationship between the interviewer and the participant, the length of the interviews can fluctuate, ranging from 20 to 60 minutes (Gill *et al*., 2008). Prior to the interview, respondents should generally be provided with the study details and the aims of the interview, and with assurance about ethical principles, such as anonymity and confidentiality (Britten, 1999). This will inform the respondents about what will be expected from them in the interview. The interview can only be started when the consent is obtained, which will be discussed further in the "ethical considerations" section.

Ice-breaking questions at the beginning of the interview are intended to warm up the atmosphere and to make respondents feel comfortable. Therefore, good questions are usually easy, open-ended, neutral, non-threatening and understandable to respondents, which are useful for the start of the interview and facilitates the interview to occur in a relaxed manner (Britten, 1999). For example, the demographic question such as 'Can you tell me about your work?' is appropriate to stimulate respondents to talk. This will help to keep the respondents at ease, build up confidence and rapport and trust before going to the more sensitive and specific questions (Trochim, 2005; Warren and Karner, 2005). Then, more difficult and essential questions in sequential order will follow which allow respondents to be aware of the specific areas they are asked to answer (Ryan *et al*., 2009). During the interviews, the transitional questions will be used between the important questions to move the conversation smoothly from topic to topic. Also, the utilization of prompts is advocated when appropriate, for they are useful for expanding the existing topic or re-involving the respondents with the interview process if they lose their train of thought (Robson, 2002). Questions like 'What happened next?' can help to re-focus the respondent's concentration on the subject matter. Similarly, the use of probes (e.g. Can you talk more about that? or Would you explain that further?) will help interviewers to explore the in-depth understanding of a particular issues elaborated on by the respondents (Ryan *et al*., 2009).

At the end of the interviews, a wrap-up is provided for respondents to bring closure of the discussion. At this stage, the interviewers summarize the conversation, thank the respondents and appreciate any of their queries. According to Longfield (2004), a well-prepared wrap-up should make respondents feel that their participation in the interviews is important and a major contribution to the study.

In qualitative research, the application of recording interviews for documentation and later analysis is useful. Various methods include audiotape recording, videotape recording and note taking (Johnson, 2002; Rubin and Rubin, 2005). Digital recorders are very effective nowadays because the recordings from these devices can be retrieved in computers and analysed with updated software packages (Johnston, 2006). However, the recordings of interviews should be included in the informed consent, for recorded data can be a source of danger for the interviewees. Therefore, cautions must be taken for keeping recorded data, and deletion of these recordings is generally carried out after analyses are complete (Dicicco-Bloom and Crabtree, 2006).

Transcribing the recorded interviews into text requires patience and endurance because various issues can interface with the accuracy of the transcribed data (Poland, 2002). Difficulties of sentence structures in spoken text, especially the run-on sentences, the uses of quotations and the modifications required by mistaken words should be taken into consideration and requires thorough transcribing skills of experienced researchers (Seale, 1999).

In the last few years, the application of computer-assisted qualitative data analysis software (CAQDAS) has helped a great deal in qualitative data analyses (Murphy, 2000; Lee and Mangabeira, 2004). Qualitative researchers have found such software to be easier to use than the manual approach in terms of handling, managing, searching, and displaying data and related items such as nodes, memos and links to the data (Bazeley, 2007; Wong, 2008). One of the most advanced and popularly used softwares for qualitative data analysis is Nvivo 10, with updated features such as automatic coding and search, which allows the process of analysing interview data to become faster and more convenient (Johnston, 2006).

3.5.2.2.2 Recruitment of stakeholders to participate in interviews

At the Intervention 1 commune, a total of nine interviews were conducted with key informants purposively selected for in-depth interviews (Table 3.2) about their risk perceptions, their opportunities to be involved and their levels of engagement in fascioliasis control activities. In addition, their views on the factors which aided or impeded the development of the model were explored, together with their perceived suggestions for the improvement of the fascioliasis control model. Invitations (Appendix 3.2) enclosed with the participant information sheets (Appendix 3.10) explaining the purposes and the contents of the research were sent to potential participants one month before their official confirmation of attending the interviews, together with the set time and place of the interviews. Ethical issues relating to the participant recruitment will be detailed later in this chapter.

Table 3.2 List of participants to in-depth interviews in Intervention 1 commune

Level	Participants	Guided questions (Appendices)
WHO office in Vietnam	1 representative	3.14
IMPE-QN[3]	1 director	3.15
PCMPE Binh Dinh	1 director	3.16
Provincial veterinary centre	1 director	3.17
District health centre	1 director	3.18
Communal health station	1 representative	3.19
Communal authority	1 representative	3.20
Communal veterinary	1 veterinarian	3.21
Secondary school	1 principal	3.22

3.5.2.2.3 Conducting the interviews

Before each interview was conducted, the details of the participant together with the date, time and place of the interview was read as the factual information for transcribing and analysis of the qualitative interview data.

The consent forms (Appendix 3.11) were signed by participants on their agreement to be involved in the interviews. As notified by the researchers, and described in the ethical considerations section, the participants could quit at any time during the interviews without bearing any consequence. Participants were met as agreed on the previously set time and date at the most appropriate place for the interviews. The interviews were conducted at the health station office of the Intervention 1 commune. Semi-structured questionnaires containing 10-12 appropriate questions (Appendices 3.14-3.22) were prepared for each participant to take part in interviews lasting approximately 30-45 minutes. These questions were previously reviewed by academics in the School of Health and Society, University of Wollongong and piloted with researchers who had majored in the field of interest at the IMPE-QN. A digital recorder (Sony IC Recorder, Model ICD-UX523F) was used to record all the interviews, by which the researcher explored in depth the responses from the participants. Before the

[3]IMPE-QN: Institute of Malariology-Parasitology and Entomology, Quy Nhon; PCMPE: Provincial Centre of Malariology-Parasitology and Entomology of Binh Dinh province

recording commenced, agreements were made with the participants upon whether or not the recordings of the interviews would be accepted. All of the participants agreed to be recorded. In addition, each recorded interview was accompanied with note-taking by hand as a supplementary reminder of the issues raised by participants, which were mentioned at the end of the interview for clarification. Also, the note-takings helped to explain the non-verbal behaviours, which conveyed particular meaning at some points of the interviews.

Warm-up greetings and introduction of the purpose and content of the research started in all official interviews, and were also used as the stimulation to encourage the participants to be at ease. A schedule of questions (Appendices 3.14-3.22) was followed to provide well-structured conversations between researcher and participants. The leading questions or prompts helped to guide appropriate answers from participants, and additional questions were used to expand the understanding of the topics of interest. Transitional questions provided connecting links between the questions, and allowed the conversations to move smoothly from idea to idea. During the interviews, participants were given the opportunity for pauses or repetition of questions to ensure clearer understanding before delivering their answers. The interviews were completed with a summary of the conversation, and appreciation and thanks to the participants for taking part. In addition, participants were given an opportunity to talk about the questions or to ask questions about the research. Brief explanations were made on the future uses of the recorded interviews, which reinforced the importance of the respondents' participation in the interviews and their contributions to the study. Each of the participants taking part in the interview received an incentive valued at 0.5AUD.

3.5.2.2.4 Data analysis

The in-depth open-ended questions for the interviews were constructed originally in English, and reviewed and clarified by academics within the School of Health and Society, UOW. These questions were translated into Vietnamese for the field-work in Vietnamese settings. The data were transcribed as Vietnamese text before being translated back into English by an expert in qualitative analysis, with attention to the accuracy and clarity of the terms.

Verbatim transcription was conducted to transfer the interview data from the recordings into text using the MS. Word 2011 software. Although using the verbatim transcription approach is a core activity in producing the exact word-to-word version of the verbal data during the qualitative research process (Poland, 2002; Hennink and Weber, 2013), researchers of this common transcription procedure face certain limitations, particularly the time and labour required and sometimes a time lag occurs between data collection and completion of transcription for analysis (Kvale and Brinkmann, 2009). In addition, the transcription in academic settings is often conducted by non-professional researchers such as administrative staff or graduate students, which can lead to poorly-transcribed data (Tilley and Powick, 2002; Tilley, 2003). Finally, transcriptionists are not usually present at the interviews or group discussions and are merely dependent on the audio recordings. This may unintentionally influence the generated data (Bucholtz, 2000; Tilley, 2003; Kvale and Brinkmann, 2009; Padgett, 2012). To minimize the occurrence of such mistakes and increase the quality of transcriptions, two trained qualitative researchers were present for both the interview data collection and transcriptions. These researchers also reviewed each interview transcribed, which was compared and clarified with the support of previously written non-verbal cues from the note-takings. They were also experts in the translation of English into Vietnamese and vice versa.

In this research, the Nvivo version 10 (QSR International Pty. Ltd. 1999-2012) software was used to assist with analysis. All transcribed interviews were imported into the "Internals folder", which were then used as the "Sources" for the qualitative data analysis process.

At the first step, the coding from the sources was performed to search and categorise the more detailed data related to aspects of the intended analysis. In the Nvivo 10 software, there are several steps in coding the imported data, including in vivo coding, free node coding, adding data to existing nodes, and tree node coding. As there was no pre-existing data analysis structure in the imported interviews of this research, the in vivo coding was employed by selecting sections of text that were meaningful for the analysis. When the in vivo coding was finished, the nodes were read again and categorised according to the sub-themes with the given meanings usually in the abstraction manner. By doing this step, the data were more apparent and organised into consistent categories, allowing the researcher to collate similar data without imposing more constraints on the structure. In NVivo, the "Tree node coding" was followed with the creation of local relationships between pieces of data (a code) when enough diversity of coded data was reached. At this stage, it was possible to code directly into the "Tree node coding" without having to create more new codes or coding into the existing nodes. When the coding was totally finished, a structure (described as a "Tree trunk") was created as a new folder in the "Nodes" pop-up and it was named 'Analysis'. Under each of the folders, there were sub-folders called themes and then sub-themes, created according to the inter-related information found in the text. This process was continued until all the information related to the risk perceptions and motivations behind being involved in development of the broadly-based fascioliasis control model in Central Vietnam were categorized and added to all nodes, together with the relationships between the coded data.

In Nvivo, querying is an important step to identify the relationships among meaningful words, nodes or groups of nodes in the documents. Meaningful words in this qualitative interview research such as 'fascioliasis' 'risks', 'perception(s)', 'participation', and 'motivation', were surrounded by a variety of words and phrases, illustrating any connections between the themes. Using the Nvivo query functions of 'text query' or 'word cloud', the most important words appear in high frequencies, or linked with other related words. The 'Group query' provides higher levels of association between items, which in combination with the 'Model' function, presents the overall content of the analysis together with the connections between the nodes, between groups of nodes and with themes.

3.5.2.3 Focus groups

Focus group methodology has been gaining popularity as a qualitative research method in various disciplines, especially in the health and social sciences (Fern, 2001; Sharts-Hopko, 2001; Liamputtong, 2011). Researchers have been developing the method to suit their research needs, or they have found it a method that can generate complex information at a cost-effective, less time consuming rate and with quicker delivery of results (Kroll, Barbour and Harris, 2007; Liamputtong, 2011). The method is not without its critics and other researchers have argued the purported disadvantages of this qualitative research method (Wilkinson, 2004).

3.5.3.2.1 Characteristics of focus groups

A variety of definitions of 'focus groups research' exist (Freeman, 2006), with a comprehensive definition described by Wilkinson (2004, p. 177): "Focus group research is a way of collecting qualitative data, which – essentially – involves engaging a small number of people in an informal group discussion (or discussions), 'focused' around a particular topic or set of issues."

It is the definition of focus groups as a 'collective conversation' (Kamberelis and Dimitriadis, 2008) that may allow researchers to elicit more social ideas and values that shape individual behaviour through the process of in-depth group discussions, which are not found in individual interviews (Willis *et al*., 2009). In addition, interactions during the focus groups are typically considered of benefit to elicit the beliefs, attitudes and feelings of the participants (Plummer-D'Amato, 2008a). Such interactions may help to enrich the information gathered on a specific area of interest, and allow exploration and clarification of various views in ways that would be less easily accessible in a one-to-one interview (Bowling, 2002; Freeman, 2006; Barbour, 2007; Stewart, Shamdasani and Rook, 2007). A researcher involved in focus groups can clarify similarities and differences as expressed in opinions between participants (Freeman, 2006). Finally, the group in the qualitative research method, when composed of participants sharing common social and cultural characteristics, may express shared perspectives and experiences or discuss a health intervention campaign collectively, which may be more insightful than individual opinions (Liamputtong, 2011).

However, like any other qualitative research methods, focus groups cannot address all research aims and are subject to criticisms. As a focus group involves group interaction, a good understanding of each participant's experiences is not fully obtained (Liamputtong, 2011). Some topics may be considered as too personal (such as living with HIV/AIDS, sexuality, financial status, divorce, domestic violence), and the expression of opinions and experiences is not always appropriate in a crowd setting (Smithson, 2008). In addition, certain personalities of participants (such as dominant and aggressive) may influence the group dynamics (Hollander, 2004; Krueger and Casey, 2009), which may leave others feeling too intimidated to speak, thus affecting the quality of the focus group data (Liamputtong, 2011). Furthermore, as focus groups involve a small number of participants, the findings from obtained data are not applicable to a wider population. However, it may be a useful strategy to combine this qualitative approach with quantitative techniques in order to deal with a research problem effectively (Cameron, 2005). Finally, although being discussed as a quick, easy and cost-effective method, focus groups containing opportunistic participants may impair the methodology, thus resulting in a low quality research approach (Willis *et al*., 2009, p. 132).

3.5.2.3.2 Guides for focus groups in the broadly-based control model for fascioliasis in Central Vietnam

The purpose of the focus group is to obtain data regarding the ideas, attitudes, understanding and perceptions, as well as to explore the process of thinking and vocabulary of the targeted sample of population on a specific topic (Plummer-D'Amato, 2008a). In order to achieve the purpose, it is important to define the research objective and to determine the organised and focused nature of the group discussion as well as the importance of interactions between participants (Freeman, 2006).

Sampling, group composition and group characteristics

Group composition involving participants on the basis of their experience related to the research topic is very important in focus groups approach (Krueger and Casey, 2000; Bloor, 2001; Fern, 2001; Cameron, 2005). For the selection of appropriate participants in the focus groups, purposive sampling is the most suitable, as the selected participants' own common experiences and interest in the common topic will be discussed; while random sampling is not applicable because the intent is not to make the sample representative to a larger population, but to understand how people in the group think and talk about the selected topic (Krueger and Casey, 2000; Munhall, 2001; Patton, 2002). It is recommended that focus group participants be more homogeneous than heterogeneous, for similar views and experiences can be easily understood and exchanged among group members and any effects of status differentials can be avoided (Patton, 2002; Parasuraman, Grewal and Krishnan, 2007, p. 181). In addition, sorting different categories of participants into separate groups - called segmentation - may yield interesting results in focus groups, since participants perceive the topic from different perspectives. This will enable researchers to generate rich information relating to the research problem (Willis *et al*., 2009); and compare and contrast the findings from groups with different knowledge and experiences in a particular topic area (Krueger and Casey, 2000).

Acquaintanceship and willingness of participants are other important factors that need considering (Willis *et al*., 2009). It was argued (Hennink, 2007, p. 117) that acquaintances could potentially disrupt the dynamics of the focus groups, inhibit responses, express taken-for-granted information, and pose more challenges to the moderation of the discussion. This could be a potential bias when a specialised group of participants is involved (Krueger and Casey, 2000). To minimize the potential for bias, 'pre-existing' or 'naturally occurring' groups can be used (Bloor, 2001). In addition, the willingness of the participants may affect the outcomes of the focus groups. Ensuring all selected participants arrive at the venue on time as scheduled and facilitating them to be actively involved in interactive discussions while eliminating confidentiality requires effort from the researchers (Willis *et al*., 2009). However, these workloads can be easier if researchers set up positive relationships with stakeholders with "gate-keeping" roles, because these people can organize the meetings, prepare the venue, provide insights into the participants' dynamics, and may assist in dealing with unexpected circumstances (Willis *et al*., 2009).

In the evaluation of the broadly-based control model for fascioliasis in Central Vietnam, the qualitative focus groups research was conducted for two separate groups at the intervention community 1. One group was composed of local health volunteers, school-teachers, veterinary health staff, and representatives of social organizations. These participants attended the training course on fascioliasis control measures that was organised during the intervention phase of the model, and regularly carried out their post-training activities such as community, school and veterinary health education, sanitation, and surveillance of fascioliasis. Although these participants came from different disciplines, their common perspectives on fascioliasis control and shared responsibilities would enrich the information collected from the focus group they attended.

The other group consisted of representatives of households who were diagnosed positive to fascioliasis infection and undertook the treatment and follow-up course.

These participants, who came from different villages in the commune, reflected their experiences of disease infection and were actively motivated to participate, which facilitated rapport among participants during the focus group and reduced the likelihood of differences in participants' perspectives on fascioliasis infection and control measures. In addition, they were willing to attend the focus groups as a result of the communal head's encouragement together with a suitable incentive.

Typically, a focus group is composed of between 6 and 8 participants who are drawn from the population of interest, and slight over-recruitment is also suggested in order to avoid the cancellation or unsatisfactory outcomes of the discussion (Krueger and Casey, 2000; Chestnutt and Robson, 2001; Polit and Beck, 2004). It is widely agreed that small groups achieve inadequate discussion outcomes, whereas large groups may be chaotic, which are difficult for moderators to control and frustrating for participants who are unable to get sufficient opportunities to speak (Krueger and Casey, 2000; Bloor, Frankland, Thomas and Robson, 2001; Chestnutt and Robson, 2001). Therefore, it is important that the moderator facilitate and guide the discussion towards the topic of interest, and ensure that participants are able to contribute as much as they can to the discussion (Freeman, 2006).

In the focus groups conducted at the Intervention 1 commune of the current study, the first group comprised eight participants and the second focus group comprised seven household representatives coming from seven different villages of the Intervention 1 commune.

Moderating the focus groups

The presence of the moderators plays an important part and is a typical feature of a focus group (Plummer-D'Amato, 2008a); for they should facilitate the group processes and ensure the discussion covers the topics of interest (Chestnutt and Robson, 2001). In academic research, the moderator is usually the researcher, who is knowledgeable about the research aim and the purpose of the focus groups (Cameron, 2005). In addition, a less experienced researcher may assist the moderator to run the focus groups by taking notes, which may be very helpful in the transcription process of the focus groups (Cameron, 2005).

Before the discussions, the moderator should explain the research purposes, the process and the methods of data collection in a non-threatening, supportive setting (Sharts-Hopko, 2001). As the actual focus group activities occur, the moderator should guide the discussion without participating, directing or constraining it (Gill *et al*., 2008). They also create the liberal climate, facilitating the open contribution of both experiences and opinions (Puchta and Potter, 2004). Accordingly, they should prevent the discussion from being dominated by more talkative participants and encourage those who are less forthcoming (Cameron, 2005). It is suitable to have more than one moderator to maintain the flow of discussion and keep on track with the interview guide (Willis *et al*., 2009).

In the focus groups conducted at the Intervention 1 commune, the moderator guided the focus groups with the support from two note-takers. During the discussions, his role was only to guide and probe the responses, without upsetting or leading the participants. No concerns in data collection or changes in the participants' willingness to participate in the discussions were identified.

Venue setting

The setting is very important to the success of the focus groups, for any settings that are out of particular and expected behaviours may lead to intimidation (Ruff, 2005). An ideal meeting place for the focus groups should be comfortable, easily accessible and free of outer noise that might interfere with the discussions and the quality of the audio recording (Polit and Beck, 2004).

The focus groups were conducted in the most convenient way for the participants. A meeting room at the communal people's committee hall was booked, which was located in a quiet place, equipped with sufficient electricity and facilities such as a round table in the middle of the room with enough chairs for the participants. On the table, the names of the participants were written on paper cardboard placed in front of them, facing each other to enable each of the participants and the facilitators to easily follow and take notes of who was giving opinions.

Question flow

Another important factor for a successful focus group is the preparation of the focus group questions. Although the questions for focus groups are generally not well-structured, they should be phrased in a simple conversational manner for the informal environment; and short questions without technical language, jargon or acronyms are preferred (Ruff, 2005). As for the interview guide, the questions for focus groups should be tested and reviewed before being applied to the field based research with participants, so as to achieve easy understanding for the respective participants (Litosseliti, 2003; George, 2013).

In the qualitative focus groups conducted at the Intervention 1 commune, guided questions were developed for each group (Appendix 3.24). At the beginning of the focus groups, opening and introductory questions were asked to create the rapport among participants before providing the topic of discussion in a natural way. An ice-breaking question, "How did you hear about the study on fascioliasis (liver fluke) in your commune?" was used to open the discussion. These kinds of questions were not designed for data collection, but encouraged the participants to be involved in the topic that would follow. As the discussion became more free-flowing, the open-ended questions "Can you tell me about the disease of fascioliasis?" and "How do you view fascioliasis?" were used to get the attention of the participants and to get them talking and sharing experiences of the topic of interest. In order to get the smooth flow of questions, a series of 'transition' questions are also used before the important questions (Plummer-D'Amato, 2008a).

In the current focus groups, questions such as "Think back when you were first involved in the fascioliasis control model, what were your first impressions?" helped to explore more of the participants' motivations for participating in the program. Usually, a set of no more than 10 key questions are prepared for the focus groups, depending on the purpose of the focus groups and the group composition; and similar to the interview guides, the use of probes and prompts at appropriate points help to guide the discussions and expand on issues of the research topic of interest (Gill *et al*., 2008). For example, "How did you get involved in the activities of the model?" and "When did you decide to take part in this activity?" were among the useful probing questions from researchers that were included in the focus groups. The key questions in the fascioliasis study aimed to explore the participants' risk perceptions, motivations, levels of participation in the control measures, and techniques for conducting health education strategies; and how they would recommend developing the model further if it were to be applied to other areas or regions. Summaries of key points at various intervals were provided to facilitate the conversation flow and initiate additional information and comments.

Finally, the ending questions are used to ensure all the important information has been obtained. These are asked some minutes before the summary of the discussion in order to give participants time to express more concerns and to give researchers the opportunity to check whether something has been missed. Ending questions in the current study such as "Is there anything else you would like to say about fascioliasis?", or "Are there any other experiences you would like to share in fascioliasis control measures?" or "Have we missed anything?" were used to wrap up the discussions before thanks were given to participants for their attendance and contributions to the discussion.

Data collection tools and analysis

Recording focus group data is not an easy task because it is necessary to not only collect the data on the participants' responses, but also to observe and record the non-verbal interactions between the participants, which may help to understand how they feel about the particular topics of interest (Barbour, 2007; Liamputtong, 2009). In addition, it is important to recognise all participants, for it is helpful to annotate the transcription to indicate who is speaking (Chestnutt and Robson, 2001). Focus group discussions are typically recorded in two ways, using audio-recording devices and note-taking. Written notes are important because they help interpretation of the recorded verbal interchange and prevent the loss of information from non-verbal communication (facial expressions, body postures, and silences) (Liamputtong, 2011, p. 82) and group dynamics, which are not captured by audio-recordings (Krueger and Casey, 2000). As mentioned earlier, two note-takers were assigned in the current focus groups to record the non-verbal communication from the participants and to monitor audio-recording equipment. They also helped the moderator with the seating arrangement, the order of speakers for easy transcription and the note-taking of main ideas during the discussion processes.

Analysing focus groups data can be an overwhelming task for qualitative researchers, as large amounts of complicated data are generated and there have been no universally accepted methods or frameworks for analysis of focus group data (Krueger and Casey, 2000; Rabiee, 2004; Onwuegbuzie, Dickinsion, Leech and Zoran, 2009). Depending on the research objectives and purpose of the reports to be prepared, the selection of various analysis methods is extremely helpful for managing the data and excluding extraneous and irrelevant information (Krueger and Casey, 2000; Rabiee, 2004). In general, analysing focus group data is similar to analysing other qualitative data, which involves transcription of the discussions as they are spoken (Bloor *et al*., 2001), with field notes made by note-takers being included in the transcripts during or right after the session (Sharts-Hopko, 2001). Care should be taken as any attempts to convert discourse into grammatically correct written English will significantly affect the potentially useful information contained in unfinished sentences or incomplete thinking processes (Chestnutt and Robson, 2001).

With in-depth interviews researchers obtain more thorough information from individual participants, whereas focus group researchers yield a more intensive range of data in a shorter timeframe (Hesse-Biber and Leavy, 2011). Together, these methods can be interchangeably used to address the research questions in more depth and breadth than a single approach (Lambert and Loiselle, 2008).

In our qualitative research, the focus groups were conducted after the in-depth interviews. The group dynamics of the focus groups empowered participants to exchange more views, opinions and perceptions, which were not as forthcoming in the individual interviews.

Similarly to the analysis of the in-depth interview data in the current research, the information obtained from the focus groups was imported into the sources by using the NVivo software version 10 (QSR International Pty. Ltd. 1999-2012). All the same processes conducted in the in-depth interviews analysis (3.5.2.2.4) were applied to the analysis of the focus groups. The findings of the focus groups were summarised and interpreted in combination with the interview data to explore the factors that influenced the implementation of the broadly-based control model for fascioliasis in Central Vietnam.

3.5.2.4 Ethical considerations of in-depth interviews and focus groups

The overall ethical issues were discussed earlier in this chapter. This section presents the ethical issues related to the qualitative interviewing and focus groups, as they both shared similar qualitative characteristics.

Informed consent

All participants had received the invitations (Appendix 3.2) attached with the information sheets (Appendices 3.3 and 3.5) describing all details of the research such as the purpose of the research, lists of investigators, the methods of data collection, the responsibilities of and possible risks or constraints to the participants, and the results and benefits of the research to the community's health, status and wellbeing. As stated in the information sheets, the involvement of the participants in the study was absolutely voluntary and confidential; and it was their decision as to whether or not to participate in the interview, which did not cause any harm to themselves if they did not participate. In addition, they could withdraw from the interview at any time without any consequence to themselves. The information sheets also listed the contact details of the researcher and his supervisors in case the participants had any concerns or complaints, or any further information related to the study. All participants agreed voluntarily to be involved in the interviews by signing the consent forms (Appendices 3.4 & 3.6).

Through the close scrutiny of our research process, expanded understandings of the ethical conduct required in implementing the respectful research were clearly made to avoid any detriment to the participants. It was always important to give the participants opportunities to raise any concerns or questions relating to the research at any time during the interview. In typical cases of in-depth interviews, there were some elite experts or high-ranked officials in this study, who were always strict on their time allowance. Therefore, "there should be special planning and foresight, with questions being carefully tailored for each individual to maximize use of time while achieving unique perspectives of the participants" (Padgett, 2012, p. 129).

Anonymity, privacy and confidentiality

The anonymity and confidentiality of the participants in the interviews and focus groups was of high concern. Although these two terms have previously been taken to mean the same thing in research for their closely related concepts, they have different implications in terms of qualitative interviewing (King and Horrocks, 2010, p. 117). By means of confidentiality, the personal information concerning the research participants in this study such as names, positions, contact details, and their consent forms were kept confidential in a locked filing cabinet, which could be retrieved only by the current researcher. In addition, the electronic versions of the interviews in the MS. Word document files were stored in appropriate password protected devices; and hard copies of the interview transcriptions were kept in the locked filing cabinet. The protection of confidentiality for participants attending the focus groups was of great importance, especially when participants interacted with each other and not just the researcher. Participants were encouraged to keep confidential what they heard during the meeting and the researchers had the responsibility to keep data from the group anonymous (Parsons and Greenwood, 2000). In terms of anonymity, the identities of the participants were concealed in all documents resulting from the research; or were replaced with pseudonyms (replacing the participants' names with alternative ones). In this way, the participants were not identifiable in the study findings and analysis.

Incentives, payback, and maintaining goodwill

Small incentives were thought to encourage the participants to be involved in the interviews and focus groups, and to partially compensate for their spending time with the researcher (Padgett, 2012). Dependent on the ethical and financial issues of the research, the allocated monetary payments should fit with the contemporary situations: if participants are paid too little, the incentive value is lost; if they are paid too much, researchers are at risk of purchasing co-operation from the participants (Padgett, 2012, p. 87). In these qualitative approaches, a monetary payment equivalent to 5AUD was paid to each interview participant and 0.5 AUD to each focus group participant, based on the Vietnamese government's norms of financial support in health studies. In addition, as stated in the information sheet (Appendices 3.14 & 3.16), the participants had the right to expect to see the results of the study in which they participated, even in abbreviated or pseudonymous writing, when the study was completed.

3.6 Summary

It is important to explore all of the possibilities to develop the most appropriate methodology for the research on development and evaluation of the broadly-based control model for fascioliasis in Central Vietnam. The rationale for selecting the explanatory sequential design as the most appropriate mixed methods design for this study was explained to frame the major component of the methodology. Comprehensive explanations of the mixed methods components helped to determine the procedures of sampling, recruitment, data collection, and data analysis strategies in the respective approaches. The quantitative research approach was to be conducted at the baseline and follow-up stages of the quasi-experimental surveys to describe the changed prevalence of fascioliasis before and after various interventions being differently applied to three communes under study. The qualitative research approaches, including in-depth interviews and focus groups, were to be conducted as the follow-up to the quantitative studies to provide further insight into the success of the model in Intervention 1 commune. In addition, various measures were discussed to increase the validity, reliability and rigour of the mixed methods approach, together with the detailed explanations of ethical considerations. The following chapters now describe the findings of the quantitative and qualitative studies.

4. STUDY RESULTS: BASELINE PREVALENCE AND RISKS OF FASCIOLIASIS INFECTION IN ADULT COHORTS IN TWO CENTRAL PROVINCES OF VIETNAM

4.1 Introduction

The overall aim of the thesis as described in Chapter 1 is to evaluate the factors that facilitate or impede the implementation of a broadly-based control model for fascioliasis (liver fluke) in a community in Central Vietnam with a high prevalence of fascioliasis. The aim was characterised in detail by the objectives including:

(i) to determine the prevalence of fascioliasis by laboratory methods prior to the interventions,

(ii) to describe the risk factors associated with fascioliasis infections by conducting knowledge, attitude and practice (KAP) surveys,

(iii) to report on the implementation of a broadly-based control model for fascioliasis infection [the broadly-based fascioliasis control model includes chemotherapy, vector control, health education, surveillance and management, evaluation, and involvement of concerned bodies such as educational, agricultural and other organizations], and

(iv) to evaluate the effectiveness of the broadly-based control model in reducing the infection rate of fascioliasis, compared to a model of treatment of humans and cattle alone, and a model for treatment of humans only.

In order to achieve the described objectives, data collection included an explanatory sequential mixed methods research design involving the quantitative and qualitative inquiries, as detailed in the methodology chapter (Chapter 3). The methods of data collection, research procedures and data analyses were also described in detail to provide the bases for the presentation and interpretation of the findings in this and the following chapters.

This chapter presents the baseline prevalence of fascioliasis (liver fluke) in Central Vietnam, together with the determination of risk factors associated with the disease transmission. Following the presentation of these baseline findings, the implementation of the broadly-based control model for fascioliasis will be described in Chapter 5 and the evaluation of the control model will be detailed in Chapters 6 and 7.

Prior to the implementation of the intervention measures to control fascioliasis (liver fluke) in Central Vietnam, it was important to establish the baseline level of the prevalence of human fascioliasis and to determine the risk factors of the disease transmission. The baseline results were obtained through quantitative inquiry, which employed mixed types of data collection. A cross-sectional study using an ELISA (Enzyme-linked Immunosorbent Assay) blood survey determined the baseline prevalence of fascioliasis (liver fluke) among three adult cohorts living in three communes of Central Vietnam. A cross-sectional survey on knowledge, attitudes and practices (KAP) and household observations described the risk factors associated with fascioliasis transmission among the cohorts. Snail surveys identified the prevalence in the intermediate hosts of fascioliasis infection in the study locations. The socio-demographic information from the surveys was important to explore the association between socio-behavioural factors and fascioliasis infection, and the potential risk factors of the disease transmission.

Before official data collection commenced, field trips were undertaken to pilot test and update the content of the questionnaires and observational forms, and to determine the tentative duration of the actual data collections. The KAP pilot test was conducted with 20 household representatives at 8/8 villages of the Intervention 1 commune, incorporated with the intentional observations of household conditions. It was from the pilot test that certain modifications were made to the questions in the survey and the observational forms. Pilot tests did not include the blood tests and snail surveys as they had been regularly conducted by well-trained technicians of IMPE-QN from their previous research studies.

Participant households were identified through random selection of the household books in the communal registrar's office, as a household numbered system does not exist in the rural areas of Vietnam.

Data collection proceeded using the modified pilot tests. As descriptions of the data collection procedures were detailed in Chapter 3, this chapter primarily presents the results of ELISA blood surveys, KAP surveys, observations and snail surveys. The results of ELISA blood surveys are presented in association with the description of clinical manifestations and laboratory-based eosinophilia of infected cases, followed by the prevalence of fascioliasis in the socio-ethnographic categories. The perceptions, knowledge, attitudes and practices data are then presented so as to explore the risks associated with the disease transmission among the studied cohorts living in the three communes under study. The results of the observations are reported and are used to objectively verify the KAP survey data. The prevalence of snail infection is presented to explore the roles of the intermediate hosts in transmitting fascioliasis from animals to humans. The chapter concludes with overall comments on the prevalence and risk factors associated with fascioliasis prior to the commencement of the intervention strategies. In the next chapter, the intervention itself will be described.

4.2 Sample characteristics

An important step was to explore the relationships between the ethnographic characteristics with fascioliasis risk and infection prevalence, in order to identify and implement the most appropriate intervention strategies. This section presents the characteristics of the cohorts involved in each of the cross-sectional studies, the ELISA blood surveys and the KAP surveys. The sampling procedures for the cross-sectional study were described in detail in Chapter 3.

In this research, the sample size determination for the blood survey was based on the formula by Lemeshow *et al*. (1990) (Appendix 3.1) with the known referential infection rate identified from a study conducted previously in the neighbouring province of Khanh Hoa (Nguyen and Le, 2007). In addition, the sample size for the cross-sectional KAP survey was calculated using the formula for estimating the difference between two population proportions with specified absolute precision (two-sample situation) (Chadha, 2006, pp. 60), with the Bonferroni adjustment applied to allow multiple comparisons while achieving the overall confidence coefficient (Bland and Altman, 1995).

4.2.1 Characteristics of participants in the ELISA blood survey

While the selection of participants was undertaken randomly, it was important to establish whether the key characteristics of the sample populations varied between the three study locations or within selection for the two data collection methods. Overall the study locations were similar in age range and educational levels, but with some variations in gender proportions and occupation.

As described in the sampling section in Chapter 3, the total population for the survey in each commune was 428 people, plus an additional 20% or 85 people in case of samples being lost or participant inaccessibility (Appendix 3). In addition, recent studies reported a very low prevalence of fascioliasis among children (Dang, 2007; Dang and To, 2010; Nguyen, 2010), thus only adults aged from 18 were selected in this study. As a result, 1,612 adults in three communes were involved in the ELISA blood surveys.

In each location more women than men participated in the blood tests: In the Intervention 2 commune (58.6%) were women, (60.2%) in the Control commune and in the Intervention 1 commune (66.4%) (Table 4.1). These disproportional differences might be due to the fact that during the surveys, a majority of men were involved in work on construction sites or industrial centres far away, leaving their wives and children at home to take part in agricultural production and husbandry activities. Across the three communes, the proportion of women attending for blood tests in the Intervention 1 commune was significantly higher than in the Intervention 2 commune ($z=2.4$, $p<0.05$), but the other comparisons were not significant ($p>0.05$).

All of the participants were over 18 years of age, with the mean ages in the three communes 1, 2, and 3 were 47.7, 44.8, and 46.2 years, respectively (Table 4.1). Statistical analysis reported no significant differences in ages among the three cohorts under the study. Results of blood test surveys will be described in age ranges in the following section, which will be compared with other studies conducted in Central Vietnam (Nguyen, 2010; Nguyen, 2012).

The surveys were undertaken in the rural areas and 54.1-63.0% of participants attending the ELISA blood tests were farmers. Significant differences were found in the proportions of women attending the surveys between Intervention 1 and Control communes ($z = 3.4$, $p<0.05$); and between Intervention 2 and Control communes ($z=2.0$, $p<0.05$). In addition, no significant difference was found in the proportion of farmers attending the blood surveys between two intervention communes ($p>0.05$) (Table 4.1).

Table 4.1 Participants' ethnographic characteristics in ELISA blood survey

Characteristics	Intervention 1 commune (n=535) No. (%)	Intervention 2 commune (n=522) No. (%)	Control commune (n=555) No. (%)
Gender[4]			
Males	180 (33.6)	216 (41.4)	221 (39.8)
Females	355 (66.4)	306 (58.6)	334 (60.2)
Age (mean±SD)	(47.7±12.1)	(44.8±12.5)	(46.2±13.2)
Educational level			
Illiterate	39 (7.3)	52 (10.0)	53 (9.5)
Primary	163 (30.5)	122 (23.4)	139 (25.0)
Secondary	215 (40.2)	191 (36.6)	210 (37.8)
High-school	82 (15.3)	119 (22.8)	118 (21.3)
Post-school +	36 (6.7)	38 (7.3)	35 (6.3)
Occupation[5]			
Farmers	342 (63.0)	313 (60.0)	300 (54.1)
Students	16 (3.0)	45 (8.6)	27 (4.9)
Gov't staff	69 (12.9)	65 (12.5)	61 (11.0)
Business	22 (4.1)	34 (6.5)	69 (12.4)
Others	86 (16.1)	65 (12.5)	98 (17.7)

4.2.2 Characteristics of participants in the KAP survey

A total of 1,800 adults (600 household representatives in each commune) were selected for the survey of knowledge, attitudes and practices (KAP) of fascioliasis. Sampling procedures were described in Chapter 3, with the application of the manual Bonferroni adjustment (Appendix 3.1). Accordingly, in the KAP surveys, statistical testing with p-values less than 0.017 was considered significant. Overall the participants' characteristics followed a similar pattern to those of the blood survey.

Similarly to the participants involved in the ELISA blood survey, higher proportions of women participated in the KAP surveys (62.5% in Intervention 1 commune, 55.2% in Intervention 2 commune, and 58.2% in the Control commune, respectively) (Table 4.2). A significant difference was found in the proportion of women participants in the KAP

[4] Significant difference in women attending blood tests between communes 1 and 2(z=2.4, p<0.05)

[5] Significant differences in farmer proportions attending the blood tests between communes 1 and 3 (z=3.4, p<0.05); and communes 2 and 3 (z=2, p<0.05).

survey between Intervention 1 and 2 communes (p<0.017); whereas no differences were significant in the remaining pairs of communes.

A majority of farmers were involved in the KAP survey in three communes, from 67.0% to 73.8% (Table 4.2). This was to be expected as the study was conducted in the rural areas of Central Vietnam, where a majority (68.16%) of the people living there are involved in agricultural production (GSO, 2014). Again, significantly higher proportions of farmers attended the KAP survey in Intervention 1 commune than attended the Intervention 2 commune (Table 4.2).

A difference in participants' educational backgrounds was found. A higher proportion of KAP survey participants in the Intervention 1 commune reported secondary or lower educational levels compared with participants in the Intervention 2 commune (p<0.01). No significant differences were found in the remaining comparisons of educational levels in the communes (p>0.017). There were no significant differences (p>0.017) in the mean ages of the three communes, which were 46.9, 44.8, and 46.0 years in the Intervention 1, Intervention 2, and Control communes, respectively.

In the two different studies, the description of ethnographic characteristics provided the general background of the cohorts involved in the study. Overall the cohort participants shared common ethnographic characteristics: a greater proportion of women, within working ages, with educational backgrounds up to secondary level, and farmers. Some significant differences were observed in some comparisons between cohorts, which mainly concerned the proportions of farmers in the two surveys (Tables 4.1 and 4.2). The characteristics of the participants will be important to consider when explaining the prevalence of fascioliasis, which will be described in the following sections.

Table 4.2 Ethnographic profile of participants attending KAP surveys

Characteristics	Intervention 1 commune (n=600)	Intervention 2 commune (N=600)	Control commune (N=600)
	No. (%)	No. (%)	No. (%)
Gender[6]			
Males	225 (37.5)	269 (44.8)	251 (41.8)
Females	375 (62.5)	331 (55.2)	349 (58.2)
Mean age ±SD	(46.9±12.4)	(44.8±12.7)	(46.0±13.1)
Education level[7]			
Illiterate	50 (8.3)	61 (10.2)	69 (11.5)
Primary	171 (28.5)	137 (22.8)	145 (24.2)
Secondary	234 (39.0)	296 (34.3)	221 (36.8)
High school	100 (16.7)	151 (25.2)	132 (22.0)
Post-school +	45 (7.5)	45 (7.5)	33 (5.5)
Occupation[8]			
Farmers	443 (73.8)	402 (67.0)	425 (70.8)
Students	10 (1.7)	23 (3.8)	28 (4.7)
Gov't staff	87 (14.5)	101 (16.8)	89 (14.8)
Business	21 (3.5)	25 (4.2)	20 (3.3)
Others	39 (6.5)	49 (8.2)	38 (6.3)

4.3 Prevalence of fascioliasis among adult cohorts in two Central provinces of Vietnam

This section presents the prevalence of fascioliasis among the adult cohorts in the studied communes of Intervention 1 commune, Intervention 2 commune, and the Control commune. The overall infection rates are described with statistical comparisons made among the cohorts and with previous studies conducted in the region. In addition, the clinical manifestations and the eosinophilic description of laboratory-infected cases as supplementary indicators for positive case confirmation are also detailed, based on the guidelines of the Ministry of Health (MOH, 2006). Descriptions of the prevalence

[6] Significant difference in women attending KAP surveys was found between Intervention 1 and communes ($p<0.017$).

[7] Participants with secondary education levels and less in Intervention 1 commune were significantly higher ($p<0.017$) than those in Intervention 2 commune.

[8] Farmers in Intervention 1 commune attributed significantly higher proportion than those in Intervention 2 commune ($p<0.017$).

by ethnographic profiles in each of the cohorts are then presented, on which the targeted strategies of intervention will be based (Chapter 5).

4.3.1 Overall prevalence of fascioliasis in three studied cohorts, clinical manifestations and laboratory-based eosinophilia description

A total of 1,612 participants aged from 18 years old were involved in the cross-sectional study by ELISA-based blood tests (Appendix 3.2). The infection rates of fascioliasis in Intervention 1, 2, and Control communes were 8.8%, 8.4% and 6.1%, respectively; and the overall infection rate was 7.8% (Table 4.3). Based on the newly proposed classification of human fascioliasis epidemiological stratification (Mas-Coma, Esteban and Bargues, 1999a), Central Vietnam would be categorised as a mesoendemic area of fascioliasis.

The confirmation of a fascioliasis case is based on the MOH guidelines for diagnosis and treatment of human fascioliasis (MOH, 2006). The clinical manifestations and the laboratory eosinophilia are recommended in the guidelines as supplementary indicators of a fascioliasis case confirmation. The descriptions of clinical and para-clinical characteristics of infected cases are presented in Table 4.3.

At each location the majority of the people with infection reported abdominal pains in the right upper quadrant, ranging from 66.0% (Intervention 2 commune), 73.2% (Intervention 1 commune) to 82.4% (Control commune). Fatigue (68.4%-79.4%), urticarial (skin rash) (40.4%-76.5%), and fever (49.0%-52.9%) were the next most predominant symptoms reported. Digestive system disturbances (36.2%-47.1%) and other symptoms such as nausea and anorexia (36.2%-41.2%) were reported less often (Table 4.3). In Intervention 1 commune, 57.4% of the infected cases had the eosinophilia from 8.0%; followed by those in Intervention 2 commune (56.8%), and Control commune (52.9%). With the 95% CI of the mean eosinophils in the three cohorts of 7.0-8.4, 7.5-9.8, and 7.3-10.3, respectively, there were no significant differences in the blood eosinophilia of the three communes ($p>0.05$) (Table 4.3).

Table 4.3 Baseline prevalence of fascioliasis in three cohorts under study

Characteristics	Intervention 1 commune (n=535)		Intervention 2 commune (n=522)		Control commune (n=555)	
	Number (%)	p	Number (%)	p	Number (%)	p
Infected cases	47/(8.8)		44/(8.4)		34/(6.1)	NS
Clinical symptoms	n=47		n=44		n=32	
Pain in RUQ[9]	34 (72.3)	NS	31 (66.0)	NS	28/(82.4)	NS
Fever	24 (51.1)		23 (48.9)		18 (52.9)	
Digestive disturbance	22 (46.8)		17 (36.2)		16 (47.1)	
Urticaria	31 (66.0)		19 (40.4)		26 (76.5)	
Fatigue	35 (74.5)		30 (63.8)		27 (79.4)	
Vomiting, anorexia	26 (55.3)		17 (36.2)		14 (41.2)	
Eosinophilia	n=47		n=44		n=32	
No. ≥ 8.0%[10]	27 (57.4)	NS	25 (56.8)	NS	18 (52.9)	NS
Min-max	2-14		2-17		2-17	
% mean ±SD	7.7±2.3		8.6±3.8		8.6±3.8	
95% CI	7.0-8.4		7.5-9.8		7.5-9.8	

4.3.2 Prevalence of fascioliasis by ethnographic profiles

This section presents the prevalence of fascioliasis according to the ethnographic profiles such as genders, ages, education and occupation (Table 4.4). Comparisons of the infections by each of the categories, and between communes are also described to give the overall picture of baseline findings, upon which intervention strategies described in the following chapter are based.

There were no significant differences in the infection with fascioliasis rates in genders among the three communes under study (p>0.05), although more females than males were infected with the disease. This can be explained by the fact that more women than men attended the blood tests, but within the gender category, more men were infected. In addition, at the time of the surveys, men were away from home to work in urban

[9] RUQ: right upper quadrant of the abdomen

[10] Recommended by the MOH (2006) as an indicator of a positive case confirmation

areas or industrial centres, leaving highly disproportioned cohorts with a majority of women.

The participants aged from 30-59 years in Intervention 1, 2 and Control communes had a higher proportion of fascioliasis infection in comparison with those aged from 18-29 years and 60+ years; however, the differences were not significant by age-specific group ($p>0.05$). In Intervention 2 commune, the infection rate of fascioliasis among people aged from 40-49 years was significantly higher than in those within the age ranges of 18-29, 50-59 and 60+ years ($p>0.05$).

By educational background, participants with lower educational backgrounds (secondary level and under) in Intervention 1 commune accounted for high infection rates (10.1%), whereas a lower infection rate (4.2%) was found among those with a higher educational background; and the difference was significant ($p>0.05$). In the two remaining communes, although more participants with lower educational levels were infected (34 cases with lower educational levels vs.10 cases with higher levels in Intervention 2 commune, and 25 vs. 9 cases in the Control commune, respectively), their compared infection rates were not significant ($p>0.05$) (Table 4.4).

Across the occupations, the farmers in this study had the highest incidence of infection in the three communes, whereas other occupational groups had relatively low infection rates (typical infection proportions of other occupations not shown); but no significant difference was found among the groups ($p>0.05$). Farmers occupied a majority of the infection in all people involved in the study (72.3%, 70.5%, and 58.8% in Intervention 1, 2, and Control communes, respectively) (data not shown).

Table 4.4 Characteristics of fascioliasis in three cohorts

Characteristics	Intervention 1 commune (n=535)		Intervention 2 commune (n=522)		Control commune (n=555)	
	Number/ total (%)	p	Number/ total (%)	p	Number/ total (%)	p
Infected cases	47/535 (8.8)		44/522 (8.4)		34/555 (6.1)	NS
Gender						
Males	15/180 (8.3)	NS	21/216 (9.7)	NS	16/221 (7.2)	NS
Females	32/357 (9.0)		23/306 (7.5)		18/334 (5.4)	
Age (mean±SD)	(47.7±12.1)		(44.8±12.5)		(46.2±13.2)	
18-29 years	0/39	NS	2/65 (3.1)	<0.05	3/62 (4.8)	NS
30-39 years	12/98 (12.2)		10/118 (8.5)		9/113 (8.0)	
40-49 years	13/152 (8.6)		20/120[11] (16.7)	<0.05	9/141 (6.4)	
50-59 years	18/148 (12.2)		9/157 (5.7)	<0.05	11/145 (7.6)	
60+years	4/94 (4.1)		3/62 (6.8)		2/94 (2.1)	
Educational level						
Secondary & under	42/417 (10.1)	<0.05	34/365 (9.4)	NS	25/402 (6.2)	NS
High school & above	5/118 (4.2)		10/157 (17.5)		9/153 (5.9)	
Occupation						
Farmers	34/342 (9.9)	NS	31/313 (9.9)	NS	20/300 (6.7)	NS
Others	13/193 (6.7)		13/209 (6.2)		14/255 (5.5)	

4.4 Perception and practice in relation to risks of fascioliasis infection in studied cohorts

The perceptions of risks most related to fascioliasis infection of the three cohorts under study are presented in this section. Participants were randomly selected from the total population based on the referential proportions of knowledge, attitudes and practices from the previous study; and with the manual Bonferroni adjustment in comparing more than two sample sizes (Appendix 3.2). Accordingly, six hundred participants in each

[11] Significant differences with age ranges from 18-29, 50-59, and 60+

commune were chosen for the knowledge, attitudes and practices (KAP) survey. Their perceptions of risks associated with fascioliasis infection were evaluated based on their responses to their face-to-face 40-question interviews, which explored their understandings of fascioliasis, and their routine activities which put them at risk of infection, including their practice of handling animal wastes. Classifying the participants by ethnographic groups best allowed exploration of the risks among the comparative groups exposed to fascioliasis infection. In addition, observations were also conducted to confirm the data reported in the surveys, which will be described in the following section.

4.4.1 Understandings of fascioliasis

General perceptions of fascioliasis held by participants in the three cohorts under study were explored. The overall findings indicated low awareness (less than 50%) among the participants in the three communes in terms of their knowledge of fascioliasis, ranging from 24.7% (Intervention 2 commune), 27.3% (Control commune) up to 46.0% (Intervention 1 commune) (Table 4.5). Participants at the Intervention 1 commune had significantly higher awareness of the disease than those in communes 2 and 3 ($p<0.001$); however, no significant difference in the people's awareness of fascioliasis was found between the other two communes ($p>0.05$).

Among participants who knew about the disease in the three communes, more than 50% stated the correct answers regarding the transmission routes, such as eating improperly washed vegetables and drinking improperly boiled water. However, less than 50% of them knew about the signs and symptoms of the disease, with the correct answers in three consecutive communes being 43.8%, 37.8%, and 45.5%, respectively. In addition, only half of the participants stated that fascioliasis was controllable, with no significant differences across the cohorts ($p>0.05$). Regarding the question on whether fascioliasis was curable, disparities were found in the participants' knowledge across the communes: more participants in Intervention 1 commune than those in Intervention 2 commune agreed that the disease was curable (χ^2 =7.2, $p<0.01$). Although the proportion of participants in the Intervention 1 commune believing that fascioliasis was curable was higher than for those in the Control commune (χ^2 =4.3, $p<0.05$), the difference in knowledge was not significant, after following and employing the manual Bonferroni adjustment (significance level set at 0.017) (Table 4.5).

Table 4.5 Description of cohorts' knowledge of fascioliasis

Item	Intervention 1 commune[a]	Intervention 2 commune[b]	Control commune[c]	χ^2, p
	Number /total (%)	Number /total (%)	Number /total (%)	
Know about fascioliasis	276/600 (46.0)	148/600 (24.6)	224/600 (37.3)	a-b: 59.8;<0.01 a-c: 22.5;<0.01 b-c: 9.3; NS
Know transmission routes	n=276	n=148	n=224	
Eat unwashed veggies	173 (62.7)	91 (61.5)	141 (62.9)	a-b: 0.2; NS
Drink improperly boiled water	165 (59.8)	95 (64.2)	129 (57.6)	a-c: 0.1; NS b-c: 0.5; NS
Know signs & symptoms	121 (43.8)	56 (37.8)	102 (45.5)	a-b: 1.4; NS a-c: 0.2; NS b-c: 2.2; NS
Know it is controllable	144 (52.2)	81 (54.7)	111 (49.6)	a-b: 0.3; NS a-c: 0.4; NS b-c: 1.0; NS
Know it is curable	145 (52.5)	59 (40.0)	97 (43.3)	a-b: 6.2; <0.01 a-c: 4.2; NS b-c: 0.4; NS

4.4.2 Practices associated with risks of fascioliasis infection among three studied cohorts.

In three communes, 28.2% to 33.8% of the participants reportedly ate improperly washed vegetables, with no significant differences found among these proportions (p>0.05) (Table 4.6). Participants from the Intervention 1 commune had proportionally better practices of eating properly treated vegetables than those from Intervention 2 commune; however, the difference was not significant as per the cut-off significant level (p<0.017). Regarding the practice of drinking water, significant differences were found as participants in Intervention 1 commune possessed better practices of drinking properly treated water than the two other communes (p<0.01). In Intervention 2 commune, more than 40% of the participants reported drinking under-boiled water. Although this appeared higher compared to those in the Intervention 2 commune (p<0.05), this was not significant at the 0.017 level. In addition, although a majority of households in three surveyed communes owned toilets, significantly lower ownership of household toilets was reported in Intervention 2 commune in comparison to the Control commune ($p<0.01$). In households without a toilet, more than half of the participants reported defecating outdoors such as on sand banks, in rice fields or into surface water sources such as canals, streams or rivers (Table 4.6). The contaminated water sources were then used for watering vegetables or cooking, hence posing high risks of fascioliasis transmission, especially in the rainy seasons.

Table 4.6 Reported practice associated with risks of fascioliasis infection in studied cohorts

Practice	Intervention 1 commune[a]	Intervention 2 commune[b]	Control commune[c]	χ^2, p
	Number/total (%)	Number /total (%)	Number /total (%)	
Eat improperly washed vegetables	169/600 (28.2)	197/600 (32.8)	203/600 (33.8)	a-b: 3.1; NS a-c: 4.5; NS b-c: 0.1; NS
Drink improperly boiled water	141/600 (23.5)	255/600 (42.5)	220/600 (36.7)	a-b: 49.0; <0.01 a-c: 24.7; <0.01 b-c: 4.3; NS
Don't own household toilets	104/600 (17.3)	85/600 (14.2)	123/600 (20.5)	a-b: 2.3; NS a-c: 2.0; NS b-c: 8.4; <0.01
Outdoor defecation[12]	65/104 (62.5)	66/85 (77.6)	90/123 (73.2)	a-b: 5.1; NS a-c: 3.0; NS b-c: 0.5; NS

4.4.3 Practices of animal husbandry with associated risks of fascioliasis transmission

Proportions from 19.8% to 46.5% of the surveyed households reported raising cattle and water buffaloes, with great disparities between communes 1 and 2, and the Control commune ($p<0.01$). A majority (76.7%-80.9%) of the households raised three or more cattle, with free grazing husbandry reported as the main practice (from 72.0%-74.2%) in the communities; while approximately one in five (18.0-20.0%) households practised shelter-based husbandry. The cattle waste was dried out in mounds or composted right at the shelters as fertilizers for rice fields or selling to rubber or coffee plantations. More than half of the households reportedly conducted de-worming of their cattle only once a

[12] Sand banks, rice fields, hilly areas and surface water such as streams, canals or river banks.

year. The proper practice of de-worming cattle, at least twice a year, was conducted by few (7.8%-12.1%) of the cattle raising households (Table 4.7).

Table 4.7 Reported practice of cattle raising households in relation to risks of fascioliasis transmission

Practice	Intervention 1 commune[a]	Intervention 2 commune[b]	Control commune[c]	χ^2, p
	Number/total (%)	Number /total (%)	Number /total (%)	
Households raising cattle	279/600 (46.5)	252/600 (42.0)	119/600 (19.8)	a-b: 2.5; NS a-c: 96.2;<0.01 b-c: 69.0; <0.01
Number of cattle				
Less than 3 cattle	65/279 (23.3)	48/252 (19.1)	27/119 (22.7)	a-b: 1.4; NS a-c: 0.1; NS b-c: 1.0; NS
From 3 cattle	214/279 (76.7)	204/252 (80.9)	92/119 (77.3)	
Cattle grazing practice				Df=2
Free grazing	201/279 (72.0)	187/252 (74.2)	86/119 (72.2)	a-b: 1.9; NS a-c: 0.3; NS
Shelter-based	54/279 (19.4)	51/252 (20.2)	21/119 (17.7)	b-c: 2.7; NS
Semi-grazing	24/279 (8.6)	14/252 (5.6)	12/119 (10.1)	
Animal waste treatment				
Composted	236/279 (84.6)	230/252 (91.3)	75/119 (63.0)	a-b: 5.0; NS a-c: 23.7; <0.01 b-c: 44.1; <0.01
Released into environment	43/279 (15.4)	22/252 (8.7)	44/119 (37.0)	a-b: 5.0; NS a-c: 23.7; <0.01 b-c: 44.1; <0.01
De-worming activities				
Once yearly	194/261 (74.3)	148/242 (61.2)	60/116 (51.8)	Df=2 a-b: 16.6; <0.01
Twice yearly	26/261 (10.0)	19/242 (7.8)	14/116 (12.1)	a-c: 21.8; <0.01 b-c: 3.4; NS
Once in many years	41/261 (15.7)	75/242 (31.0)	42/116 (36.2)	

4.5 Household observations

Observations were conducted in 120 households, or 20% of 600 households for KAP surveys in each of three studied communes (Refer Table 4.8). The frequency of households in Intervention 1 commune that built protected wells (wells covered with lids) and installed tap water was significantly higher than in Intervention 2 commune ($p<0.01$), but not significantly different from the Control commune ($p>0.05$). Also, no significant difference was observed between the water systems of communes 2 and 3 ($p>0.05$). Regarding the hygienic conditions of the latrine facilities, the observed data showed that more than half (from 53.3%-63.3%) of the households in the three communes constructed the well-structured (self-disposal) toilets. Otherwise, in the absence of the properly hygienic facilities, a significant proportion of the communal houses still practiced defecating in the open air, or in sparse structures with unhygienic conditions such as decomposing or dug latrines, which put householders at risk of fascioliasis infection (Table 4.8).

From the observations of households with cattle shelters, more than half (54.8%-58.3%) of cattle raising households constructed well-built shelters for their animals. However, the number of households that built sparsely structured shelters or no shelters at all still remained significant (25.0%-30.5% of households had poorly-structured animal shelters, and 11.0%-19.0% of households did not have animal shelters). Decomposing cattle waste for fertiliser use was observed in more than half of the households that raised cattle, and the poor practice of releasing untreated animal waste into the environment (into gardens or water sources) was observed in three communes, at rates from 18.6% to 12.4% (Table 4.8). Such practices would facilitate the larvae to reach their infective stage for humans and animals.

Table 4.8 Observational reports of household hygienic conditions

Item	Intervention 1 commune[a]	Intervention 2 commune[b]	Control commune[c]	χ^2, p
	Number/total (%)	Number/total (%)	Number/ total (%)	
Water source for washing vegetables				Df=3
Protected well	51/120 (42.5)	39/120 (32.5)	44/120 (36.7)	a-b: 16.0;<0.01
Unprotected well	9/120 (7.5)	18/120 (23.3)	14/120 (11.7)	a-c: 6.6; > 0.05
Tap water	47/120 (39.2)	31/120 (34.2)	37/120 (30.8)	b-c: 2.2; > 0.05
Surface water	13/120 (10.8)	32/120 (26.7)	25/120 (20.8)	
Latrine structure				Df=3
Self-disposal	76/120 (63.3)	64/120 (53.3)	69/120 (57.5)	a-b: 4.4; > 0.05
Decomposed	13/120 (10.8)	24/120 (20.0)	11/120 (9.2)	a-c: 1.7; > 0.05
Digging	14/120 (11.7)	13/120 (10.8)	17/120 (14.2)	b-c: 0.1; > 0.05
Without toilet	17/120 (14.2)	19/120 (15.9)	23/120 (19.1)	
Cattle shelters (if any)				Df=2
Well-structured	34/59 (57.6)	23/42 (54.8)	21/36 (58.3)	a-b: 1.0; > 0.05
Sparsely-structured	18/59 (30.5)	11/42(26.2)	9/36 (25.0)	a-c: 0.6; > 0.05
No shelter	7/59 (11.9)	8/42 (19.0)	6/36 (16.7)	b-c: 0.1; > 0.05
Animal waste disposal				Df=2
Composted	41/59 (69.5)	27/42 (64.3)	23/36(63.9)	a-b: 0.3; > 0.05
Biogas	7/59 (11.9)	6/42 (14.3)	6/36 (16.7)	a-c: 0.5; > 0.05
Into environment	11/59 (18.6)	9/42 (21.4)	7/36 (19.4)	b-c: 0.1; > 0.05

4.6 Surveys of lymnaeid snails as intermediate hosts of fascioliasis

To examine the prevalence of *Lymnaeid* snails as intermediate hosts of fascioliasis, baseline surveys of the snails were conducted at aquatic areas in the study communes, including rice fields, canals and small streams, considered as appropriate habitats of the snails. During April-May, 2013, a total number of 2,669 *Lymnaeid spp*. snails were collected at various aquatic habitats (Table 4.9), with more snails caught from rice fields than streams and canals. Laboratory examination for species identification was performed at IMPE-QN. The major species found was *L. viridis* (2,189 snails, 82.1%), followed by *L. swinhoei* (480 snails, 17.9%). These *Lymnaeid* snails were then further examined to identify any infection with *Fasciola* larva. The snail infection rates of *Fasciola* larva in the three ordered communes were 0.49%, 0.62% and 0.47%, respectively (Table 4.9).

Table 4.9 Fascioliasis infection in collected lymnaeid snails, April-May 2013

Aquatic habitats	**Intervention 1 commune**	**Intervention 2 commune**	**Control commune**
	No./total (%)	No./total (%)	No./total (%)
Rice fields	4/849 (0.47)	4/656 (0.61)	3/684 (0.44)
Streams, canals	1/164 (0.61)	1/154(0.65)	1/162 (0.62)
Total	5/1,013 (0.49)	5/810 (0.62)	4/846 (0.47)

4.7 Discussions

This section presents the discussions of the findings in this study, with references from other studies previously conducted in central Vietnam. The similarities and differences between the results of this study and others are explained by the selection of methods applied in data collection and result interpretations.

Overall, the three studied cohorts shared common ethnographic characteristics: more females than males attending the blood tests and KAP survey; the mean ages ranged from 44.8-47.7 years old for blood tests and from 44.8-46.9 years in KAP surveys; more participants had secondary educational levels or lower; and there were more farmers in comparison with other occupations. A majority of these ethnographic profiles were not significantly different ($p>0.05$ in blood surveys and $p>0.017$ in KAP surveys) (Appendices 3.1 and 3.2). However, significant differences were found in women attending blood tests between the Intervention 1 and 2 communes ($z=2.4$, $p<0.05$); in farmer proportions attending the blood tests between the Intervention 1 commune and the Control commune ($z=3.4$, $p<0.05$); and between communes 2 and 3 ($z=2$, $p<0.05$). Additionally, significant differences were found when more women, more participants with secondary educational levels or less, and more farmers in the Intervention 1 commune than those in Intervention 2 commune, participated in the KAP surveys ($p<0.017$).

4.7.1 Seroprevalence of fascioliasis in three studied cohorts in Central Vietnam

The overall seroprevalence of fascioliasis in the three cohorts in Central Vietnam is 7.6%, with the typical infection rates of the three ordered communes at 8.8%, 8.4% and 6.1%, respectively. In comparison with other studies conducted previously in other provinces of the region, the prevalence of this baseline study was higher than the rate in Quang Ngai province (3.2%) and higher than in Gia Lai province (3.4%) (Nguyen, 2007); higher than in Phu Yen province (7.1%) and Khanh Hoa province (3.7%) (Nguyen *et al*., 2007); higher than in Binh Dinh province (6.0%) (Nguyen *et al*., 2011); and higher than in Quang Nam province (3.2%) (Nguyen, 2012). Meanwhile, it was lower than the rates found in some other studies: lower than in Khanh Hoa province (11.1%) (Nguyen *et al*., 2003); lower than in Gia Lai province (10.2%) (Tran, Phan, Dang and Nguyen, 2008); lower than in Quang Ngai province (8.7%) (Nguyen, 2009); lower than in another 2009 study in Quang Ngai (8.7%) (Nguyen *et al*. (2009); and lower than in a 2012 study again in Quang Ngai province (10.2%) (Nguyen, 2012). These differences might be attributed to the use of different ELISA test kits by different authors. Some researchers (Nguyen *et al*., 2003; Nguyen, 2012) used the test kits produced by the National Veterinary Institute-Ministry of Agriculture and Rural Development; whereas in this study the test kits were produced by the Faculty of Pharmacy-Ho Chi Minh City University of Medicine and Pharmacy-Vietnam, with high sensitivity and specificity (Tran and Tran, 2004) and legalised by the Ministry of Health (Appendix 4.1). In addition, although using the same ELISA test kits, the interpretations of the test results were different, as in this study the results were calculated by the mean optical density (OD) of negative control + 3 standard deviations (mean ± 3 SD); while other researchers (Nguyen, 2007; Nguyen, 2009; Nguyen, Do and Nguyen, 2011; Nguyen, 2012) read the results at the antibody titres of 1/1.600 and 1/3.200.

In comparison with other studies conducted in other parts of the world, the infection rate reported in this study was higher than the 1.5% rate in Mexico (Ignacio, Gutiérrez-Quiroz, Romero-Cabello, Gonzalez, Gutiérrez-Cádenas, Alpizar-Sosa and Pimienta-Lastra, 2006) and the 3.0% in Turkey (Ozturhan *et al*., 2009); and was much lower than the 51.9% rate in Peru (Marcos, Maco, Terashima, Samalvides, Espinoza and Gotuzzo, 2005) and the 19.7% rate in Turkey (Karahocagil, Akdeniz, Sunnetcioglu, Cicek, Mete, Akman, Ceylan, Karsen and Yapici, 2011).

Most of the studies conducted in many other countries of the world have used the ELISA-based serological rather than the manual coprological (stool) tests to identity the infection of fascioliasis in the human antibody, especially in the field-based settings. The Kato-Katz coprological test, considered the gold standard for fascioliasis examination by counting the number of eggs per gram of stool, has commonly been applied elsewhere (Valero *et al*., 2009). However, this technique was not completely reliable, for several reasons. Eggs are not produced during the invasive stage of the immature worms, and are only detected in the chronic stage of the disease when liver damage has already happened (Hillyer, 1999; Valero, Terashima, Tamayo, Engels, Gabrielli, Mas-Coma, Periago, Pérez-Crespo, Angles, Villegas, Aguirre, Strauss, Espinoza and Herrera, 2012). Even in the chronic stage of the disease, not all patients shed eggs, especially in endemic areas, as these patients are repeatedly infected with the disease (Le, De, Agatsuma, Blair, Vercruysse, Dorny, Nguyen and McManus, 2007; Valero *et al*., 2012). In addition, during the biliary stage, the eggs are sporadically released from the bile ducts and thus the stools may sometimes not contain eggs (Mas-Coma, Bargues and Esteban, 1999b). Meanwhile, the ELISA serological blood test provides conclusive immune-diagnosis and possesses low cut-off sensitivity at all stages of the liver fluke life cycle, especially during the invasive or acute phases (Reichel, 2002; Rokni, Massoud and Hanilo, 2003; Kumar, Ghosh and Gupta, 2008). Therefore, the ELISA technique can be applied in a variety of field-based diagnoses for fascioliasis.

Clinical examinations reporting abdominal pains in the right upper quadrant was the most common complaint symptom among infected participants, followed by fatigue, urticarial (skin rash), and fever. These were among the signs that assist medical professionals to identify the symptoms of a typical fascioliasis case, as instructed in the MoH guidelines on diagnosis and treatment of fascioliasis (2006).

Similar results were also reported in previous studies conducted in some provinces of the Central region (Nguyen *et al*., 2007; Huynh *et al*., 2011; Nguyen, 2012), with colic pains in the right upper quadrant being the predominant symptom of fascioliasis. Studies in Peru, Turkey and Egypt also found that a majority of cases involved abdominal colic pain, showing the relationship between the presence and movement of the adult worms in the liver and the bile ducts, and the typical symptoms of fascioliasis.

Fatigue, urticarial and fever have also been common symptoms identified by patients in other studies, varying from 34.5% (Nguyen, 2012); 70.0% (Nguyen, 2010); and 70.9% (Huynh *et al*., 2011). Proportions of reported symptoms have fluctuated in these studies, possibly the result of different numbers of reported cases, patients' recalls, and the interpersonal skills of medical staff during clinical examinations (Nguyen, 2012).

Considered an important sign of fascioliasis, eosinophilia occurs in fascioliasis infected patients during the acute stage, with high concentrations of the white blood cells in peripheral vessels and liver granulomas as a result of the host defences against the infection (Meeusen and Balic, 2000; David, Ofra, Silvia, Chun Chi, Ann Marie, Laura, James and Sara, 2004; WHO, 2007a; Aly, Diab, El-Amir, Hendawy and Kadry, 2012). The MOH (2006) has recommended the use of elevated eosinophil as a good indicator of suspected fascioliasis at the peripheral health facilities. In this study, the eosinophilia was at a higher level than in previous studies conducted in the neighbouring provinces of Central Vietnam (Nguyen *et al*., 2007; Nguyen, 2009; Nguyen, 2012) but also was lower than in other studies conducted in Central provinces (Tran *et al*., 2008; Nguyen, 2012).

In studies conducted elsewhere in the world, elevated eosinophilia was not found in more than 50% of infected patients at the chronic stage (Marcos, Mcaco, Terashima, Samalvides and H.E., 2002; Marcos, Vinetz, Gotuzzo, Tagle, Terashima, Bussalleu, Ramirez, Carrasco, Valdez, Huerta-Mercado and Freedman, 2008). In Turkey, Turhan *et al*. (2006) reported the increased proportion of the white blood cells was not significantly different between the infected and non-infected groups; and concluded that the eosinophilia did not provide a surrogate marker of fascioliasis infection. However, elevated eosinophilia was found to increase in 40.7% (11/27 cases) of infected Turkish patients in another study (Yesildag, Yildiz, Demirci, Goren and Isler, 2009). In addition, eosinophilia was found to be strongly related to fascioliasis infection in Egypt (Curtale, Mas-Coma, El Wahab Hassanein, Barduagni, Pezzotti and Savioli, 2003). Therefore, in the absence of other better indicators of the diagnostic signs for fascioliasis, eosinophilia could still be considered to be a helpful indicator of the disease, especially in endemic areas (MOH, 2006; Sezgın, Altintaş, Tombak and Uçbılek, 2010).

4.7.2 Prevalence of fascioliasis by ethnographic profiles

The results of this survey indicated that more women than men were infected with fascioliasis. However, the difference in fascioliasis infection between the two genders was not significant (p>0.05) as there was a higher proportion of infected cases within the male gender category. Other studies conducted in Central Vietnam reported higher infection rates in women than in men (Dang, 2007; Huynh *et al*., 2007; Nguyen, 2010; Nguyen, 2012), although other authors claimed no significant distinction in the infection between the two genders (Nguyen, Dang and To, 2008; Tran *et al*., 2008; Nguyen, 2010). In addition, results from studies conducted in other countries such as Bolivia, Peru, and Turkey also reported significantly higher proportions of women than men being infected with fascioliasis (Esteban *et al*., 1999; Esteban *et al*., 2002; Curtale *et al*., 2003; Curtale, Hassanein, Barduagni, Yousef, Wakeel, Hallaj and Mas-Coma, 2007; Karahocagil *et al*., 2011). So far, there has been no clear difference in the prevalence of fascioliasis between men and women. Explanations may be that in study areas women were more often in contact with *Fasciola* larvae than men through the daily household activities such as housekeeping, washing vegetables, preparing meals, washing clothes and grazing cattle (Esteban *et al*., 1999; Esteban *et al*., 2002; Curtale *et al*., 2003; Curtale *et al*., 2007). In Vietnam, while men are often absent from home for work in rural areas and industrial centres, women take care of all household work and may be exposed to infection with fascioliasis (Nguyen, 2012). This may account for the higher rates of infected cases of fascioliasis in women than in men.

The majority of infected cases of fascioliasis were reported in people aged from 30-59 years, being at 91.5%, 88.7% and 85.3% in the Intervention 1, 2, and Control communes, respectively. Similar results were also reported in several other studies in Vietnam. In a study evaluating the effectiveness of triclabendazole in fighting fascioliasis in Vietnam, Nguyen *et al*. (2006) found the 20-49 year age group accounted for a majority (69.5%) of the infected cases. Studies by Dang *et al*. (2007; 2010) revealed the those under 60 years old accounted for over 80% of all infected cases. More recently, Nguyen (2012) reported higher infection cases (88.6%) in adults than in children. Only one study conducted in Central West Highland (Vietnam) reported a high proportion of fascioliasis (14.1%) in children (Tran *et al*., 2008). This result might come from the fact that the study was conducted in a different ethnic community (the Ede ethnic minority), who have the common habit of drinking improperly boiled water and eating raw cattle livers. In other regions of the world, very high infection rates in children have been reported in Peru, Bolivia, and Egypt (Esteban, Flores, Aguirre, Strauss, Angles and Mas-Coma, 1997; Marcos *et al*., 2005). This study selected people aged over 18 years, as previous studies had reported very low infection cases in children (Dang, 2007), (Dang and To, 2010) (Nguyen, 2010). In addition, people aged from 18-59 years are main earners in the family and put themselves at risk of fascioliasis infection from their living activities. In this study however, there were no significant differences in the infection with fascioliasis between age groups ($p>0.05$).

With respect to infection with fascioliasis by educational level, the study reported that participants with educational backgrounds up to secondary level presented with much higher infection rates than those with high school education and above. However, the only significant difference was found in the Intervention 1 commune ($p<0.05$), whereas no significant differences between compared rates of infection were indicated in the two other communes. The results in the current study correspond with reported results in previous studies (Nguyen, 2010; Nguyen 2012). While the study by Nguyen (2012) found an increasing incidence of fascioliasis infection in accordance with higher education levels (except for the university graduates); Nguyen (2010) noted that those with lower educational backgrounds had significantly higher infection rates of the disease. The results of this study differ from other studies, which may be related to the different sample sizes and study localities. One study (Nguyen, 2010) was conducted in two communes with a total sample of 600 people (300 people/each commune). Another study (Nguyen, 2012) was conducted in a wide range of communes (18 communes in 6 districts) and a sample size of 2,760 people. However, the sample size in each commune was low (approximately 150 people per commune) and hence was not representative of the wider populations. This study was conducted in three communes that shared common natural and epidemiological settings (Chapter 3). The sample sizes ranged from 525 to 555 people in each commune, determined as representative of the populations, and thus the 6-8% infection rates within the populations reported in this study, were likely to be an accurate reflection of the wider population's fascioliasis infection status in this region of Vietnam.

Regarding the prevalence of fascioliasis by occupation, farmers represented a higher proportion of infection in comparison with other occupations; however, no significant differences were indicated. Similar findings were reported in other studies (Phan, Pham and Nguyen, 2008; Nguyen, 2009; Nguyen, 2010; Nguyen, 2012). Most of these studies were conducted in rural areas with farmers as major attendants, whose typical career was related to exposing themselves to the risks of fascioliasis infection. In Vietnam, a majority of the population live in rural areas, accounting for 68.0% of the labour force and representing 47.0% of the total population nationwide (GSO, 2014). Similar findings were reported in other studies (Phan *et al*., 2008; Nguyen, 2009; Nguyen, 2010; Nguyen, 2012). In this study, the rural population accounted for high proportions of the total sample size, ranging at 54.1% (300/555) in the Control commune, 59.0% (313/522) in the Intervention 2 commune, and 63.9% (342/535) in the Intervention 1 commune, respectively (Table 4.1). Their daily activities that put them at risk of getting fascioliasis infections include exposure to unsafe sources of water, vegetables and meat, poor animal husbandry practices and unhygienic conditions of household and sanitary facilities. These were considered associated risks of fascioliasis infection that will be discussed in detail in the following section.

4.7.3 Perceptions and practices in relation to risks of fascioliasis infection in studied cohorts

In this study, less than 50% of the participants in the three communes were knowledgeable about fascioliasis, with participants in the Intervention 1 commune having significantly higher awareness of the disease than those in Intervention 2 commune and the Control commune ($p<0.001$), and no significant difference in the people's awareness of fascioliasis was found between the latter two communes ($p>0.05$). Among the participants who did have an awareness of fascioliasis, although more than 50% knew the transmission routes of the disease, more than 50% did not know the symptoms and signs. Previous studies conducted in Central Vietnam have reported similar results. A baseline survey by Nguyen (2012) reported that 34.1% of the community at the studied sites knew about the disease and their knowledge of the causes, and damages caused by it, was 36.5%. However, this study's results were much lower in comparison with other studies, with the reported baseline knowledge of fascioliasis at 64.5% (Nguyen *et al*., 2011) and 69.4% (Nguyen, 2012), respectively. In addition, this study's results were in agreement with a former study (Nguyen, 2012) in which 66.1% of the study participants indicated that eating improperly washed vegetables was the main transmission route of fascioliasis, and 52.2% of them stated that drinking improperly boiled water was the main route.

Regarding the risk behaviours associated with fascioliasis transmission, noticeable proportions of participants in all three communes (28.2%, 32.8% and 33.8%, respectively) reported eating raw and improperly washed vegetables. Eating raw vegetables during meals has been considered a long standing habit of Vietnamese people. Vegetables improperly treated prior to consumption, and consumption of vegetables previously fertilized with cattle manure has been reported to lead to fascioliasis transmission in humans (Marcos, Maco, Samalvides, Terashima, Espinoza and Gotuzzo, 2006). In Central Vietnam, several studies (Nguyen *et al*., 2007; Nguyen, 2010) have reported that some aquatic plants were contaminated with *Fasciola* larvae at different rates, from 0.40 to 1.34 metacercaria per kilogram of vegetable. In addition, another study (Nguyen, 2009) indicated the relationship between human fascioliasis with eating raw lettuce, a popular plant in mixed vegetables. In Cuba, China, Japan, Thailand and elsewhere in the world, various studies reported similar connections between fascioliasis and the consumption of raw vegetables such as watercress, houttuynia (also known as heartleaf or fishwort) and lettuce (Aroonroch, Worawichawong, Nitiyanant, Kanchanapitak and Bunyaratvej, 2006; Marcos *et al*., 2006; Rojas *et al*., 2010; Muhsin Kaya Remzi Bestas Sedat, 2011; Chen *et al*., 2013).

Water-borne parasites including *Fasciola* larvae use water bodies as direct habitats for their intermediate and final hosts and for transmission of diseases (Zhou, 2012). Water bodies containing *Fasciola* larvae are important sources of fascioliasis transmission, either via direct consumption or from preparation and processing food with contaminated water (Slifko, Smith and Rose, 2000; Collins, Dalton, Donnelly, Stack, O'Neill, Doyle, Ryan, Brennan, Mousley, Stewart and Maule, 2004; Aksoy *et al*., 2005; Nouri, Mahvi, Saeedi, Dindarloo, Rafiee and Dobaradaran, 2008; Mas-Coma *et al*., 2009b).

Although some types of ground-grown vegetables have not been directly linked to fascioliasis transmission, the use of water contaminated with *Fasciola* larvae for watering these plants can contribute to the transmission of the disease. In Egypt, freshly-eaten plants such as lettuce are watered from hydroponic systems and canals, and rinsed with these water sources at the harvest time. It is the exposure of the non-aquatic plants to water containing *Fasciola* larvae that facilitates the contamination of vegetables with fascioliasis (Farag, El-Khoby, Salem, Abou El Hoda and Amin, 1998; Ezzat, Karboli, Kasnazani and Hamawandi, 2010). Similar findings have also been reported in other studies showing the relationship between man-made irrigation systems and the transmission of human fascioliasis (Esteban *et al*., 2002; Marcos *et al*., 2006)

Considerable proportions of the cohorts in the current study reported drinking improperly boiled water, which would place them at risk of fascioliasis infection from water contaminated with *Fasciola* larvae. Although some authors (Tran *et al*., 2008; Nguyen, 2009) reported no relationship between drinking under-boiled water and fascioliasis transmission in Central Vietnam, others did and indicated that the proportional infections of fascioliasis among under-boiled water drinkers were ranging from 13.8%, 26.5%, and 35.7% in the Central provinces of Quang Nam, Gia Lai and Quang Ngai, respectively (Tran *et al*., 2008; Nguyen, 2009; Nguyen, 2012).

Humans can participate in fascioliasis transmission through their lifestyle habits. For example, outdoor and indiscriminate defecation, a common practice in developing countries, facilitates the egg shredding (Crompton and Savioli, 2006, pp. 100; Mas-Coma *et al*., 2009; Tolan, 2011; Agnamey, Fortes-Lopes, Raccurt, Boncy and Totet, 2012). In this study, considerable proportions (62.5%, 77.6% and 73.2% in Intervention 1, Intervention 2, and Control communes, respectively) of participants lived in households without toilets and went to defecate outdoors (on the hills, sand banks, rice field or into the river banks or other water sources), which shed the *Fasciola* eggs into the environments, facilitating the transmission of fascioliasis in the community.

Other practices also facilitate the *Fasciola* parasite's dissemination of the eggs and enable the completion of their life cycle (Shuhardono *et al*., 2006; Nguyen *et al*., 2011). In recent years in Central Vietnam, strategies of animal husbandry development, such as increasing the number of herds and importation of different breeds of cattle (often more susceptible to fascioliasis) have been reported to significantly contribute to the reservoirs of fascioliasis transmission (Nguyen *et al*., 2011). Also, grazing cattle freely in grass fields, and using fresh animal excrement to fertilize paddy fields and aquatic vegetables are common practices (Huynh *et al*., 2011; Nguyen *et al*., 2011).

Binh Dinh and Quang Ngai provinces are among the central provinces with high endemicity of fascioliasis in cattle (Huynh *et al*., 2011; Nguyen *et al*., 2011; Nguyen, 2012). In comparison with other regions, in Vietnam and other countries, the infection of *Fasciola* in cattle in the two central provinces is higher, with calves exposed to infection at younger ages (Holland, Luong, Nguyen, Do and Vercruysse, 2000). These higher rates of infection of cattle could be explained by several risk factors. The traditional practice of free-grazing husbandry facilitates the dissemination of eggs into the environment, especially in grassland areas or rice fields, which provides favourable conditions for the development of *Fasciola* larvae. In addition, farmers often dry cattle dung in mounds in shadow (close to shelters) or on the roadsides. These practices do not achieve radical egg destruction by the sunlight; moreover, *Fasciola* eggs are usually washed out as a result of heavy rains if dried out on roadsides. More importantly, untreated cattle waste is released into the gardens or the environment in a direct way, coupled with low frequencies of de-worming activities (less than twice per year), which is also likely to pose threats of fascioliasis transmission on vegetables or water sources.

Human fascioliasis has also emerged as a public health problem in Central Vietnam, including Binh Dinh and Quang Ngai provinces (Nguyen, 2011). Previous studies (De, Chuong, Thach, Nguyen, Thuan and Trung, 2006; Nguyen, Le, De, Doan, Dao, Vercruysse and Dorny, 2010) reported high acute infection rates of human fascioliasis, but low egg shedding rates. This suggested that animal reservoirs of fascioliasis were responsible for most of the environmental contamination (Nguyen *et al*., 2011). Although the expected correlation between animal and human fascioliasis only appears at the basic level (Mas-Coma, 2005), recent studies in Binh Dinh and Quang Ngai indicated high prevalence of the disease in animals in correlation with humans cases (Nguyen, 2011; Nguyen *et al*., 2011; Nguyen, 2012). In the presence of long-existing husbandry practices such as free-grazing, direct release of waste into gardens or water sources, and insufficient de-worming cycles, the risks of human fascioliasis infection from animal contamination remains high. This implies a need for more comprehensive and co-ordinated strategies to control fascioliasis, which will be discussed further in the following chapter.

4.7.4 Observation

In our study, the risk factors for fascioliasis transmission were not merely explained from the results of the KAP surveys, but were confirmed with observational data. Central Vietnam is characterised by rural areas with a majority of the population involved in agricultural production and animal husbandry. Cattle free-grazing has been a common husbandry practice of local farmers in the region, including Binh Dinh and Quang Ngai provinces (Nguyen *et al*., 2010; Huynh *et al*., 2011). Various water sources are used for feeding cattle or cleaning cattle shelters, mainly surface water such as rivers, streams, rice fields or domestic water systems such as wells or tap water. Waste water from cleaning the shelters was often directly released into the garden or surface water, which not only contaminated the water with *Fasciola* larvae but also transmitted other germs and parasites to the water reservoirs (Huynh *et al*., 2011). Increasingly, vegetables were rinsed in the parasite-contaminated water for household use or for selling to urban markets, which would increase the risks of fascioliasis transmission (Slifko *et al*., 2000; Mas-Coma, 2004b; Robinson and Dalton, 2009).

The observational study found no significant differences in the three studied communes in terms of observed facilities ($p>0.05$) and all three communes exhibited practices that may have posed risks of fascioliasis infection in the cohorts under study.

4.7.5 Snail surveys

As described in Chapter 2, snails belonging to the lymnaeid species are known to be intermediate hosts of *Fasciola* (Maha, 2008), and the populations of these molluscan snails are influenced by various factors such as temperature, light, vegetation, water pH, current and depth, and snail competitive ability (Wright, 1981; Lockyer *et al*., 2004). Increasingly, wide adaptation of the parasites to the existing *Lymnaeid* snail populations in new geographical areas has contributed to the spreading of fascioliasis (Mas-Coma, 2004b). In endemic areas of Europe, South America, Africa, Asia and the Middle East, the expansion of fascioliasis transmission in recent years has been reported to be the result of the distribution and ability of the aquatic Lymnaeid snails to adapt to a wide range of environmental niches (Mas-Coma *et al*., 2005b; Kenyon *et al*., 2009; Mas-Coma *et al*., 2009b; Bargues *et al*., 2012).

In Central Vietnam, two *Lymnaeid* snails have been found to be intermediate hosts of *Fasciola* larvae, including *L. viridis* and *L. swinhoei*. *L. viridis* snails have a small body size and are usually found living in small water bodies such as rice fields after harvest; meanwhile, *L. swinhoei* snails have a larger body and shell opening (aperture) and are often found in large water bodies such as canals and streams (Dang and Nawa, 2005; Dang, Nguyen, Nguyen and Trieu, 2011). In Quang Ngai province, Nguyen (2012) collected a majority of *L. swinhoei* (92.0%), then *L. viridis* (8.0%), mainly from streams and canals of plain areas during June-July, October-November and February-March. A laboratory examination found the infection rate of *Fasciola* larvae in *L. swinhoei* was 0.61% (Nguyen, 2012). In addition, another study (Nguyen *et al*., 2010) reported the infection rates for *Fasciola* larvae in snails were 3.0% in hilly areas, 1.7% in plain areas and 0% in mountainous areas. Those results, which were different from the present study, might be attributed to the time and localities of snail collection. In freshly-cut rice fields, the aquatic environment is suitable for the *L. viridis* snails, whereas in summer, all springs and streams are drying out of water, leaving unfavourable conditions for the development of *L. swinhoei* (Dang and Nawa, 2005).

In this study, lymnaeid snails were collected during April-May 2013, at the end of the rice harvest and the beginning of summer. This might explain why a majority of the snails caught were *L. viridis* (which prefers to live in rice fields) while the minority was the *L. swinhoei* (which have a preference for large water body habitats). In addition, as a result of the dry season, not many snails were caught in the aquatic biotopes. The taxonomical identification of collected snails, however, could result in inaccurate species being analysed as the snail morphological characteristics are influenced by the environmental and weather conditions, coupled with human errors on species identification (Doanh, Hien, Duc and Thach, 2012). However, the appearance of *Fasciola* larvae in two snail species provides evidence for the capacity of larval transmission of fascioliasis even in the unfavourable season of the year.

4.8 Conclusion

This chapter presented the baseline prevalence of fascioliasis (liver fluke) in Central Vietnam, together with the determination of risk factors associated with the disease transmission. These baseline findings provided the initiatives for the implementation of the intervention measures, which will be discussed in the following chapter.

Overall the participants involved in baseline ELISA blood tests and KAP surveys in the three communes had quite similar demographic profiles. Exceptionally, significant differences were found between the proportions of women in communes 1 and 2 attending the blood and KAP surveys; and between the proportions of farmers from the two first communes attending the blood test compared to those from the Control commune who attended.

The baseline surveys of three adult cohorts in two central provinces of Vietnam indicated fascioliasis was prevalent at high levels, and that the communities were mainly ignorant of the disease and how to prevent infection. The overall seroprevalence of fascioliasis was 7.75% of the study population, a higher rate than reported in previous studies. Rates of infection were higher in participants who were women, farmers, aged from 18-59 years old and less educated. Knowledge of fascioliasis in the study population was low and their long-existing practices of living with and raising animals exposed them to potential fascioliasis infection. In addition, while the presence of the intermediate host lymnaeid snails infected with *Fasciola* larvae was found to be low, there still existed a risk of transmission of the disease.

Therefore, intervention measures should be implemented to decrease the seroprevalence of fascioliasis and to increase the awareness, behaviours and practices of the community. This would require a comprehensive range of control strategies for fascioliasis, incorporated in a broadly-based control model including chemotherapy, vector control, health education, surveillance and management, evaluation, and involvement of concerned bodies such as educational, agricultural and other organizations. The descriptions of the implementation of each component in the model will be detailed in the following chapter.

5. INTERVENTION STRATEGIES: IMPLEMENTATION OF THE BROADLY-BASED CONTROL MODEL OF FASCIOLIASIS

5.1 Introduction

In order to achieve the reduction of the prevalence of fascioliasis and the improvement of the health status of the studied sites, it is important to implement intervention measures that are effective in the control of fascioliasis in Central Vietnam. These appropriate measures, selected from available approaches discussed in Chapter 2, comprise five co-ordinated components including: chemotherapy, health education, involvement of other concerned bodies, vector control, and improvement in the monitoring and evaluation system (Figure 2.2). In the model, chemotherapy and health education were adopted from a previous trial study on fascioliasis control measures in two communes of the Binh Dinh province, Central Vietnam (Nguyen *et al*., 2011) and the three remaining components were incorporated as adaptive interventions described by Molyneux (2006, p. 5).

The focus of this chapter is to report on the implementation of the broadly-based control model of fascioliasis in Central Vietnam. Descriptions of each typical intervention measure are presented, together with the duration and the studied objects involved in the intervention implementation. Implemented as designed in Chapter 2, the association of the recommended components aimed to reduce the fascioliasis morbidity and improve community health. Variations and challenges to any of the implementation components are also presented in the discussion section. The outcomes of the intervention measures will be presented in the following chapter (Chapter 6), and process evaluation of the intervention measures will be further discussed qualitatively in chapter 7.

5.2 Implementation of intervention measures

This section provides the description of the implementation of the intervention measures incorporated in the broadly-based control model of fascioliasis in Central Vietnam. Previously in chapter 3 the details of the study design and the different stages of data collection were presented (Table 3.1). The interventions were implemented from May-December 2013 and comprised various measures differently applied to each commune, as was described in the quantitative design (Chapter 3) and now presented in Table 5.1 below.

The Intervention 1 commune received all of the broadly-based intervention measures of fascioliasis control, including chemotherapy, improvement of the health system activities, health education, co-ordination of related bodies, and vector control. The Intervention 2 commune received chemotherapy and vector control. Human chemotherapy was the only control measure applied to the control community.

Table 5.1 Duration and intervention measures of fascioliasis control typically applied to three studied communes

Intervention measures	Duration of intervention (commune applied)							
	May	June	July	Aug	Sept	Oct	Nov	Dec.
Chemotherapy/ chemoprevention	(red)						(red)	
	(green)						(green)	
	(yellow)						(yellow)	
Vector control		(red, second half)	(red)	(red)	(red)	(red)	(red)	(red)
		(green, second half)						
Health education		(red, second half)	(red)	(red)	(red)	(red)	(red)	(red)
Improved management		(red)	(red)	(red)	(red)	(red)	(red)	(red)
Multi-sectoral involvement		(red, second half)	(red)	(red)	(red)	(red)	(red)	(red)

5.2.1 Chemotherapy/chemoprevention

Chemotherapy was applied to all cases infected with human fascioliasis in the three studied communes, and chemoprevention to cattle de-worming activities in intervention communes 1 and 2. The follow-ups of the adverse reactions to treatment of human fascioliasis following the WHO guidelines (WHO, 2007b) were also reported to evaluate the drug efficacy.

During May 2013, chemotherapy was given to people who were detected with fascioliasis from blood surveys conducted at the baseline data collection (Chapter 4). A total of 125 people in three communes were treated with a single dose of triclabendazole (TCZ) 250mg (Egaten®) at 10mg/kg of body weight. Before the administration of the medication, the participants had their details recorded in the personal forms (Appendix 3.29). Their manifestations of signs and symptoms, including the confounding symptoms of previous illnesses not related to fascioliasis,

(red) Intervention 1 commune; (green) Intervention 2 commune; (yellow) Control commune such as cholecystectomy or hepatitis, were also recorded. Then they were weighed to count the appropriate dose of TCZ on the basis of 10mg/kg body weight and provided the medication orally, and the information on weight and doses of TCZ were put in the records (D0) (Appendix 3.29). People who received treatment were monitored over seven days post-treatment to record and manage any side effects: at Day 1 (one day after treatment) and Day 7 (seven days after treatment) (Appendix 3.29) (WHO, 2007b). All recorded unwanted symptoms from the medication are presented in Table 5.2. The infected participants had their blood re-examined after 6 months (in November, 2013) and 12 months (in April, 2014) and would be treated again if their results remained positive to fascioliasis (Table 5.1).

At the baseline of treatment course, a majority of infected people presented typical clinical signs and symptoms of fascioliasis, such as right upper quadrant (RUQ) pain (45.6%), other abdominal pain (44.0%), diarrhoea (36.8%), skin rash (34.4%), jaundice (29.6%), fever (28.8%), and fatigue (25.6%) at a mild level. Some patients showed moderate symptoms of fatigue (23.2%), RUQ pain (22.4%), abdominal pain and fever (17.6%); and no severe cases were reported. One day after treatment (D1), the majority of the patients reported their symptoms had reduced drastically but gastrointestinal disturbances such as diarrhoea, abdominal pain and RUQ pain remained for some people, at 31.2%, 28.8%, and 24.8%, respectively. Side effects that were less frequent included fatigue (17.6%), fever (16.8%), skin rash (15.2%) and vomiting (14.4%). Compared with the severity of adverse reactions recorded at the baseline time (D0), the moderate severity after one day of treatment (D1) had reduced in most patients, with symptoms mainly related to the gastrointestinal disturbance at the highest of 9.6%. All these symptoms disappeared seven days after treatment (D7) (Table 5.2). All infected cases were clinically diagnosed and had their blood re-examined after six months and also after one year. These results were compared with baseline survey data and will be presented in Chapter 6.

Animal chemoprevention was applied in the Intervention 1 and 2 communes. Approximately 650 cattle in 210 cattle-raising households of the Intervention 1 commune were treated with anthelmintic drugs twice in the study year, during August and December 2013 (before and after the rainy season, the optimal time of fascioliasis development). Similarly in the Intervention 2 commune, approximately 469 cattle in 189 households twice received de-worming drugs during the study year.

Vitamins and other supplementary medication were also administered to these animals to increase their immunity and to fight against diseases (Appendix 5.1).

Table 5.2 Adverse reactions following the administration of triclabendazole at 10mg/kg body weight on patients infected with fascioliasis (WHO, 2007b)

Symptoms	Baseline – administration of drug			Day 1 after drug treatment			Day 7 after drug treatment		
	Mild (%)	Moderate (%)	Severe (%)	Mild (%)	Moderate (%)	Severe (%)	Mild (%)	Moderate (%)	Severe (%)
Biliary colic (pain in the RUQ[13])	57 (45.6)	28 (22.4)	0	31 (24.8)	11 (8.8)	0	0	0	0
Other abdominal pain	55 (44.0)	22 (17.6)	0	36 (28.8)	12 (9.6)	0	0	0	0
Vomiting	27 (21.6)	9 (7.2)	0	18 (14.4)	3 (2.4)	0	0	0	0
Diarrhoea	46 (36.8)	12 (9.6)	0	39 (31.2)	6 (4.8)	0	0	0	0
Fever	36 (28.8)	22 (17.6)	0	21 (16.8)	10 (8.0)	0	0	0	0
Skin rash	43 (34.4)	12 (9.6)	0	19 (15.2)	5 (4.0)	0	0	0	0
Jaundice	37 (29.6)	14 (11.2)	0	12 (9.6)	5 (4.0)	0	0	0	0
Fatigue	32 (25.6)	29 (23.2)	0	22 (17.6)	7 (5.6)	0	0	0	0
other[14]	34 (27.2)	17 (13.6)	0	21 (16.8)	4 (3.2)	0	0	0	0

[13] RUQ: right upper abdominal quadrant

[14] Includes: digestive disturbance, dizziness, chest pain, sweating, cough, difficult breathing

5.2.2 Improvement of health and other professionals' activities

This component of the broadly-based control strategies was implemented in the Intervention 1 commune in order to improve the skills and knowledge of fascioliasis control activities for not only local health staff but also other involved stakeholders. A training course to improve the skills and knowledge of fascioliasis diagnosis, treatment, surveillance and management was given to health workers, agricultural staff, local authorities and schoolteachers. A total of 33 participants attended the training course, known as "Capacity building and health education on fascioliasis control", with the training curriculum covering all aspects of fascioliasis control and management (Appendix 5.2). In addition, the participants were trained in techniques of health education and promotion such as group communication, household visits, informal communication at other events, and strategies to incorporate health communication in other communal health meetings.

After the training course, the village health volunteers and communal health staff were involved in fascioliasis suspected case detection and management. From June to November 2013, 37 people with suspected symptoms of fascioliasis were referred to district and provincial hospitals for case confirmation.

To support the capacity building of village health volunteers, monitoring and evaluation trips were conducted on a monthly basis to the villages to observe their fascioliasis control activities. During the six months following June 2013, there were 48 monitoring and evaluation trips implemented by multidisciplinary teams to monitor community involvement in health protection, environmental cleaning and fascioliasis control. The teams comprised the communal people's committee official, communal health head, school headmaster, veterinary staff and a social organization member. Feedback on the fascioliasis control activities was communicated back to the village health volunteers for improvement, either at the end of the trips or at the monthly meetings held by the vice-chairman of the communal people's committee. This intervention component was incorporated with the health education campaign and will be further detailed in the following section.

5.2.3 Health education for raising the awareness of fascioliasis control in the community

A variety of health education activities were conducted at the Intervention 1 commune, as shown in Table 5.3. Health communication activities were conducted separately in school and community locations.

At the communal Secondary School, the “message about fascioliasis control”, which contained information on the causes of, damage caused by and control measures for fascioliasis, was regularly read by the headmaster of the school at the Monday flag salute. In addition, the homeroom teachers also updated the students’ awareness during the common weekend class periods on Saturday. Students were also trained to avoid potential risks of fascioliasis by being given reminders such as “do not eat raw vegetables”, or “do not drink freshwater from rivers or canals”, “drink boiled water”, and “wash hands before meals or after toileting”. Approximately 1,000 students received leaflets on fascioliasis control (Appendix 5.3) to read and memorise the content, and they were then encouraged to conduct health education at their homes. The leaflets were to be hung at easily-seen locations in the house, where everyone could read and practice the fascioliasis control measures. Moreover, the motto “Fascioliasis is the responsibility of the school, family and the whole community” was hung in front of the schools in the commune to raise the awareness of fascioliasis control among teachers and students. Another school activity related to fascioliasis control was the collection of cattle dung on village roads. The students collected and dried the dung in the sun, and then sold about 286 kilograms of dung to buyers from coffee and rubber plantations, with the generated revenues contributing to funds for the classes.

Health education activities were conducted to encourage community participation in fascioliasis control. From the commencement of the health education campaigns in the community, there were 3,328 weekly household visits by village health volunteers to conduct health education for about 9,984 participants. In addition, community meetings were conducted monthly at 8 villages by teams of representatives from the communal local authorities, health, veterinary, educational, and social organizations (Table 5.3). Billboards depicting the problems of fascioliasis and appropriate control measures were erected in front of the communal health station, village administration offices and markets to draw the attention of the community. The main community-directed messages included: hygienic eating habits and sanitation, proper food handling, better veterinary public health practices such as proper grazing management, dung treatment, improved nutrition for their cattle, and de-worming of their cattle for fascioliasis control; which were also broadcast to improve the awareness of the community. Every week, information about fascioliasis control was read twice (at 8.00 am and 6.00 pm on Mondays and Saturdays) for 15 minutes on the broadcasting systems installed in every village. These simple health education approaches such as direct household communication, community discussion, and delivery of leaflets on fascioliasis control were implemented to gain more attention from the community (Table 5.3).

Table 5.3 Health education activities conducted at the Intervention 1 commune

Health education activity	**Number / month**	**Number of months**	**Total**	**Participants**
School - Reading of fascioliasis control message	4	8	32	900
School - Updated information of fascioliasis control	4	8	32	900
School - Mottos on fascioliasis control at schools			4	
School - Dung collection by students (kg)			286	
Community -Household visits	416	8	3,328	9,984
Community - Community meetings	8	8	64	2,560
Community - Broadcasting fascioliasis control message	16	8	128	9,600
Community - Panels of fascioliasis control			11	

5.2.4 Involvement of other sectors to empower the capacities of health care sector in fascioliasis control

Multidisciplinary collaborations among the health, agricultural and educational sectors, under the overall leadership of the local authority, were implemented to empower the capacity of the broader local health network. The aim of this collaborative approach was to increase awareness of the stakeholders, as well as the affected populations, of the disease burden.

An official notice dated 31 May, 2013 was issued by the local Communal People's Committee outlining the multidisciplinary collaboration and the goal to strengthen the shared responsibilities and activities among the local authorities, health, educational, agricultural and social organizations for fascioliasis control in the community. This notice was followed by a variety of co-ordinated activities.

Human and veterinary public health intervention measures were conducted by the health and agricultural sectors, including the health education campaigns, household visits and community meetings (Table 5.3), as described in the previous sections. Animal fascioliasis control activities were also explained by veterinary staff during the two sessions of animal chemotherapy, as previously described. Eight health education campaigns were conducted on a monthly basis in co-ordination with other sectors. During each campaign key messages on animal fascioliasis control were communicated, such as the need for periodic de-worming of animals, the proper treatment of cattle waste both in the shelters and outdoors, appropriate grazing practices, and improved animal nutrition for disease prevention. Details of the resultant changed behaviours and practices in animal fascioliasis control, together with the barriers to this implementation measure, are described in the discussion section 5.3, and in Chapters 6 and 7.

Mutual commitments between the health and education sectors facilitated stronger involvement of the school-teachers and students in the fascioliasis control activities. During monthly fascioliasis control campaigns launched jointly by the health and education sectors, the students were encouraged to participate in environmental cleaning activities such as collecting animal waste and garbage (Table 5.3), cleaning streams and canals, or releasing fish into water sources for killing snails. As described in the previous section, the fascioliasis control message was read weekly at the Monday morning flag salutes by the school headmasters, with the participation of the communal health official, who also provided more insights into personal protection measures against fascioliasis infection. Increasingly students also undertook their health education role at home, explaining the causes of, problems caused by, and control measures for fascioliasis to their family members using leaflets provided from communal health stations. School representatives participated in the monthly program review meetings, which discussed activities of fascioliasis management, including feedback on the health sector's fascioliasis control activities (Appendix 5.3).

Intersectoral efforts also included the participation of the local authority and other related bodies such as the social-cultural sector and social organizations. The engagement of the communal people's committee representatives with their important 'gate-keeping' roles facilitated, and increased, public awareness of fascioliasis. Monthly health education meetings on fascioliasis control were held at the communal people's committee and were presided over by the communal vice-chairman; and community meetings at village administrative offices were also directed by the communal representatives (Table 5.3). In addition, members of the communal and village women's associations participated in the fascioliasis education program, alongside undertaking their other responsibilities for maternal health promotion and family planning. This strategy aimed to increase women's awareness of fascioliasis and promote the practises of safe vegetable treatment and food preparation to avoid fascioliasis infection. Finally, as described in the previous section, the delivery of information related to fascioliasis control was performed four times a week (twice on Mondays and Saturdays) by the cultural-information sector via the communal broadcasting system, to increase community awareness of fascioliasis and to help them change their attitudes and practices concerning fascioliasis (Table 5.3).

5.2.5 Vector control

In this section, the combined grazing, feeding and environmental management activities which served as the vector and reservoir control measures contributing to reducing the risks of animal fascioliasis infection are described. The implementation of vector control was incorporated in public and veterinary health education campaigns at the Intervention 1 commune.

The survival of *Fasciola* larvae and snails is dependent on humidity and temperature. They are easily killed by high temperatures, low humidity and intensive exposure to direct sunlight (Maha, 2008; Mas-Coma *et al*., 2009a). The animal health education campaigns conducted monthly by the veterinary sector encouraged the farmers to dry out their rice fields for at least two weeks after harvest. This action would confine the metacercariae to the rice stubbles and hence reduce the risks of transmitting infections to animals.

In addition, as most cattle raising households in Central Vietnam practiced free grazing husbandry, animal health education was implemented monthly by veterinary staff to encourage farmers to practise zero-grazing, which provided a steady and important source of income to the smallholders, increased milk productivity, and avoided diseases from the outside environment. Farmers were told how to provide good nutrition to their cattle, and to regularly clean animal shelters to minimise the effects of lameness and leg injury that can result from increased shelter-based husbandry. Farmers were also encouraged to construct sanitary drenches close to cattle shelters to store and decompose the dung and waste from animals, in order to prevent the transmission of metacercariae to proximal areas.

Relying on optimal temperature control conditions is an inexpensive fascioliasis management activity in Central Vietnam where dung is used as fertilizer. Instead of drying dung in mounds as previously practised, the farmers were encouraged to flatten the dung in order to absorb more sunlight to kill the parasite's eggs. In addition, the easy, environmentally friendly and cost-effective practice of mixing stored dung with carbohydrate to increase the heat of the mixture through fermentation, so as to destroy all the eggs in dung heaps, was promoted to the farmers in the Intervention 1 commune. Discussions with household representatives and veterinary officials about the relevance and uptake of this practice are explored in Chapter 7.

Above all, regular de-worming of cattle would be the best of the animal husbandry solutions for controlling fascioliasis. As described in the previous section, a majority of cattle raising households conducted de-worming for their cattle twice a year, before and after the rainy season, under the guidance and surveillance of the veterinary staff. During the intervention period, about 650/1,621 (or 40.1% of) cattle in 210/534 cattle-raising households (or 39.3%) in the Intervention 1 commune, and 469/1,398 (or 33.5%

of) cattle in 189/561 (33.7% of) households in Intervention 2 commune were de-wormed with anthelmintic drugs (Appendix 5.1). However, a severe typhoon and heavy flooding in late 2013 caused major cattle losses, making it difficult to evaluate the outcomes of this veterinary fascioliasis control measure.

5.3 Discussion

Overall, the components of the model were implemented as designed. The Intervention 1 commune received all the components of the intervention model with some modifications; the Intervention 2 commune received the chemotherapy for human and animal de-worming activities only; and only case treatment of human fascioliasis was applied to the Control commune. This section will reflect on how each of the components in the broadly-based control model for fascioliasis was implemented, with reference to previous studies conducted in Central Vietnam and other countries.

5.3.1 Chemotherapy/chemoprevention

This field-based study applied both human chemotherapy for infected cases in three studied cohorts and animal de-worming measures in two intervention communes (Table 3.1). For human fascioliasis treatment (administered to 125 or 100% of seropositive participants following the baseline blood survey - Chapter 4; and 80 or 100% of those with positive results in the follow-up blood survey, Chapter 6), the single dose of 10mg/kg body weight triclabendazole was recommended as the first line medication for the disease (MOH, 2006; WHO, 2007b). Also as recommended by the MOH (2006), the efficacy of the medication should be evaluated after 6 months and one year each for follow-ups. This aspect of the effectiveness of the human chemotherapy will be discussed in the following chapters. Alternative medical agents were nominated, such as bithionol, nitazoxanide, and artesunate; however, it was reported that the parasites had developed resistance to them and they were still undergoing clinical experiments (Favennec, Jave Ortiz, Gargala, Lopez Chegne, Ayoub and Rossignol, 2003; Hien, Truong, Minh, Dat, Dung, Hue, Dung, Tuan, Campbell, Farrar and Day, 2008).

Follow-up of the infected participants after the treatment found only mild side-effects on D0 and D1, and the disappearance of these symptoms for D7. This result is similar to previous studies conducted in Central Vietnam (Huynh *et al*., 2007; Nguyen *et al*.,

2007) which found the mild side-effects had disappeared for D7 following the drug administration. However the previous studies were conducted in hospital settings, where the availability of facilities for follow-up is good. The adverse events suggested by the WHO (2007b) in field-based studies, as a result of difficult conditions or any other unknown reasons (Nguyen *et al*., 2011; Nguyen, 2012; Nguyen, 2012), were not observed in this study.

In this study, the application of chemical de-worming for animals was an important measure to prevent the transmission in both human and animals, and a core element of the control model. The one-health control measure has been suggested elsewhere (Nguyen *et al*., 2011), but no studies have yet been reported in Central Vietnam, or as a collaborative effort of both the health and veterinary sectors (Nguyen *et al*., 2010; Nguyen *et al*., 2011). As the financial funds of this study were limited, the cattle de-worming coverage only achieved less than 40.0% coverage of the total cattle in the two intervention communes; and 33.7% of the cattle-raising households and 33.5% of the cattle in Intervention 2 commune. Cattle de-worming was implemented in August 2013, ahead of the rainy season in Central Vietnam. Repeat de-worming activities undertaken after the rainy season in January 2014, were part of the regular activities conducted by the veterinary sector, with the payment made by farmers. However these activities were significantly disrupted by the severe typhoon and heavy flooding in late 2013 which swept away a considerable number of cattle, making it not possible to evaluate the veterinary fascioliasis control measures. Details of the obstacles to this intervention component will be discussed in Chapter 7.

While chemotherapy was core to fascioliasis control, by itself it could not achieve successful outcomes. Integration with other intervention measures, such as health education, improvement of fascioliasis management, the involvement of concerned bodies, and vector control, is essential for an effective broadly-based control model for fascioliasis in Central Vietnam.

5.3.2 Health education

Health education activities in the Intervention 1 commune included a number of approaches and were assisted by the participation of previously-trained staff involved in health, educational, agricultural, socio-cultural, and other social organisations and local authorities. Direct health education during household visits was mostly undertaken as an effective measure to gain attention from the community; this has been reported in previous studies (Nguyen *et al*., 2008; Nguyen *et al*., 2011; Nguyen, 2012). Also, indirect health education, which incorporated other related sectors and made use of delivered leaflets, communal broadcasting systems, and construction of panels and mottos on fascioliasis control, provided easy-to-read and understandable communication messages on fascioliasis control, aimed to result in positive changes in community awareness and practices against the disease. The effectiveness of all of these health education measures will be discussed in chapter 6.

Overall, the combined direct and indirect health education measures provided the best opportunities for gradually increasing community awareness of the disease utilising the various local resources available. Nevertheless, the participation of staff and local officials involved in the health education campaigns relied on their acceptance and availability. These issues will be further discussed in the following section and explored in detail by the qualitative study in Chapter 7.

Previous studies conducted in Central Vietnam also utilised health education strategies in fascioliasis control (Dang *et al*., 2011; Nguyen, 2011, 2012). However, all of the strategies in these studies were conducted just by the health sector, without the involvement of other sectors. In addition, no evaluations on the involvement of stakeholders and the community in previous programs have been conducted, in terms of their acceptance of and participation in the health education campaigns. This study attempted to involve the engagement of the related sectors in fascioliasis control strategies including health education campaigns, and their involvement will be further explored in the qualitative study (Chapter 7).

5.3.3 Improvement of disease surveillance, management and evaluation

As discussed in the literature (Chapter 2), the emergence of fascioliasis in Central Vietnam as a public health concern cannot be determined, as the data may have come either from the increasing recording of case numbers through improved laboratory diagnostics and reporting, or were generated from health facilities with limited capacities such as provincial general hospitals (Hien *et al*., 2001; Carrique-Mas and Bryant, 2013). To date the only attempt to counter the increasing prevalence of fascioliasis in Vietnam, promulgated in the issued guidelines on diagnosis and treatment of human fascioliasis in Vietnam (MOH, 2006), has been passive case detection and was focused on clinical case management, not on prevention and control (WHO, 2006a).

Communal health staff and village health volunteers in the Intervention 1 commune were trained in the guidelines of case detection, referral to highly-advanced laboratory-based health facilities for fascioliasis case confirmation, and the effective management of confirmed cases. As a result, prompt treatment of the disease was possible following timely referrals of suspected cases to advanced laboratory facilities for fascioliasis diagnosis, such as the provincial general hospital or an IMPE-QN clinic. In addition, the confirmed cases were sent reminders of the next hospital visits three months after treatment of the disease. This could be considered the best management practice concerning fascioliasis as there had been no similar management system for fascioliasis applied to Vietnam (MOH, 2006).

Prior attempts to improve the quality of diagnosis, treatment, and management of fascioliasis in Vietnam faced various difficulties. The facilities for laboratory-based diagnosis of fascioliasis were available only at provincial and district health levels, and were operated by experienced staff (WHO, 2006a), which could not be accessed at peripheral health levels. As a result of this centralised system, high hospitalization costs were imposed on patients, creating inequality in access to health care (MOH, 2006). In addition, the existing policies promulgated passive-case detection at the grass-roots health levels on the basis of clinical symptoms, which were often misdiagnosed with other liver-related diseases (WHO, 2006a). The results of this study support the importance of increasing the capacity of grass-roots health staff in fascioliasis detection and management to facilitate access to specialist health facilities. Discussions of the capacity of local health care, together with other challenges in fascioliasis management will be described in Chapter 7.

5.3.4 Involvement of a range of sectors

In this study, the involvement of other sectors in the campaigns launched by the health sector and under the leadership of the local authority proved their readiness to adopt and participate in this fascioliasis control program. The two key elements that facilitated the successful implementation of the program were the co-ordination between health and other related sectors such as educational, agricultural, and social organisations, and the "gate-keeping" role of the local authority. The engagement of the local authority provided effective administrative support to involve other related sectors and the community in fascioliasis control activities. In addition, the other sectors became actively engaged in the health activities, such as health education in schools and in the community, communal meetings, and monitoring and evaluation activities, which would not have been possible if conducted only by the health sector.

The utilization of a multisectoral approach in communication strategies has been demonstrated previously to increase community awareness (Kinzie, 2005; Albonico *et al*., 2006; Maha, 2008); and long-term interventions utilising existing resources (the range of community-level organisations) may gradually help to change health behaviours (Newson *et al*., 2013). However, prior studies in Vietnam have identified that the levels of participation were influenced by various factors such as the availability of the staff in charge, the turnover of staff previously involved in health campaigns, and the commitment of long-term involvement in health protection activities by local authorities, health staff and other association bodies and individuals (Kay and Vu, 2005; Tran, Peter, Brian and Tran, 2009). In addition, prior health campaigns for fascioliasis control had been limited to either the combined health and education sectors, or health and social organisations such as women's associations (Nguyen *et al*., 2008; Nguyen *et al*., 2011). Moreover, capacity building training courses on information, education and communication had been conducted only for health staff and had omitted acknowledgement of the roles and active participation of local authority officials, school teachers, veterinary staff, and members of social organizations as important human resources for fascioliasis control campaigns (Nguyen, 2010; Nguyen *et al*., 2011). Importantly, as with other zoonoses, or disease transmissions between humans and animals, fascioliasis is only one of the many objects of interest of the "One Health" concept, requiring close co-ordination between human and veterinary public health agencies (WHO, 2002a). The 'One Health" concept advocates shared policies which aim at preventing and controlling pathogens within animal populations, at the interface between humans, animals and the environment (IOE, 2013). Therefore, effective control measures for fascioliasis and other zoonosis diseases could only be achieved from intersectoral collaboration, jointly planned activities among concerned bodies, and the advocacy of cost-effective transactional options for control in low-income countries (Zinsstag, 2008).

The contribution of the inter-sectoral approach to the achievement of effective fascioliasis control will be considered in Chapters 6 and 7.

5.3.5 Vector control

A number of inexpensive and environmentally friendly vector control measures for fascioliasis control were included in this intervention. These measures included evasive grazing husbandry, safer environmental sanitation, improved cattle waste treatment and regular animal de-worming activities. The current study indicated that farmers in the Intervention 1 commune did practise the movement of cattle between different pastures to provide safe grazing for the animals. In addition, the avoidance of releasing cattle on rice fields immediately after the harvest, and grazing only the upper two-thirds of the rice stubbles to guard against infective larvae (Suhardono *et al*., 2006c), was gradually accepted and practised by farmers. Moreover, rather than releasing cattle waste into the environment, the practice of mixing cattle dung with rice stubbles or drying the flattened dung in the sun became a common practice in most of the cattle-raising households, which was reported to have positive larvicidal effects (Suhardono *et al*., 2006a). Finally, regular de-worming and the improved nutrition of cattle under the strict guidelines of the veterinary staff was employed to prevent the resistance of animal fascioliasis to drugs, which was beginning to occur as a result of the compulsory and excessive use of chemoprevention (Iqbal, Sajid, Hussain and Khan, 2007; Agnamey *et al*., 2012). All of these vector control measures were perceived as inexpensive and effective, which will be further discussed in the next chapter.

However, the implementation of the vector control measures faced several challenges. The grazing management strategies would be effective if practiced over the long term, but they remain dependent on the weather conditions. Although Central Vietnam has on average sunny days for 75% of the year (FAO, 2011), farmers reported difficulties grazing their cattle during the rainy season, which resulted in grazing their cattle in the unsafe pastures inhabited by infective larvae and lymnaeid snails. Also, the dung could not be dried on rainy days, and if dung was spread out to dry the metacercariae would be swept into the water and facilitate larval development. The heavy flooding at the end of 2013 not only caused losses in the number of cattle, but also may have facilitated larval development in submerged areas. This could create obstacles to the achievement of fascioliasis control outcomes.

5.4 Conclusion

This chapter reported the implementation of the broadly-based control model of fascioliasis in Central Vietnam. The implementation of the five-component model was found to be effective and complete, demonstrating it was appropriately adaptive to the socio-economic and environmental settings of this rural area of Vietnam. The results of the model will be described in chapter 6 and the levels of success of the model will be discussed in chapter 7. Most importantly, if found to be effective, the combination of these intervention measures could translate into the long-term achievement of decreased fascioliasis prevalence and also inform initiatives in other regions of the country.

6. STUDY RESULTS: PREVALENCE AND RISKS OF FASCIOLIASIS INFECTION IN ADULT COHORTS AFTER INPLEMENTATION OF THE BROADLY-BASED CONTROL MODEL IN TWO CENTRAL PROVINCES OF VIETNAM

6.1 Introduction

The preceding chapter described the implementation of the broadly-based control model of fascioliasis in Central Vietnam [the model includes chemotherapy, vector control, health education, surveillance and management, evaluation, and the involvement of concerned bodies such as educational, agricultural and other organizations]. It also revealed that all the components of the model were implemented as designed, although certain variations and challenges unexpectedly occurred.

This chapter reports on the results of the model implementation, with comparisons being made between the communes, with the entire broadly-based control model applied to the Intervention 1 commune, a model for the treatment of humans and cattle alone to the Intervention 2 commune, and the treatment of humans only at the Control commune. In addition, the results of this follow-up stage were compared to the baseline.

The prevalence of fascioliasis is described at the beginning of the chapter, covering the overall infection rates in the three communes as well as exploring the prevalence of the infection by ethnographic characteristics of participants. Also, the changes in prevalence are presented by comparing the rates with the baseline study and among each of the communes. The knowledge, attitudes and practices of the studied participants in the three cohorts are then described, with perceptions of risks being compared among these cohorts and with previous views on fascioliasis. The observational records are also presented and compared with the baseline. The snail surveys data reports on the prevalence of the intermediate hosts of fascioliasis transmission following the implementation of the intervention measures. The effectiveness of the broadly-based fascioliasis control model is then discussed, based on these quantitative indicators. The effectiveness of the control model is explored further in the following chapter (Chapter 7), based on the data from the qualitative study components, which explored the community-based, stakeholder and environmental factors that facilitated or impeded the success of the program's implementation.

6.2 Data collection

The methods of data collection, research procedures and data analyses for the post-intervention phase were similar to those of the baseline data collection stage described in detail in Chapters 3 and 4. Importantly, the studied participants were again randomly selected within the communes to increase the validity of the study in terms of comparisons of prevalence and perceptions of fascioliasis risks of the cohorts under study.

Similar to the baseline data collection, the mixed quantitative inquiry included:

a) a cross-sectional study on the ELISA (Enzyme-linked Immunosorbent Assay) blood survey to determine the baseline prevalence of fascioliasis (liver fluke) among three adult cohorts living in communes 1 and 3 (Binh Dinh province) and Intervention 2 commune (Quang Ngai province) of Central Vietnam,

b) a cross-sectional survey on knowledge, attitudes and practices (KAP),

c) household observations to describe the risk factors associated with fascioliasis transmission among the cohorts, and

d) snail surveys to identify the prevalence of the intermediate hosts of fascioliasis infection in the study locations.

6.3 Sampling and characteristics of cohorts

Sampling procedures for the post-intervention data collection were similar to those of the baseline surveys (Chapter 4) and as described in detail in Chapter 3. The sample size determination for the blood survey was based on the formula by Lemeshow *et al*. (1990) (Appendix 3.1) with the known referential infection rate conducted previously in the neighbouring province of Khanh Hoa (Nguyen and Le, 2007). The sample size for the cross-sectional KAP survey was calculated using the formula for estimating the difference between two population proportions with specified absolute precision (two-sample situation) (Chadha, 2006, pp. 60), with the

Bonferroni adjustment applied to allow multiple comparisons while achieving the overall confidence coefficient (Bland and Altman, 1995).

6.4 Results

6.4.1 Prevalence of fascioliasis in the studied cohorts after intervention – compared with the baseline level.

This section presents the findings of ELISA blood surveys in three communes after the implementation of the broadly-based control model of fascioliasis in the Intervention 1 commune, a model for treatment of humans and cattle only (Intervention 2 commune) and for treatment of humans only (the Control commune) (as detailed in Chapter 3). The seroprevalence is then compared between the three cohorts under study, and with the previous surveys to assess the outcomes of the intervention. Also, as the selection of participants was undertaken randomly, fascioliasis seroprevalence is compared based on ethnographic characteristics of the participants.

As described in the sampling section in chapter 3, the total population for the survey in each commune was 428 people, plus an additional 20% or 85 people in case of sample losses or participant inaccessibility (Appendix 3). As a result, 1,500 adults (500 in each commune) were involved in the ELISA blood surveys (Table 6.1). The infection rates in the three cohorts were 4.2% in the Intervention 1 commune (broadly-based model), 5.4% in the Intervention 2 commune (model comprising human chemotherapy and animal chemoprevention) and 6.4% in the Control commune (Control commune, human chemotherapy only). In comparison with the baseline surveys, a significant difference ($p<0.05$) in infection prevalence was found in the Intervention 1 commune, which received the broadly-based control model for fascioliasis (Figure 2.4), while the differences were not significant in the two other communes ($p>0.05$).

Similar to the baseline surveys, more females than males attended the follow-up blood tests, but the infection rates were not significantly different between the two genders in the three cohorts. However, compared with the baseline surveys, significant reductions ($p<0.05$) were reported in women of the Intervention 1 commune and men from the Intervention 2 commune, the two communes applying more intervention measures in comparison with the Control commune. No significant difference based on gender ($p>0.05$) was found among the combined three cohorts post intervention compared with baseline.

Differences in fascioliasis seroprevalence were also found with regard to certain age ranges. A significantly decreased ($p<0.05$) prevalence of infection was displayed in participants aged from 40-49 years in the two Intervention communes, and from 50-59 years in the Intervention 1 commune. Non-significant increases in infection were found among participants aged from 18-29 years.

With regard to educational levels, the only significant change in infection rates was found in the Intervention 1 commune, where the number of infected people with lower educational backgrounds was reduced by more than half ($p<0.05$). No significant differences were found in the prevalence among the groups with higher educational backgrounds, or in the overall prevalence by educational background in each of compared communes

Compared with the baseline survey, the follow-up prevalence of fascioliasis was significantly reduced by more than half ($p<0.05$) in Intervention 1 farmers, while no significant differences for farmers infected with the disease were found in the other two communes ($p>0.05$). Farmers remained the group with the highest proportion of fascioliasis infection cases, but no significant differences ($p>0.05$) were found in comparison with other occupational groups.

Table 6.1 Changed seroprevalence of fascioliasis in three studied cohorts after the implementation of intervention measures

Characteristics	Intervention 1 commune			Intervention 2 commune			Control commune		
	Baseline	Follow-up	p	Baseline	Follow-up	p	Baseline	Follow-up	p
	Number/total (%)	Number/total (%)		Number/total (%)	Number/total (%)		Number/total (%)	Number/total (%)	
Infected cases	47/535 (8.8)	21/500 (4.2)	<0.05	44/522 (8.4)	27/500 (5.4)	NS	34/555 (6.1)	32/500 (6.4)	NS
Gender									
Males	15/180 (8.3)	7/169 (4.1)	NS	21/216 (9.7)	7/168 (4.2)	<0.05	16/221 (7.2)	15/209 (7.2)	NS
Females	32/357 (9.0)	14/331 (4.2)	<0.05	23/306 (7.5)	20/332 (6.0)	NS	18/334 (5.4)	17/291 (5.8)	NS
Age (mean±SD)	(47.7±12.1)	(45.4±10.9)		(44.8±12.5)	(43.7±11.4)		(46.2±13.2)	(45.2±12.7)	
18-29 years	0/39	2/48 (4.2)		2/65 (3.1)	3/59 (5.1)	NS	3/62 (4.8)	6/63 (9.5)	NS
30-39 years	12/98 (12.2)	7/97 (7.2)	NS	10/118 (8.5)	7/112 (6.3)	NS	9/113 (8.0)	8/100 (8.0)	NS
40-49 years	13/152 (8.6)	4/159 (2.5)	<0.05	20/120 (16.7)	8/172 (4.7)	<0.05	9/141 (6.4)	7/147 (4.8)	NS
50-59 years	18/148 (12.2)	8/147 (5.4)	<0.05	9/157 (5.7)	7/114 (6.1)	NS	11/145 (7.6)	8/120 (6.7)	NS
60+ years	4/94 (4.1)	0/49		3/62 (6.8)	2/43 (4.7)	NS	2/94 (2.1)	3/70 (4.3)	NS
Education level									
Secondary & under	42/417 (10.1)	17/407 (4.2)	<0.05	34/365 (9.4)	20/366 (5.5)	NS	25/402 (6.2)	24/375 (6.4)	NS
High school & above	5/118 (4.2)	4/93 (4.3)	NS	10/157 (6.4)	7/134 (5.2)	NS	9/153 (5.9)	8/125 (6.4)	NS
Occupation									
Farmers	34/342 (9.9)	18/430 (4.2)	<0.05	31/313 (9.9)	24/400 (6.0)	NS	20/300 (6.7)	24/353 (6.8)	NS
Others	13/193 (6.7)	3/70 (4.3)	NS	13/209 (6.2)	4/100 (4.0)	NS	14/255 (5.5)	8/147 (5.4)	NS

6.4.2 Effectiveness of chemotherapy on seropositive cases of fascioliasis

This section presents the treatment outcomes of the seropositive cases of fascioliasis, detected by the ELISA from the baseline and follow-up surveys. The eosinophilic changes are also described as an affiliated parameter of fascioliasis. Overall, the serological ELISA results showed a reduction over the 12 months of follow-ups, which correlated with the decreased eosinophilia in the seropositive participants of fascioliasis (Table 6.2).

The treatment course and side-effect monitoring procedures in the follow-up surveys were conducted in the same procedural manner as in the implementation following the baseline survey (Chapter 5), and the corresponding side-effects follow-up is presented in Appendix 6.1.

In the baseline blood survey, the serological ELISA results following the treatment with triclabendazole (at 10mg/kg of body weight) were significantly reduced after six months and twelve months among seropositive participants in all three communes. Similarly, the follow-up surveys indicated the same results as significant reductions were shown in the ELISA antibodies of the treated seropositive participants after 6 months and after one year from the start of the chemotherapy (Table 6.2). The significantly reduced ELISA antibodies also correlated with decreased eosinophilia among the seropositive participants receiving the treatment of the medication, which were also significantly different after one year following the chemotherapy with triclabendazole (Table 6.2). All of the seropositive participants were diagnosed as negative, which demonstrated the efficacy of the currently-used medication for fascioliasis treatment. This will be detailed further in the discussion section.

Table 6.2 Clinical manifestations and eosinophilic fluctuation in seropositive participants following the treatment courses (baseline and follow-up surveys)

Characteristics	Baseline survey (n=125)			Follow-up survey (n=80)		
	Before treatment	After 6 months	After one year	Before treatment	After 6 months	After one year
Ab-ELISA (+)	125 (100%)	9 (-92.8%)	0 (-100%)	80	13 (-85.0%)	0 (-100%)
Mean (SD)	1.1(0.1)	0.59 (0.26)	0.22(0.12)	1.14 (0.14)	0.72 (0.22)	0.36 (0.11)
Min-Max	1.0-1.53	0.28-1.69	0.04-0.61	1.0-1.55	0.33-1.38	0.20-0.81
SE Mean	0.01	0.02	0.01	0.02	0.03	0.01
t-test, p[15]		t: 25.6, p <0.001	t: 19.6, p<0.001		t: 29.2, p<0.001	t: 29.1, p<0.001
Eosinophilia (≥8.0%)	70 (56.0%)	17 (13.6%)	0	52 (65.0)	17 (21.25%)	0
Mean (SD)	8.19 (3.33)	3.84 (2.52)	2.64 (1.54)	9.33 (3.96)	6.03 (2.51)	3.35 (1.66)
Min-max	2.0-22.0	1.0-12.0	1.0-7.0	2.0-14.0	1.0-9.0	1.0-6.0
SE Mean	0.37	0.28	0.17	0.44	0.28	0.19
t-test, p[15]		t: 13.6, p <0.001	t: 15.4, p<0.001		t: 21.5, p <0.001	t:18.0, p<0.001

[15] t-test, p for trends: after 6 months and one year following treatment

6.4.3 Changed perception of fascioliasis among the three cohorts under study after intervention

The surveys of knowledge, attitudes and practices (KAP) were implemented to explore the participants' perceptions of the risks associated with fascioliasis in three cohorts, with outcomes compared among the cohorts, and with the baseline surveys. The objective of the comparisons was to evaluate the changes in perceptions of risks associated with fascioliasis and in the practices employed against the disease after the intervention measures.

A total of 1,800 adults (600 household representatives in each commune) were randomly selected for the survey of knowledge, attitudes and practices (KAP) regarding fascioliasis. The same 40-question interview survey as at baseline was applied face-to-face with the selected participants to explore their understandings of fascioliasis. The sampling procedures of the surveys were previously described in chapter 4, with the manual Bonferroni adjustment (Appendix 3.2, Formula 2) applied to identify the sample sizes for multiple comparisons. Accordingly, in the KAP surveys, statistical testing with p-values less than 0.017 was considered significant.

Following the implementation of the intervention measures applied differently in the three cohorts, significant increases ($p<0.01$) in the overall knowledge were indicated in Intervention 1 commune and Intervention 2 commune, compared with the baseline level; whereas no significant difference ($p>0.017$) was found for the Control commune (Table 6.3). Across the communes, the proportions of participants from Intervention 2 commune and the Control commune being aware of fascioliasis increased compared with the baseline level, but they still scored less than 50.0% and were significantly lower compared with those in the main Intervention 1 commune ($p<0.01$).

In addition, participants in Intervention 1 commune showed extensive understanding of fascioliasis transmission routes ($p<0.01$). In the other two communes participants demonstrated slight changes ($p>0.017$) in their knowledge of how fascioliasis was transmitted, except for the significant improvement of Intervention 2 commune participants' awareness in identifying unwashed vegetable consumption as a cause of fascioliasis infection ($p<0.01$) (Table 6.3). Similar findings were also made in the changed knowledge of the three cohorts, with significant improvement in knowledge of the participants of Intervention 1 commune who correctly described the signs and symptoms of fascioliasis, and affirmed that the disease was controllable and curable ($p<0.01$). No significant increases were found in the responses to the same questions of the cohorts in the two other communes ($p>0.017$).

In summary, significant differences ($p<0.01$) were clearly indicated among the participants from Intervention 1 commune compared with those of the two other communes regarding their knowledge of the causes of fascioliasis, its signs and symptoms, and whether it was controllable and curable. In addition, higher proportions of participants from the Intervention 2 commune compared with the Control commune showed their adequate knowledge that there were fascioliasis risks from eating raw cattle meat, and believed the disease was controllable; and these differences were significant ($p<0.017$) (Table 6.3).

6.4.4 Reported changes in practice of the studied cohorts against fascioliasis, compared with the baseline surveys

The changes in practice of the participants following the implementation of the intervention measures against fascioliasis are presented in Table 6.4. Considerable changes were found in the Intervention 1 commune, with all poor practice items reduced significantly in comparison with the baseline level ($p<0.017$). In the other two cohorts, the only changed behaviour was a reduction in the number of participants reporting that they drank improperly boiled water ($p<0.017$).

6.4.5 Reported practices of cattle raising households in relation to risks of fascioliasis infection

The husbandry activities explored in the study include grazing practices, animal waste treatment and frequencies of de-worming cattle. The results are presented in Table 6.5. In comparison with the baseline level, better grazing practices were found in the Intervention 1 commune and the Control commune, with significant reductions in free-grazing practice reported among the participants ($p<0.017$), whereas no significant difference was indicated in the Intervention 2 commune. However, a higher proportion of cattle raisers in the Intervention 2 commune as compared with those in the Control commune, reported practising shelter-based grazing for their cattle as a fascioliasis control measure (p<0.017, data not shown).

Appropriate composting of animal waste as manure for future use was properly practiced in the Intervention 1 commune, which was significantly higher in comparison with the baseline survey and with the other two communes (p<0.017). This practice was not conducted adequately in the Intervention 2 commune or the Control commune, resulting in small proportional changes (42.8% vs. 40.9% in Intervention 2 commune and 56.9% vs. 62.5% in the Control commune, respectively) and no significant differences compared with the previous surveys (p>0.017, data not presented).

In comparison with the baseline surveys, greater numbers of cattle were reported as being de-wormed in the follow-up stage in the three communes. In the Intervention 1 commune, a significantly higher proportion of cattle were de-wormed twice a year, resulting in fewer cattle being treated only once a year (p<0.017). In the intervention 2 and Control communes, increased proportions of cattle were de-wormed more regularly, but the differences were not at significant levels (p>0.017) in comparison with the baseline surveys.

Table 6.3 Description of cohorts' knowledge of fascioliasis after intervention measures, compared with baseline level

Item	Intervention 1 commune[a]			Intervention 2 commune[b]			Control commune[c]		
	Baseline	Follow-up	p	Baseline	Follow-up	p	Baseline	Follow-up	p
	number (%)	number (%)		number (%)	number (%)		number (%)	number (%)	
Know about fascioliasis[16]	N=600 276 (46.0)	N=600 481 (80.2)	<0.017	N=600 148 (24.6)	N=600 225 (37.5)	<0.017	N=600 224 (37.3)	N=600 219 (36.5)	NS
Know transmission routes	N=276	N=481		N=148	N=225		N=224	N=219	
Eat unwashed veggies	173 (62.7)	410 (85.3)	<0.017	91 (61.5)	173 (79.1)	<0.017	141 (62.9)	143 (65.3)	NS
Drink impure water	165 (59.8)	421 (87.5)	<0.017	95 (64.2)	152 (67.5)	NS	129 (57.6)	126 (57.5)	NS
Know signs & symptoms	121 (43.8)	424 (88.1)	<0.017	56 (37.8)	111 (49.3)	NS	102 (45.5)	105 (48.1)	NS
Know it is controllable[17]	144 (52.2)	404 (84.1)	<0.017	81 (54.7)	144 (64.1)	NS	111 (49.6)	97 (44.1)	NS
Know it is curable	145 (52.5)	402 (83.6)	<0.017	59 (40.0)	115 (51.1)	NS	97 (43.3)	117 (53.4)	NS

[16]Significant differences found all compared follow-up values between a and b (p<0.017); and a and c (p<0.017)

[17] Significant difference in compared follow-up value between b and c (p<0.017)

Table 6.4 Reported practice of participants in relation to associated risks of fascioliasis, compared with baseline level and among three studied cohorts

Practice	Intervention 1 commune[a]			Intervention 2 commune[b]			Control commune[c]		
	Baseline (N=600)	Follow-up (N=600)	p	Baseline (N=600)	Follow-up (N=600)	p	Baseline (N=600)	Follow-up (N=600)	p
	number (%)	number (%)		number (%)	number (%)		number (%)	number (%)	
Eat improperly washed vegetables[18]	169 (28.2)	114 (19.0)	<0.017	197 (32.8)	166 (27.7)	NS	203 (33.8)	182 (30.3)	NS
Drink improperly boiled water	141 (23.5)	44 (7.3)	<0.017	255 (42.5)	178 (29.7)	<0.017	220 (36.7)	156 (26.0)	<0.017
Do not own household toilets	104 (17.3)	41 (6.8)	<0.017	85 (14.2)	90 (15.0)	NS	123 (20.5)	89 (14.8)	NS
Outdoor defecation	65/104 (62.5)	16/41 (39.0)	<0.017	66/85 (77.6)	68/90 (75.6)	NS	90/123 (73.2)	54/89 (60.7)	NS

[18] Significant differences in the follow-up values between a and b, and a and c (p<0.017)

Table 6.5 Reported practice of cattle raising households in relation to risks of fascioliasis infection

Practice	Intervention 1 commune[a]			Intervention 2 commune[b]			Control commune[c]		
	Baseline	Follow-up	Df, p	Baseline	Follow-up	Df, p	Baseline	Follow-up	Df, p
	number (%)	number (%)		number (%)	number (%)		number (%)	number (%)	
Households raising cattle[19]	N=600	N=600	NS	N=600	N=600	NS	N=600	N=600	NS
	279 (46.5)	319 (53.2)		252 (42.0)	243 (40.5)		119 (19.8)	137 (22.8)	
Number of cattle	N=279	N=319		N=252	N=243		N=120	N=137	
Less than 3 cattle	195 (69.9)	207 (64.9)	NS	182 (72.2)	159 (65.4)	NS	77 (64.2)	84 (60.6)	NS
From 3 cattle	84 (30.1)	112 (35.1)		70 (27.8)	84 (34.6)		43 (35.8)	54 (39.4)	
Cattle grazing practice[20]	N=279	N=319	Df=2	N=252	N=243	Df=2	N=120	N=137	Df=2
Free grazing	144 (51.6)	64 (20.1)	<0.017	177 (70.2)	146 (60.1)	NS	86 (71.7)	89 (65.0)	NS
Shelter-based	88 (31.5)	157 (49.2)		56 (20.2)	81 (33.3)		27 (22.5)	25 (18.2)	
Semi-grazing	47 (16.9)	98 (30.7)		19 (7.5)	16 (6.6)		7 (5.8)	23 (16.8)	
Animal waste treatment	N=279	N=319	<0.017	N=252	N=243	NS	N=120	N=137	NS
Composted	213 (76.3)	289 (90.6)		103 (40.9)	104 (42.8)		75 (62.5)	78 (56.9)	
Released into environment	66 (23.7)	30 (9.4)		149 (59.1)	139 (47.2)		45 (37.5)	59 (43.1)	
Deworming activities	N=149	N=288	Df=2	N=148	N=173	Df=2	N=36	N=71	Df=2
Once yearly	79 (53.0)	105 (36.5)	<0.017	75 (50.7)	114 (65.9)	NS	24 (66.7)	50 (70.4)	NS
Twice yearly	52 (34.9)	177 (61.5)		42 (28.4)	57 (32.9)		7 (19.4)	18 (25.4)	
Once in many years	18 (12.1)	6 (2.1)		31 (20.9)	2 (1.2)		5 (13.9)	3 (4.2)	

[19]Significant differences in follow-up values between a and b, and a and c (p<0.017)
[20]Significant differences in follow-up values between b and c (p<0.017)

6.4.6 Reported observation of household hygienic condition, compared with the baseline level

Follow-up observations were conducted in 120 households in each commune, with information recorded on observation forms regarding the conditions of water sources for washing vegetables, latrine structure, cattle shelters, and animal waste disposal facilities (Table 6.6). Similar to the KAP surveys in the previous section, comparisons were made between these data and corresponding data at baseline and between the studied cohorts, with the p values less than 0.017 being considered as significant differences. The observed results are subsequently discussed in Chapter 7, together with the KAP survey data to explore the risk perceptions and practices of fascioliasis control.

Overall, changes in follow-up observations were only found in the Intervention 1 commune, which used the broadly-based model, with all observed conditions of household facilities in that commune being significantly different to the baseline levels ($p<0.017$); meanwhile, almost no changes were significant in the two remaining communes. Among 120 observed households in eight villages of Intervention 1 commune, the number of households using tap water significantly increased (from 39.2% to 55.9%) and almost none (less than 1.0%) consumed surface water for their daily household activities. In addition, more well-structured latrines were observed in the surveyed households in Intervention 1 commune, resulting in fewer households owning no toilets or constructing unsafe latrine facilities. Moreover, significant increases ($p<0.017$) were observed in the number of cattle shelters constructed and in the safe treatment of animal waste, as more cattle-raising households built well-structured facilities for their cattle and paid more attention to safely composting animal waste (Table 6.6).

Compared with the baseline surveys, the follow-up observations of the two other communes indicated no remarkable changes ($p>0.017$) in terms of the hygienic conditions of the households, except for the cattle shelter facilities in the Control commune. Although the number of households without toilets in these two communes had reduced by the second observation of the study, higher proportions of those used the decomposted latrines or digging in the Control commune. In the

Control commune, significantly lower proportions of households owning well-structured shelters were observed, and there were increased numbers of households without any cattle shelters ($p<0.017$). Meanwhile in the Intervention 2 commune, increased proportions of cattle-raising householders were more aware of animal waste treatment measures, but this was not significant ($p>0.017$).

Table 6.6 Observational reports of household hygienic conditions

Item	Intervention 1 commune[a]			Intervention 2 commune[b]			Control commune[c]		
	Baseline	Follow-up	p	Baseline	Follow-up	p	Baseline	Follow-up	p
	number (%)	number (%)		number (%)	number (%)		number (%)	number (%)	
Water source for washing vegetables[21]	N=120	N=120		N=120	N=120		N=120	N=120	
Protected well	51 (42.5)	46 (38.3)	Df=3,	39 (32.5)	37 (30.8)	Df=3,	44 (36.7)	45 (37.5)	Df=3,
Unprotected well	9 (7.5)	6 (5.0)	<0.017	38 (23.3)	26 (21.7)	NS	14 (11.7)	11 (9.2)	NS
Tap water	47 (39.2)	67 (55.9)		21 (34.2)	33 (37.5)		37 (30.8)	36 (30.0)	
Surface water	13 (10.8)	1 (0.8)		22 (26.7)	24 (20.0)		25 (20.8)	28 (23.3)	
Latrine structure			Df=3,			Df=3,			Df=3,
Self-disposal	76 (63.3)	92 (76.7)	p<0.017	64 (53.3)	61 (50.8)	NS	69 (57.5)	67 (55.8)	NS
Decomposed	13 (10.8)	19 (15.8)		24 (20.0)	29 (24.2)		11 (9.2)	20 (16.7)	
Digging	14 (11.7)	6 (5.0)		13 (10.8)	17 (14.2)		17 (14.2)	14 (11.7)	
Without toilet	17 (14.2)	3 (2.5)		19 (15.9)	13 (10.8)		23 (19.1)	19 (15.8)	
Cattle shelters (if any)	N=59	N=69	Df=2,	N=42	N=51	Df=2,	N=36	N=44	Df=2,
Well-structured	34 (57.6)	57 (82.6)	p<0.017	23 (54.8)	27 (52.9)	NS	21 (58.3)	23 (52.3)	NS
Sparsely-structured	18 (30.5)	11 (15.9)		11 (26.2)	14 (27.5)		9 (25.0)	3 (6.8)	
No shelter	7 (11.9)	1 (1.5)		8 (19.0)	10 (19.6)		6 (16.7)	18 (40.9)	
Animal waste disposal	N=59	N=69	Df=2,	N=42	N=51	Df=2,	N=36	N=44	Df=2,
Composted	41 (69.5)	62 (89.9)	p<0.017	27 (64.3)	35 (68.6)	NS	23 (63.9)	22 (50.0)	NS
Biogas	7 (11.9)	4 (5.8)		6 (14.3)	11 (21.6)		6 (16.7)	9 (20.5)	
Into environment	11 (18.6)	3 (2.9)		9 (21.4)	5 (9.8)		7 (19.4)	13 (29.5)	

[21] Significant differences in all follow-up values between a and b, and a and c (p<0.017)

6.4.7 Snail surveys

The snail collection from aquatic niches was conducted in the same manner as during the baseline data collection to explore the roles of the intermediate hosts in fascioliasis transmission. The results from these follow-up snail surveys were compared with the baseline levels and between the three communes under study (Table 6.7).

Generally, more snails were collected at the post-intervention stage in the rainy months between November-December, 2013 in Central Vietnam, with the snail infection rates in two intervention communes reduced drastically ($p<0.05$) compared with the baseline surveys, although not many infected snails were collected in the various aquatic settings. In contrast, there was a significant increase in the number of infected snails collected in the Control commune rice fields, but not in other aquatic settings such as streams and canals ($p>0.05$).

When comparing the rates of infected snails between the communes, there was a larger number of snails collected in the Intervention 1 commune but they had significantly lower rates of infection compared with those in the intervention 2 and the Control commune ($p<0.05$). The locality of snail collection was also important. The rates of infected snails collected at the rice fields and overall snail infection were significantly different between the Intervention 2 commune and the Control commune ($p<0.05$), whereas no significant difference was indicated in the infected snails collected in the streams and canals in these two communes ($p>0.05$).

Table 6.7 Snail collection at studied sites over the study periods

Aquatic habitats	Intervention 1 commune[a]			Intervention 2 commune[b]			Control commune[c]		
	Baseline	Follow-up	p	Baseline	Follow-up	p	Baseline	Follow-up	p
	No./total (%)	No./total (%)		No./total (%)	No./total (%)		No./total (%)	No./total (%)	
Rice fields[22]	4/849 (0.47)	2/924 (0.22)	<0.01	4/656 (0.61)	3/698 (0.43)	<0.01	3/684 (0.44)	5/664 (0.75)	<0.01
Streams, canals	1/164 (0.61)	2/642 (0.31)	<0.01	1/154 (0.65)	2/419 (0.47)	<0.01	1/201 (0.50)	3/553 (0.54)	NS
Total[23]	5/1,013 (0.49)	1/1566 (0.26)	<0.01	5/810 (0.62)	4/1117 (0.45)	<0.01	4/885 (0.45)	8/1217 (0.66)	<0.01

[22] Significant differences in the follow-up values between communes a and b, and a and c (p<0.05)

[23] Significant differences in the follow-up values between communes b and c (p<0.05)

6.5 Discussions

Most of the significant changes found post intervention occurred in the Intervention 1 commune where the broadly-based control model of fascioliasis was applied. Possible factors contributing to these changes are discussed in this section and referential comparisons with other previous studies conducted in the region are made.

6.5.1 Changes in prevalence of fascioliasis in three cohorts after intervention

In the Intervention 1 commune, the seroprevalence of fascioliasis reduced markedly (from 8.8% to 4.2%, $p<0.05$) compared with the baseline survey. It reduced, but not significantly, in the Intervention 2 commune (8.4% to 5.4%) and increased in the Control commune (6.1% to 6.4%). These results most likely reflect the different levels of intervention applied in the three communes under study. Full broadly-based control measures were implemented in the Intervention 1 commune, which included intensified fascioliasis control measures such as health education, chemotherapy, co-ordination between health and other related bodies, improvement of the health sector in case detection and management, and vector control. These activities were conducted during the implementation of the model, hence could be contributing factors to the significant reduction in seroprevalence fascioliasis. Meanwhile, chemotherapy for human treatment and animal de-worming chemoprevention only was applied to the Intervention 2 commune human treatment only was applied to the Control commune, which was unlikely to achieve success, as there should be factors other than chemotherapy behind the successful reduction of the disease prevalence.

Other studies conducted previously in the region also reported significant reductions in fascioliasis prevalence *(Nguyen, 2010; Nguyen et al., 2011; Nguyen et al., 2011; Nguyen, 2012)*, but the reduced prevalence of infection in the intervention communes found in this study was greater. This could be as a result of the different sampling methods employed for the study. The above-mentioned studies recruited the same participants to be involved at the beginning and end of the study, whereas in this community study different sample cohorts were recruited for the two stages of the study. In addition, the larger sample size in this study had greater statistical validity, and was likely to reflect a more valid report of the disease prevalence than in other studies.

6.5.2 Effectiveness of chemotherapy for fascioliasis control

Among the interrelated factors involved in the model, chemotherapy and early detection played important roles in the reduced prevalence of fascioliasis. As presented in the findings, the cure rates of the disease for all seropositive cases from two blood surveys after 6 months were 92.8% and 85.0% respectively, and 100% after 12 months. These findings support the effectiveness of the recommended chemotherapy (triclabendazole 250mg, 10mg/kg body weight) for selective treatment (MOH, 2006). This confirmed that the medication was still effective against fascioliasis in selective treatment in Vietnam. Previous studies (Nguyen, 2010; Nguyen, 2012) also reported evidence that this medication was still highly effective in fascioliasis treatment in Vietnam (with 95.0-100% cure rates), while the resistance of the parasites to the drug was identified in other countries (Fairweather, 2009; Olaechea *et al*., 2011; Winkelhagen *et al*., 2012; Ortiz *et al*., 2013). These results reinforce the importance of intensified detection and prompt treatment of fascioliasis in the community.

The findings in our study also indicated significant reduction of eosinophilia in seropositive participants after 6 months and one year following the treatment of fascioliasis. These results were also consistent with previous studies in the region (Nguyen, 2012; Nguyen, 2012). Elevated eosinophils are considered to be a contributing factor to possible fascioliasis infection (Curtale *et al*., 2003; Nguyen *et al*., 2007) and their reduction reflects successful treatment of the disease (MOH, 2006).

6.5.3 Changes in perception of risks and practice associated with fascioliasis infection in three cohorts

Compared with the baseline level, significant improvements in knowledge of fascioliasis was found in the intervention communes 1 and 2, although the disparity of the awareness between these two cohorts was great (80.2% vs. 37.5%, $p < 0.017$). In the Intervention 1 commune, the higher rates of knowledge were likely to reflect the more intensive educational activities undertaken, including health education campaigns by health volunteers using various means such as clear publicly displayed panels and mottos, and leaflets directly delivered to houses showing detailed information concerning fascioliasis. Similar results have been reported in previous studies, with variances of knowledge ranging from 57.0% to 99.0% (Dang *et al*., 2011; Nguyen *et al*., 2011; Nguyen *et al*., 2011; Nguyen, 2012). However, these studies were conducted on small-scales with limited sample sizes, which did not reflect wider representation of the region.

The cohorts in this study also performed differently in their practices to reduce the risks of fascioliasis infection. Although significant reductions were reported in all three cohorts relating to drinking improperly boiled water, most changes were noticed in the Intervention 1 commune, with improvements in all surveyed practices. In the Intervention 1 commune, the reduced proportion of respondents drinking improperly boiled water (7.3%) was higher than some studies previously conducted in Central Vietnam, such as 1.2% (Nguyen, 2012) and 2.6% (Nguyen, 2010) in Quang Nam province; but lower than 34.0% in a study conducted in Binh Dinh province (Nguyen *et al*., 2011). In addition, the proportion of participants of the commune reportedly eating improperly washed vegetables was lower than those in some other studies (Nguyen *et al*., 2011; Nguyen, 2012). The health education campaigns in Intervention 1 commune in this study appeared to effectively achieve the desired outcomes, as more people accepted the practice of washing vegetables under running tap water, or dipping vegetables in water containing non-toxic chemicals or salt for minimum periods of time. This practice of the safer treatment of vegetables has also been reported in other studies (Dang *et al*., 2011; Nguyen, 2012), and could be considered to be a more appropriate household practice compared with destroying the infected vegetation areas, as had been conducted in some countries (Rojas *et al*., 2010).

This study clearly demonstrated that without a full range of control measures, improvements in raising awareness of the community about fascioliasis are unlikely to occur. No health education campaigns, just chemotherapy, were conducted in two of the communes, together with animal de-worming activities in the Intervention 2 commune. Limited significant changes were found in the knowledge and practice of these cohorts, except for “eating unwashed vegetables” as one transmission route of fascioliasis, indicated by participants at of the Intervention 2 commune (Table 6.2). This change may have resulted from education about reducing the risks of fascioliasis infection associated with the de-worming activities conducted by local veterinary staff. However, eating unwashed vegetables is not the only transmission route of fascioliasis; other transmission routes include drinking impure water, as has been identified in other documents (Keiser and Utzinger, 2009; Chen *et al*., 2013).

The follow-up surveys also indicated significantly fewer participants reportedly having no household toilets in the Intervention 1 commune (6.8% post intervention vs. 17.3% at baseline, $p<0.017$), with no significant changes in the other communes (Table 6.3). In addition, a significant difference was also found in the Intervention 1 commune in relation to a reduction in the number of respondents in the non-toilet households (39.0%) reportedly defecating in public places, thus reducing the risks of fascioliasis transmission among the community. Intervention 1 commune also reported a lower prevalence of fascioliasis following intervention, expressed in Table 6.1. Outdoor defecation is commonly practised in the absence of adequate latrine facilities, which facilitates human participation in fascioliasis transmission (Mas-Coma *et al*., 1999a; Agnamey *et al*., 2012). In a survey conducted of Binh Dinh in Central Vietnam by Nguyen (2011), 33.8% of respondents reported defecating into the rice fields or sandbanks as they did not own household toilets, and this was associated with a higher prevalence of fascioliasis (6.5%) in that study. The results of the current study support the importance of encouraging the intensive use of public toilets as a good way of reducing fascioliasis infection.

Strategies to improve cattle fascioliasis control in intervention communes 1 and 2 may also have contributed to the reduced infection rates in that cohort, and this supports the active involvement of the veterinary sector in fascioliasis control activities. A significantly lower proportion of households in Intervention 1 commune reported practising free-grazing of animals in the follow-up stage compared with the baseline level. More shelter-based and semi-grazing forms of animal husbandry result in lower free grazing, and thus reduced risks of fascioliasis transmission in the cattle. Free grazing has been found to enable *Fasciola* to complete its lifecycle from the intermediate hosts (lymnaeid snails) to the final hosts (cattle) (Mas-Coma *et al*., 2005b; Danbirni, Okaiyeto, Pewan, Allam, Akam and Sackey, 2011). Therefore, restricted or no free grazing helps to reduce the contact between cattle and larvae on the same grazing land (Suhardono *et al*., 2006c). Another positive practice in the Intervention 1 commune was the safer treatment of animal waste, such as mixing animal dung with rice straw to promote fermentation and increase the temperature of the compost, thus killing the Fasciola eggs. This practice was previously proven to kill the fluke eggs, thus cutting the developmental stage from eggs to larvae of the *Fasciola* (Copland and Skerratt, 2008). Finally, the awareness of appropriate cattle chemotherapy by cattle raisers was higher in the Intervention 1 commune, with almost two thirds of households de-worming their cattle twice a year (before and after the rainy season). This practice could result in a considerable number of cattle being freed from fascioliasis infection during the grazing season (Copland and Skerratt, 2008). The results of this study indicate that similar outcomes could be achieved more widely by greater involvement of the human public and veterinary health sectors to increase the awareness of cattle raisers regarding fascioliasis.

6.5.4 Changes in observational premise conditions

Following intervention, a significantly higher proportion of households in Intervention 1 commune were observed to own hygienic water sources (tap water and protected wells) and well-structured toilets, as compared to the baseline level. This latter change is likely to have contributed to the significant reduction in participants practising outdoor defecation (Table 6.4). In addition, a significant increase in the use of cattle shelters was observed in Intervention 1 commune, reflecting the better practises of the cattle raisers, who also reported how to process the animal waste properly (Table 6.5). The findings in this study are consistent with some previous studies in the region. In a study by Nguyen (2010) in Quang Nam, where health education was the only intervention measure introduced, Nguyen observed that practices changed and significantly lower proportions of households were consuming surface water sources (down from 61.1-16.2%), and owning unhygienic latrines (down from 60.1-22.5%).

6.5.5 Snail surveys

The snail survey results indicated significantly lower snail infection rates in the two intervention communes, despite a higher number of snails being collected post intervention. This compared to a significantly higher snail infection rate in the Control commune (Table 6.7). Moreover, the snail fascioliasis infection rate in Intervention 1 commune was significantly lower than in the Intervention 2 commune ($p<0.05$). These lower snail infection rates were reported despite the second snail surveys being implemented during the rainy season, when there were more favourable conditions for the development of the intermediate host lymnaeid snails. The results are consistent with some other studies, where more snails were collected in the rainy season, with low infection rates ranging from 0.42-0.56% (Nguyen *et al*., 2008; Nguyen, 2010).

However, other studies (Nguyen, 2012) reported a higher infection rate of the snails (0.72%) despite lower numbers of snails collected compared with the dry season. The significantly lower fascioliasis prevalence rates in snails reported in this study are likely to be an outcome of the veterinary chemotherapy and other intervention measures implemented in Intervention 1 and 2 communes.

As discussed in Chapter 4, the current study applied the morphological identification of the snails as intermediate hosts of fascioliasis, which could not reach highly-specific species identification, probably due to a lack of experience (Doanh *et al*., 2012). This could have led to wrong interpretations of the transmission roles of the mollusc species in comparison to the highly sensitive PCR (Polymerase Chain Reaction) technique (Dung *et al*., 2013).

6.6 Conclusions

This chapter presented the findings following the implementation of the broadly-based control model of fascioliasis. With full intervention measures applied, the Intervention 1 commune indicated a significantly reduced prevalence of fascioliasis, considerably increased awareness of, and practices against, the disease transmission, and decreased larval infection of snails compared with the baseline stage. Across the communes, significant differences in the levels of change were found for most of the indicators between the Intervention 1 commune and the other two communes. The post intervention changes reported in this chapter provide very strong support for the effectiveness of a broadly based control model to reduce infection from fascioliasis.

In the commune where all the intervention measures of the model were applied, significantly reduced prevalence of fascioliasis was achieved. The commune members were also found to be significantly more aware of, and practised, disease transmission reduction activities. Importantly, there was a significant decrease in larval infected snails in this commune (and the other commune where chemotherapy of cattle was implemented). In contrast, in the communes with either fewer or no intervention strategies, only a few outcome measures were found to improve. Importantly, there was no significant change in fascioliasis infection rates in the communes that did not receive all components of the broadly based control model.

Having established the effectiveness of the broadly-based control model, it is important to explore the factors that enable, or act to impede, the implementation of a broadly based control model. In the next chapter, the qualitative description of the factors will provide further insight into the model.

7. EXPLORING THE INFLUENCIAL FACTORS BEHIND THE SUCCESSFUL BROADLY-BASED FASCIOLIASIS CONTROL MODEL OF CENTRAL VIETNAM

7.1 Introduction

As presented and discussed in the previous chapter, the implementation of the broadly-based control model resulted in a significant reduction in the prevalence of fascioliasis. Awareness of fascioliasis increased and disease risk management practices improved in a community with high endemicity of the disease. The success of this initiative could inform initiatives in other regions of the country. However, the post intervention changes in the disease indicators alone were not sufficient to understand the contributions made by the different components of the model. Exploration of the perceived effectiveness of the various factors in the model was required.

The Qualitative inquiry aimed to provide important insights into the fascioliasis control model by elaborating on the factors that contributed to, or impeded, the successful intervention measures. A mix of qualitative data were collected through semi-structured, in-depth interviews with key informants including officials from the health sector from central and communal levels, local authorities, local officials in the agricultural and educational sectors, social associations, and through focus group discussions with local health volunteers and selected household representatives. The procedures of initial piloting, sampling and recruitment, and the development of guides for program implementation and data analysis of these two qualitative methods were presented in chapter 3.

This chapter commences with a presentation of the characteristics of the participants to provide contextual information. The outcomes of the initial content analysis undertaken, using word frequency and group query, provide a basis for the subsequent thematic analysis of the qualitative data.

The results indicate that the factors contributing to the success of the model included recognition of the risks associated with fascioliasis, combined with the commitments and motivations of stakeholders and the household representatives to participate in the control measures. Perceived negative factors included the challenges of time constraints, technical issues, difficult resourcing and natural disasters. This chapter concludes with recommendations to increase the effectiveness of fascioliasis control initiatives and proposes changes to the intervention model.

7.2 Characteristics of the participants attending the in-depth interviews and focus groups

Qualitative data collection incorporated both in-depth interviews and focus groups, as described in Chapter 3. Nine stakeholders were recruited for the in-depth interviews. The participants' levels of expertise in parasitic diseases control ranged from international (WHO regional office), national (IMPE-QN), provincial, district to communal levels (Table 3.1). All invited potential stakeholders agreed to participate in the interviews and signed the consent forms (Appendix 3.11). The invited participants came from different sectors, including health (n=5), veterinary (n=2), education (n=1) and local government (n=1). This provided a variety of perspectives regarding their awareness of fascioliasis, perceptions of the risks, motivations for involvement in fascioliasis control, and expressions of interest for developing better control measures for the disease. The participants were aged from 25-58 years, with all but one having tertiary education levels. Detailed characteristics of the participants are presented in Table 7.1.

Two groups of participants were recruited for the focus groups, with one group comprising eight village health volunteers and the other group comprising seven purposively selected household representatives from Intervention 1 commune (refer to Chapter 3 for further details). As with the participants attending the interviews, all people recruited for the focus groups provided their consent before participating.

In the first focus group there was an equal distribution of age ranges; almost all the participants had achieved a high-school education; and all were involved in general health care activities at the village levels. All participants in the second group were farmers, the majority (n=6 of 7) of whom had a primary level of education (Table 7.1). Three participants had experience of fascioliasis infection prior to the study.

Table 7.1 Characteristics of participants attending in-depth interviews and focus groups in the Intervention 1 commune

Characteristics	Stakeholders for in-depth interviews (N=9)	Stakeholders for focus group (N=8)	Household representatives for focus group (N=7)
Age (years)			
• 25-39	2	4	2
• 40-59	7	4	5
Education levels			
• Primary school	0	0	6
• High-school	1	8	1
• Graduate and higher	8	0	0
Occupation			
• Health and veterinary related	7	8	0
• Others (education, government, farming)	2	0	7

7.3 Overview of the qualitative data

The interview and focus group questions were originally prepared in English and reviewed by academic researchers in the School of Health and Society, UOW. As actual qualitative data field collection was undertaken in Vietnam, these questions were translated into Vietnamese. All verbatim data were transcribed into text using the MS. Word 2011 software before being translated back into English by an expert in qualitative data analysis and in translation from the Hanoi School of Public Health. Data analysis was assisted by use of the NVivo qualitative data analysis software - QSR International Pty Ltd. Version 10, 2012.

The data are presented in two parts. First the outcomes of the word-frequency and group query analyses used to explore the words and word group associations are presented. The application of Computer Assisted Qualitative Data Analysis Software (CAQDAS) tools provided initial insights through a systematic search for meaning of words or groups of words (Siccama and Penna, 2008). In this step the text data were sorted, grouped and structured to facilitate the initial interpretation (Welsh, 2002). The second part of this section presents the more in-depth exploration of the data. The awareness and risk perceptions of participants, their motivations for engagement in the intervention, their views on what contributed to the success of the intervention and also their recommendations for improvements are explored. These data and their analysis add depth to the overall evaluation of the intervention, providing insights into the less quantitative but nevertheless critically important aspects of the model.

7.3.1 Word frequency counts

Word frequency counts (or word counts for short) are based on participants' use of distinctive vocabulary and word patterns (Leech and Onwuegbuzie, 2007). They contribute to meaning through highlighting more important and significant words in addition to their narrations (Sandelowski, 2001). In the combined dataset from both the interviews and focus groups, the word-frequency count technique was applied as the summative content analysis to identify the most frequent re-occurrence of key words that might reflect the topics of interest and of greatest concern (Stemler, 2001; Hsieh and Shannon, 2005). The display of the word frequency results - either as a 'word tree' (visual branching structure with a word as main tree trunk and other related words as branches) (Wattenberg and Viegas, 2008) or 'word cloud' (graphic presentation of word size proportional to its frequency) (Vasconcellos-Silva, Carvalho and Lucena, 2013) – provides an indication of the relationships between the key word with other surrounding terms or phrases. The word connections can then be used to inform the analysis of the full text transcripts of the in-depth interviews and focus groups.

The core word 'fascioliasis' appeared with the highest frequency as the topic of the discussions. In the visual branching structure (Figure 7.1), 'fascioliasis' is displayed as the trunk while associated words and word phrases are connected as branches. There are a range of relationships inferred through this diagram, along with the commonly discussed aspects of the disease including awareness, perspectives and implementation of the control measures of the disease (Figure 7.1).

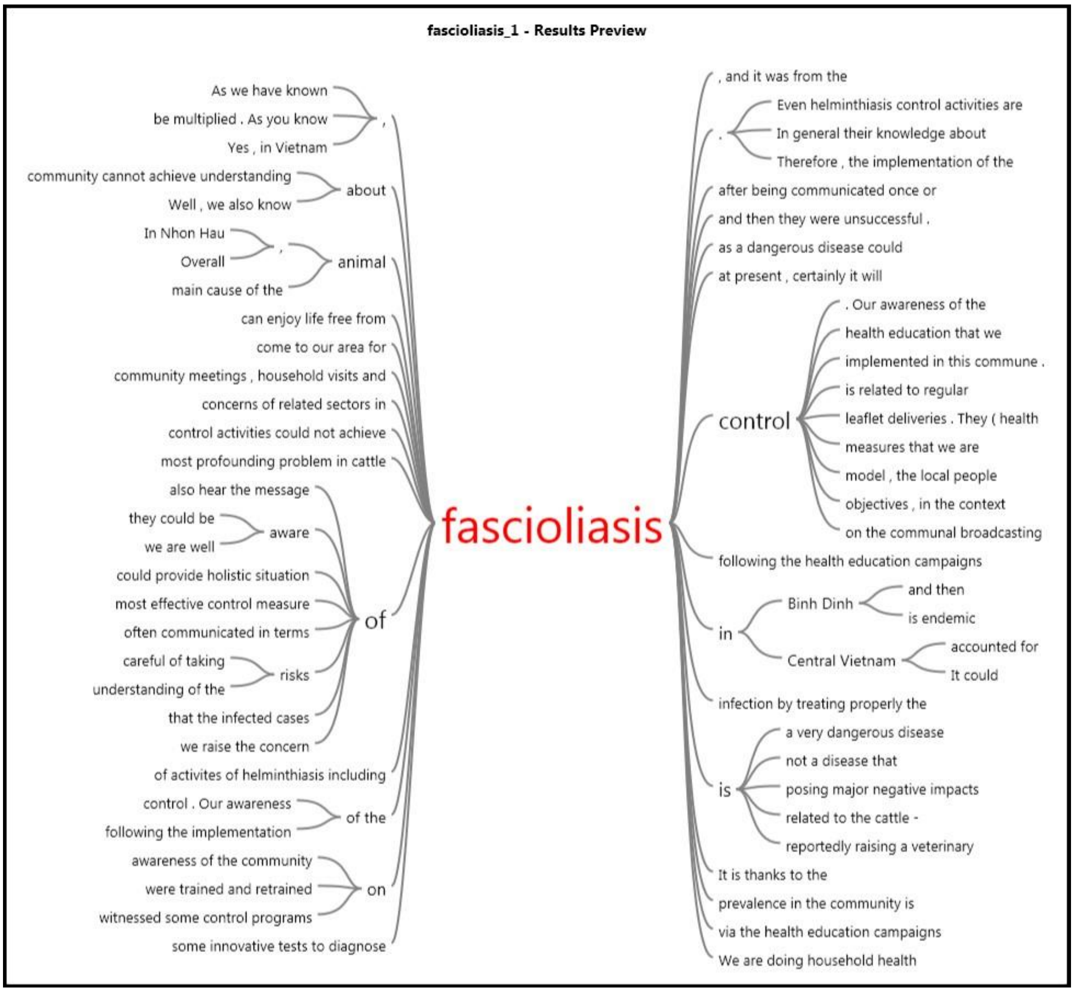

Figure 7.1 Word frequency showing the association of ‘fascioliasis’ and other terms of interests

‘Health education’ was the second important word phrase that was raised by many of the respondents. The term also was clearly identified in the word cloud following the ‘fascioliasis control model’ (Figure 7.2). High frequency of the phrase reflected the participants’ views that health education was one of the most important control measures of the broadly-based control model for fascioliasis. In addition, the terms ‘community’, ‘disease’, ‘cattle’, ‘activities’, ‘sectors’, ‘awareness’, ‘co-ordination’, ‘implementation’, ‘participation’ and ‘difficulties’ were also present in a majority of the participants’ discussions, as shown in Figure 7.2. These meaningful words signposted the level of acceptance and participation of the community in fascioliasis control measures, and the co-ordination of related sectors in the model which are explored in detail in the following thematic analysis sections.

Figure 7.2 Word cloud showing ‘health education’ and associated words

7.3.2 Group Query

The group queries were performed on the data to identify a higher level of association between the items (Wiltshier, 2011). When in groups, the words and their related terms could enable researchers to identify particular aspects for further analysis (Pope, Ziebland and Mays, 2000).

In this study the group query tool was used to scope the combined qualitative data and group them. Two main groups describing the factors influencing the fascioliasis control model were identified (Figure 7.3). One group comprised positive factors within the fascioliasis control model, including the roles of stakeholders and the community and their motivations to participate in the model. The other group comprised factors acting as barriers to the control model, including time constraints, technical issues, limited resources and natural disasters. Awareness was perceived by participants as both a motivating and an impeding factor to the model’s success, as shown in the Figure 7.3.

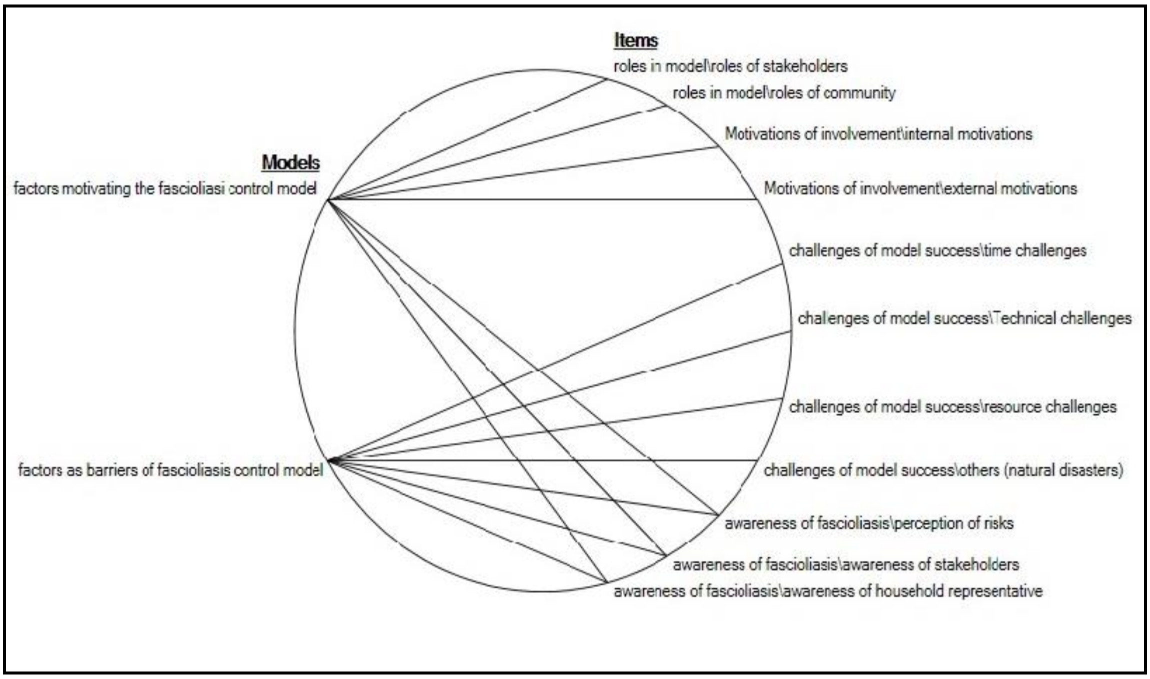

Figure 7.3 Group query showing the relationship between the grouped items 'influential factors' with other related nodes

7.3.3 Exploring the awareness and risk perceptions of respondents of fascioliasis

This section presents the findings from the two qualitative data collection methods, which provide detailed information on how participants perceived fascioliasis as a major public health problem and how they described the risks of the disease transmission. Positive perceptions of fascioliasis and its associated risks could stem from the two motivations of participation and commitment for support to the intervention measures, which are explored in the following section.

The guidelines on qualitative data collection, management and analysis were presented in Chapter 3 (items 3.5.1 and 3.5.2). Key findings are reported here under the main themes with appropriate verbatim quotes being used as illustrations; and the discussions of these findings are presented in the following section (Burnard, Gill, Stewart, Treasure and Chadwick, 2008).

Across the respondents, there was a general sense that fascioliasis was a 'hot' disease in the locality, although the reported levels of understanding of the disease varied with the different participants. Experts in the field of human and animal fascioliasis provided more detailed problem descriptions of the disease, which had previously been underestimated for various reasons and more importantly, had not been a reportable disease. Following its substantial increase in recent years due to the absence of effective control measures, coupled with the inadequate supplies of the specific drugs to treat the disease, concerns were expressed by the participants about the disease and the apparent failure to achieve reductions in morbidity. The need for more effort from the health sectors was advocated:

> *"In Vietnam, fascioliasis is not a disease that is regularly reported. Rapid increase in infected cases during 2008-2011 in Central Vietnam and drug shortages made the disease a public health concern, which required much attention in terms of detection, treatment and management."* (IDI #1, health expert, male 53)

Participants also identified that the problems of fascioliasis could not be presented just from hospital-based perspectives. Rather, they considered that a comprehensive picture of the disease should be determined from community-based surveys. Supportive awareness of the disease burden was considered to contribute to more integrated design and implementation of control strategies.

> *"Previous studies conducted at the community areas in Binh Dinh indicated high prevalence, but no effective control measures have been in place. Therefore, more community surveys could both provide holistic situation of fascioliasis in and then design integrated control approaches to the disease."* (IDI #3, health expert, male 49)

Positive awareness of fascioliasis was also expressed by the non-expert individuals. There were some indications that awareness and perceptions of fascioliasis risks motivated householders to make strong commitments to change their practices and for professionals to play active roles and to participate in the control of fascioliasis. Focus group participants described the disease at a basic level and from the knowledge they had obtained following health education campaigns, or experiences of formerly contracting the disease. This account from a participant who previously had the disease raised the importance of the disease awareness among the community:

> *"I am well aware of the disease since I contracted it last year, as I still feel it is painful. Now I and my family members have known how to control it from our daily life activities. If everyone is following as we are doing now to prevent the disease, we can enjoy life free from fascioliasis."* (FG2, #14, household representative, female 32)

Importantly, the effects of health education, as perceived by the household focus group of participants, helped them to clearly distinguish the differences between fascioliasis (liver fluke) and opisthorchiasis (another form of liver fluke with different modes of transmission and clinical symptoms from fascioliasis) based on their different routes of transmission, causes and damage. With this improved understanding of the disease, they considered that they could practice appropriate control measures:

> *To me, it is important to be well aware of fascioliasis from the health education campaigns conducted in our areas. We know how to distinguish between the fascioliasis with the small liver fluke* [caused by eating raw fresh water fish]*, then to protect ourselves from getting the fascioliasis such as: do not eat uncleaned raw vegetables or drink impure water.* (FG2, #13, household representative, male 44)

7.3.4 Participants' motivations for engagement, their roles and levels of support in the model

The stakeholder participants expressed that they were motivated to take action when the issue was considered relevant to their professional roles and when new opportunities for working were presented. For example, the researcher participants commented on the research opportunities; the veterinarians identified the links with their roles pertaining to animal health; local health volunteers indicated their opportunity to integrate fascioliasis control with their primary health care activities; and the local authorities determined their administrative roles in relation to the model (best practice) activities.

A key motivating factor was perceived to be the important facilitating role of the World Health Organization's country office, which was raised by the participating WHO official and also other participants. The WHO office in Vietnam was considered to have established the status of fascioliasis, identifying it as a public health concern and a health priority, and to have provided essential resources. The status of the disease was enhanced through WHO investigations of increasing infection cases, reviewing adequacy of the supply of medication specific to fascioliasis, and the development of new guidelines on simplified diagnostic procedures and post-treatment follow-ups. The WHO also had provided drugs specific to fascioliasis free-of-charge, to facilitate the affected population's access to the treatment without them bearing the burden of the disease. The actions of the WHO office in Vietnam to make available simplified guidelines and to provide the drug for seropositive cases, were considered to have enabled the project to achieve the intervention of chemotherapy.

> *"We* [WHO Office] *are very interested in this model as I could make considerable change in fascioliasis control approach. The model could radically solve the problems of increasing fascioliasis in Central Vietnam if applied to other localities. For our part, we are still supporting amounts of specific drugs specifically for fascioliasis treatment."* (IDI #1, health expert, male 53)

An important motivating factor was identified as the potential research opportunities. No intervention models had previously provided evidence of their effectiveness. Participation in this broadly-based intervention was considered an important chance to be actively engaged in a comprehensive research study into the control measures of parasitic diseases, including fascioliasis in Central Vietnam, a 'hot spot' of the disease. This was expressed by a participant when talking about his directive role in the implementation of the fascioliasis control model at the Intervention 1 commune. He described his professional roles with regard to the general direction and support of the intervention activities.

> "*Thus in this project study, I provided various supports in terms of partial budget, technical issues, and assigned some specialists involved in helminthiasis control activities to be engaged in this model, which facilitated the significant achievement of the broadly-based control model of fascioliasis*." (IDI #2, health expert, male 39)

Fascioliasis was also a focus for the veterinary sector and the design of this intervention was the subject of great interest from veterinarians. A veterinary expert explained her motivation for being engaged in the implementation as based on her views regarding the practical values of increasing community awareness of human and animal fascioliasis, and the economic benefits of animal fascioliasis prevention and control. In addition, having been aware that human and veterinary public health sectors applied different fascioliasis control strategies, she perceived that the co-ordinated work between the two sectors, in which she had never been previously involved, had resulted in effective outcomes.

> *"The public health looks after human health; the veterinary sector takes care of animal health. I am very interested in this model as it created the relationship between the two sectors against fascioliasis. Therefore, I am happy to take my role in the co-ordinative activities in training the veterinary staff involved in the model and in providing advice for de-worming, properly processing cattle dung, and cleaning animal shelters so as to create the radical changes in cattle fascioliasis control."* (IDI #4, veterinary expert, female 46)

Motivations for engagement in the broadly-based control model for fascioliasis were also explored at the communal level. A local authority participant expressed his awareness of fascioliasis as the hot disease that was greatly affecting the local people in terms of their health and socio-economic life. He also acknowledged that the implementation of any health related program required the engagement of a multisectoral system coupled with the participation of the community in their communal living area. Thus when the broadly-based control model was introduced to the locality, he was highly motivated to participate in terms of locally directing and organizing the implementation of health related campaigns.

> *'I was so interested and dedicated most of my time to be involved* [in the model] *although I had lots of work to do then. I engaged the multisectoral participation in health education activities, which focused on hygienic eating and drinking, and avoidance of outdoor defecation among students [education], and the community* [local authorities, health and social organizations]*; and good animal husbandry practices* [veterinary]*.'* (IDI #6, communal official, male 57)

Above all, he said he was particularly motivated by his role and his dedication '*for the sake of the people's health in the whole commune*'.

Finally, the motivation for being actively engaged in the broadly-based control model for fascioliasis was expressed among local health volunteers. Their perceived motivations included the benefits of the program to their localities, the positive changes in the community's awareness and practice of fascioliasis control, and the considerable interests and investments in their locality from concerned bodies. Other factors motivating them included their professional opportunities and incentives. As indicated by a local health participant, these motivating factors could probably encourage her and other volunteers to be more devoted to the assigned work:

> *"Firstly, the model promoted the positive changes in the community daily eating and drinking habits, which we perceived could lead to a safer life from fascioliasis. Secondly, we have never seen such good concerns and investment from the local authority, health, education and other involved sectors in engaging them to participate in the model….I think besides small incentives there were more important reasons behind our motivations."* (FG # 1, village health volunteer, female 46)

In conclusion, various factors positively influenced the motivation of participants to be engaged in the broadly-based control model for fascioliasis in Central Vietnam. The motivations were both internal, such as the alignment of the program's aims and designs with the participants' own views of the disease burden and the provision of new professional opportunities for working; and external, through acknowledgment via the interests and investments of the concerned bodies and possible availabilities of incentives (Figure 7.2). Together, these motivations translated into active engagement and strong support for the program.

7.3.5 Challenges to the successful fascioliasis control model

Participants attending the interviews and focus groups also identified factors that challenged the achievement of successful outcomes. The challenges were associated with time availability, technical issues, difficulty accessing resources and an unanticipated natural disaster.

Time constraints were identified as an important issue by participants in both the interviews and the focus groups, although the nature of the time constraints varied. Much more time and intensive effort was considered to be required by the professionals to change their awareness and behaviour so that they were able to be involved in the intervention. For the community members, time constraints were mentioned in relation to the health education component. Many of the intervention measures were directed at farming families, who spent most of their time in the fields and only had limited time available in the evenings at their homes. Even when they were at home, they were reportedly busy doing errands after dinner. Thus health education activities were considered to be very difficult and time consuming when the communal workers also had other responsibilities. In addition, the participants reported that changing the community's awareness could not be achieved after only one or even several education sessions.

> *'I had to come to their house for health education so many times; and repeated that activities should be implemented to gain their participation. That meant more time had to be spent while we still had a lot of other community work to do."* (FG1, village health volunteer #1, female 46)

Technical issues associated with the nature of the disease were perceived by participants as major obstacles to the accomplishment of the program activities. Among the technical issues identified by participants, vector control was the most difficult model component to achieve. This component required intensive inputs in terms of finance and other technical aspects to deal with the pathogen-host relationship. This viewpoint was expressed by a participant specialised in the field:

> *"The complicated pathogen-host relationship is really a considerable problem to the effectiveness of the intervention. Therefore, it would be successful if we could control the vectors effectively."* (IDI #1, health expert, male 53)

Technical aspects identified also related to the long-existing behaviours of the community in their cattle husbandry practices, which perpetuated the risks of fascioliasis transmission in humans and animals. These practices included unsafe grazing and (poor) entrenched and irregular de-worming practices, which continued despite the intensive health education initiatives.

Unsafe grazing included releasing animals to graze in the rice-fields immediately after the harvest as *'farmers believed keeping them in shelters for a long time would cause malnutrition, lameness and injuries for their cattle.'* (FG1, village health volunteer #4, male 47). This was an identified risk of getting *Fasciola* infection, as the larvae were still active on the rice stubble after harvest. Other unsafe cattle husbandry practices identified included releasing cattle to bathe, drink or release excrement in water bodies, as these activities could facilitate the parasites completing their life cycle.

> *"It is so difficult to change the habits of the farmers on their animal husbandry practice. You know, the commune is surrounded by rivers, which facilitates the unsafe practices of grazing animals in contaminated riverside paddies and water bodies."* (IDI #9, local veterinary staff, male 25)

Poor, entrenched and irregular de-worming practices were also concerns related to grazing. Common perceptions raised by participants included the lack of well-structured sheltering facilities, together with the inappropriate management of cattle waste. Poor farming households in the community could not afford to build cattle shelters or find enough space to treat cattle dung. In the absence of frequent de-worming practices, the release of untreated cattle waste in the heavy rain would cause the contamination of the environment and the transmission of fascioliasis.

A further constraint was the lack of allocation of resources to address fascioliasis, as it was not an identified health priority. Consistent efforts and integrative co-ordination could not ensure successful intervention measures if the availability of funding and human resources was not guaranteed in the long term. Lack of resources was identified as a considerable obstacle to maintaining the achieved outcomes of the intervention, especially at the community levels, where most of the intervention measures were conducted. This account was expressed by a participant:

> *"As it has been known, the MoH* [Ministry of Health] *hasn't granted any budget in a large scale for the control of helminthiasis including fascioliasis because these activities are not listed as a national target program for health."* (IDI #2, health expert, male 39)

The participants identified that because of insufficient financial support, the implementation of fascioliasis surveillance has been integrated into the overall health care activities of the community. This resulted in limited amounts of the generated budget being allocated by the provincial health sector, affecting the sustainability of efforts. This was expressed by one participant, *'this insufficient financial support could not afford regular activities of fascioliasis surveillance and management, which posed considerable challenges on the model effectiveness.'* (IDI #3, health expert, male 49)

Challenges were also identified in the allocation of staff involved in the implementation of the fascioliasis control model. Most discussed by participants was the impost on local health volunteers, who were required for the activities of health education, surveillance, and management within the fascioliasis control program. The existing heavy workload at the community level meant that a program such as this could only be sustained through more human resources. Staff turnover also was identified as an issue. The replacement of pre-trained personnel in assigned positions raised concerns regarding re-training for new staff. This would place more pressure on the time and efforts required. Any lack of updated skills and knowledge regarding human and animal fascioliasis control and prevention meant that more intensive training would be required, a particular challenge across the combined activities of the public health and veterinary health sectors. Further explanation of these challenges was expressed by a participant:

> *"The allocation of staff involved in the model implementation was not always good. Besides previously discussed issues such as insufficient availability of village health volunteers due to shifted positions and limited capacity in updated information of disease control, we also face difficulties in the allowances for these staff, which partially influenced the model success."* (IDI #5, health expert, male 46)

Finally, the occurrence of natural disasters was an unexpected challenge that was considered to have had considerable impact on the outcomes of the fascioliasis control model in Central Vietnam. Heavy flooding from monsoon rain caused economic losses such as the drowning of cattle and submergence of rice fields. Flooding also impacted directly on some of the fascioliasis control strategies, as identified by one participant; [it] '*washed out the stored dung from shelters in the commune, which can cause contamination of the disease to humans and animals.'* (IDI #9, local veterinary staff, male 31)

In conclusion, reflections of participants attending the interviews and focus groups provided further insights into the model components, some of which were not anticipated in the development of the model or during the implementation of the intervention measures. The factors of time constraints, technical challenges, allocation of resources, and the inevitable occurrence of natural events were considered by participants to affect the effectiveness of the model in terms of participation, vector control and health education measures.

7.3.6 Recommendations for improved intervention measures of the model

After the participants shared their various perspectives relating to the challenges to the fascioliasis control model, they went on to provide constructive comments for the improvement of the intervention measures. The main suggestions put forward were improving the co-ordination between the involved sectors, followed by the improvement of the health education approaches, a mandatory reporting system for fascioliasis control activities to facilitate the health information system for fascioliasis control, and sufficient budget allocation to improve the quality of fascioliasis control activities at the community level.

Stronger co-ordination between the human and veterinary public health sectors, and other involved bodies was identified as having the potential to significantly reduce the burden of fascioliasis. Accounts of intense relationships were shared among participants, stating the importance of co-operative work conducted by staff of the health, veterinary, educational and other social organizations. This was raised by a participant as *'extremely important, for fascioliasis is a zoonosis, involving human and cattle in a complex pathogen-host relationship'* (IDI #4, veterinary expert, female 46). In addition, co-operation between health and other related sectors when involved in activities aimed at fascioliasis control were also perceived as essential in the events of externalities, which would require a great deal of human resources.

> *"Fascioliasis is related to health, veterinary and agricultural issues. The combination of the assigned work from involved sectors should be reinforced to provide strong interdisciplinary co-ordination."* (IDI #2, health expert, male 39)

Participants identified the importance of a long-term commitment to health education. Most participants involved in the interviews and focus groups perceived there were benefits that could be achieved from this intervention measure. In addition to the educational attempts to change community behaviour, it was considered important to have a long-term commitment because:

> *"...health education could not change the community behaviour if conducted only once or twice, or within few months or few weeks as we previously noticed. There should be long-term intervention measures to engage the community participation."* (IDI #1, health expert, male 53)

Not only was it considered that health education should be undertaken on a regular basis. Participants expressed a view that this intervention must be targeted for the full coverage of the community, especially those free from the disease infection, so as to decrease any potential future infection. The participants considered that people should be made well aware of fascioliasis and its burden on their health and life. This view on the necessity of repeated activities of health education for fascioliasis control was shared by a local health volunteer.

> *"To me, health education should be directed to those who were examined but not infected, as they could feel contempt for* [the risks of disease infection]*."* (FG1, village health volunteer #1, female 46)

Another recommendation to increase the effectiveness of the control model for fascioliasis was to improve the reporting system at the local health network, and to shift the reporting system from a passive to an active approach. Overall, it is clear from these various views that active case detection right at the community level was considered important to provide a good information system of monitoring and managing patients infected with fascioliasis, rather than just relying on reports of detected cases from upper-level health facilities. An improved reporting system would result in the timely updating of information on the incidence of the disease, which through good logistics would be linked to control measures of the disease.

> *"…it should be noticed clearly that we are operating the information system in a passive way, meaning we collect the data from patient records from the hospitals. Therefore, there should be reinforcement of a good and mandatory reporting system from the grass-roots levels, which will enable us to generate accurate data on the disease burden and demands of the medication supplies."* (IDI #1, health expert, male 53)

In order to achieve a well-managed information system for fascioliasis control, it was noted that training and support would be required, particularly at the local level:

> *'local health staff and volunteers should be trained on literacy, completing forms, and integrate fascioliasis reports with other existing diseases in the community.'* (IDI #7, local health staff, male 51)

The allocation of a sufficient financial budget was another recommendation. Nearly all participants shared their ideas of the various benefits of the model when more incentives were provided. Among the most discussed benefit was the effective maintenance of work performance at the grassroots health and veterinary levels, as shared by local participants:

> *"Although we are enthusiastic with our job, there should be some sources of financial supports, as we had to conduct lots of health programs in one integrative activity."* (FC1, village health volunteer #8, female 35)

> *"When more budgets are spent on the activities of de-worming the cattle, either in money or in kind [medication], full coverage of cattle being de-wormed could be achieved."* (IDI #8, local veterinary staff, 25)

In conclusion, various recommendations by participants of the interviews and focus groups provided insights into the improved implementation of the broadly-based control model for fascioliasis in the intervention communes. Recommendations focused on stronger multidisciplinary co-ordination, improved health education measures, an active reporting system of fascioliasis, and sufficient financial allocation.

7.4 Discussion

The aim of the mixed methods data collection was to elicit insights from key participants in, and recipients of the interventions into the various components of the fascioliasis control model in the intervention communes and the additional actions that could be taken. The results included positive factors such as increased awareness of participants and their commitments to participation in, and strong support for the model; and negative factors comprising time constraints, technical difficulties and financial issues. Some important factors not adequately covered in the initial model were also identified. The exploration of these factors not only added further information to help develop the model, but also confirmed the importance of this qualitative data collection aspect of the program evaluation.

A connection was identified between increased awareness of fascioliasis and the motivation to be engaged in the activities for the disease control. These motivations could be categorised as internal (own professional opportunities for gaining experience working to prevent the disease infection) and external (inputs of the program and incentives). At the program level, the well-described awareness of fascioliasis and its associated risks initiated strong motivation from key informants, which translated into commitments of engagement and support. At the household level, perceived awareness from personal experiences of the disease infection, and regular health education strategies in the communal setting, enabled a well-informed community to pro-actively participate in the intervention. As presented in the model implementation (Chapter 5), the concrete components in this broadly-based control model for fascioliasis included health education, workshops to increase the quality of diagnosis and treatment of fascioliasis, veterinary and other related sectors' activities, vector control, and improvement of disease surveillance and management (Figure 2.2, Chapter 2). These inter-linked factors were considered to contribute to the successful outcomes in terms of reduced seroprevalence and increased awareness of the disease (Chapter 6). However, not mentioned in the model were several subjective factors, including commitment and support from the key informants and stakeholders, and especially the involvement of the community. These factors were considered to have made important contributions to the outcomes achieved through the intervention and hence need to be added to the model.

The study results were consistent with other studies in terms of factors identified as contributing to a successful pilot or to small programs aimed at disease control. Such factors included stakeholders' participation, positive community motivation and support, availability of funding, and effective communication (Molyneux, 2006). The results from this study were in agreement with some community-based projects and studies in Vietnam and other regional countries (Sinh Nam, Thi Yen, Minh Duc, Cong Tu, Trong Thang, Hoang Le, Hoang San, Le Loan, Que Huong, Kim Khanh, Thuy Trang, Lam, Kutcher, Aaskov, Jeffery, Ryan and Kay, 2012; Sripa *et al*., 2015), which considered the participation of stakeholders and community to be a key for success. Achieving high levels of community involvement in the disease control measures would only be possible when community members are well aware of the disease as a public health concern, and the intervention is considered effective (Halton, Sama, Barnett, Leonardo and Graves, 2013). These qualitative findings found a strong connection between the well-described awareness of the disease and the pro-active participation of the community. This factor should be considered a priority in future community-based programs for vector-borne disease control.

Factors that impeded the successful fascioliasis control model were identified as time constraints, technical difficulties in vector control and resourcing, and other non-human related causes. These challenges were important factors that should be pro-actively considered in order to improve the current model.

The challenge of time constraints in relation to the limited time available to spend on health education activities at the household levels had not been identified in previous studies. The challenge involved both time to access household members within the constraints imposed by their farming lifestyle, as well as conducting health education over a longer time, so as to reinforce the message and facilitate behaviour change. Time challenges have been raised in previously reported studies (WHO, 2007a), however, this issue has not been mentioned in relation to health education campaigns in the other studies conducted in Central Vietnam (Nguyen, 2010; Nguyen, 2012).

Among the technical difficulties identified by participants, vector control measures were perceived to present the most challenges. Vector control included consideration of the host-pathogen relationships, community behaviours and practices, and available resources. The complex relationship between the pathogens (*Fasciola* larvae) and hosts (snails, human, and animals) has been discussed in the literature (Mas-Coma *et al*., 2009) and various options to deal with vector control of fascioliasis have been introduced (Copland and Skerratt, 2008). Although integrated approaches such as "One Health" were advocated elsewhere for the control of fascioliasis and other zoonotic diseases (Bidaisee and Macpherson, 2014; Mramba and Abdul-Hamid, 2015; Welburn, Beange, Ducrotoy and Okello, 2015), such a comprehensive approach had not been in place or conducted within the Asian region (Sripa *et al*., 2015). The lack of existing measures to deal with vector control for fascioliasis was not well acknowledged in the model. These results have highlighted the major challenges associated with vector control and the need to provide sufficient attention to achieving vector control in a fascioliasis control model.

Resourcing difficulties in budgets and with human resources were presented as challenges to the fascioliasis control model. Poor financing and limited staff allocation problems arose as fascioliasis was not listed among Vietnam's national health target programs (adapted from http://www.chinhphu.vn), despite Central Vietnam being categorised as a hyperendemic region of fascioliasis with an annual seroprevalence of 200 cases (WHO, 2007b). Resourcing limitations could hamper the long-term achievement of the fascioliasis control models. A comprehensive control program would strive to have the disease (in this case fascioliasis) identified as a priority at the national level, as a minimum at least in relation to areas of the country that were experiencing hyperendemic foci of infection (Hotez, Bottazzi, Franco-Paredes, Ault and Periago, 2008; Rojas *et al*., 2010).

Measures to minimize unexpected but still somewhat predictable externalities should be included in a disease control model. Natural disasters such as rain and flooding are predictable and their sudden occurrences have considerable impacts on communities in terms of health, and emotional and economic burdens (de Ville de Goyet, Marti and Osorio, 2006). In particular they may pose significant negative impacts on components of a control model, for example through dispersal of infected cow dung, and thus impact on a program's effectiveness. All the components in the model were profoundly feasible and could be conducted as planned, when 'normal' circumstances occur. However, the model should also have the capacity to plan for, deal with or manage the impacts of predictable externalities such as sudden monsoon rains and flooding, which would be common occurrences in geographic areas where fascioliasis was likely to occur.

7.4.1 Limitations

The qualitative inquiry of this study complemented the quantitative methods by providing insight into the in-depth information relating to the subjective factors of the model. There are several limitations of this qualitative research with respect to the sampling strategy and the types of analysis.

The qualitative inquiry employed purposeful sampling as the most appropriate technique for the identification and selection of individuals or groups of individuals, who own specific knowledge of fascioliasis or are experienced with the disease, for interviews and focus groups (Creswell and Plano Clark, 2011). By identifying and selecting the sample, the researcher aimed to achieve information-rich participants for the most effective use of limited resources (Patton, 2002). However, purposive sampling strategies in this qualitative research are prone to challenges in terms of participant selection and possible influences on their expression of ideas or opinions.

For interviews, the purposive sampling strategies focused on maximum variation, with which the researcher aimed to achieve different perspectives in awareness of, motivations for, and roles in participating in the model. Nevertheless, as involved participants ranged from different professional areas such as health, education, veterinary sectors, and local authorities, the range of variation should be known at the outset of the study (Palinkas, Horwitz, Hoagwood, Green, Wisdom and Duan, 2015). In addition, although identification of the participants was highly relevant to the researcher's purpose of the study, experts in fascioliasis might focus on providing data related to the disease control and not other social-economic activities, thus resulting in no new ideas being expressed, but not actually providing data saturation (Patton, 2002; Macnee, 2004).

However, similar to any other non-probability sampling approach, purposive sampling is subject to some sampling issues. Over confidence on a small number of purposively selected participants can result in findings which may not represent the general population (Keele, 2011).

For focus groups, homogeneity was the focus in choosing participants as the researcher aimed to explore their common experiences with fascioliasis. Although there was no coercion among the group containing household representatives, this kind of ethical challenge could happen in the group containing local health volunteers, a problem which has been reported in other health-related studies (Hem, Molewijk and Pedersen, 2014; Molewijk, Hem and Pedersen, 2015). This could result in primarily positive comments being expressed among the group. In addition, it is possible that not all factors contributing to or impeding the model's effectiveness were identified by the focus groups (Marshall and Rossman, 2006), as placing too much reliance on the information given by a small number of participants in a study such as this may lead to accidental bias (Morse, 2006).

Therefore, guidelines should be developed for interviews and focus groups as was undertaken for this study, as presented in the Methodology chapter (Chapter 3).

The application of word frequency count and group query was helpful to organize, structure and store the qualitative data (Bazeley, 2007; Wong, 2008) but this also had some limitations. The word frequency count de-contextualized the words (for example 'fascioliasis' in this study) to the extent that they might not be understandable. Application of the word frequency could be misleading as participants attending the interviews or focus groups might mention the words by habit, which unnecessarily raised the importance of the counted words. At the group level, the exploration of the word-group-related aspects could not be entirely achieved as they were developed from the personal experiences of the researcher, which may not fully explore the richness and meanings of the data.

7.4.2 Refinements to the model

The qualitative inquiry in this study explored and discussed the underlying factors that either assisted or impeded the success of the broadly-based control model of fascioliasis in Central Vietnam. Besides the motivating factors that were identified to further strengthen the effective intervention measures, factors that acted as barriers to the model should be determined as they may help in any further consideration on designing and implementing any community-based disease control models. These factors should be added to the existing model (Figure 2.2), which was described in Chapter 2. Consequently, the new updated model comprises factors belonging to two groups (system level support and sustainability), which is visually presented (Figure 7.4). The refined broadly-based control model of fascioliasis l could potentially and effectively help control parasitic diseases in Vietnam, and hence inform the initiatives of the other community-based control projects in other countries of the region.

7.5 Conclusions

Qualitative data collection provided important insights into the components of the community-based model and areas for improving the model in the future. Overall the control model was considered effective. Positive factors of the model included strategies to develop the awareness, motivation, commitment and support of the stakeholders and the community. Factors impacting on the success of the model included time constraints, technical difficulties and significant natural environmental events. The information gained through speaking with key stakeholders, community workers and community members themselves identified important factors that hitherto have not been incorporated into disease control models. These important factors played a significant contribution to the refinement of the broadly-based control model for fascioliasis in Central Vietnam.

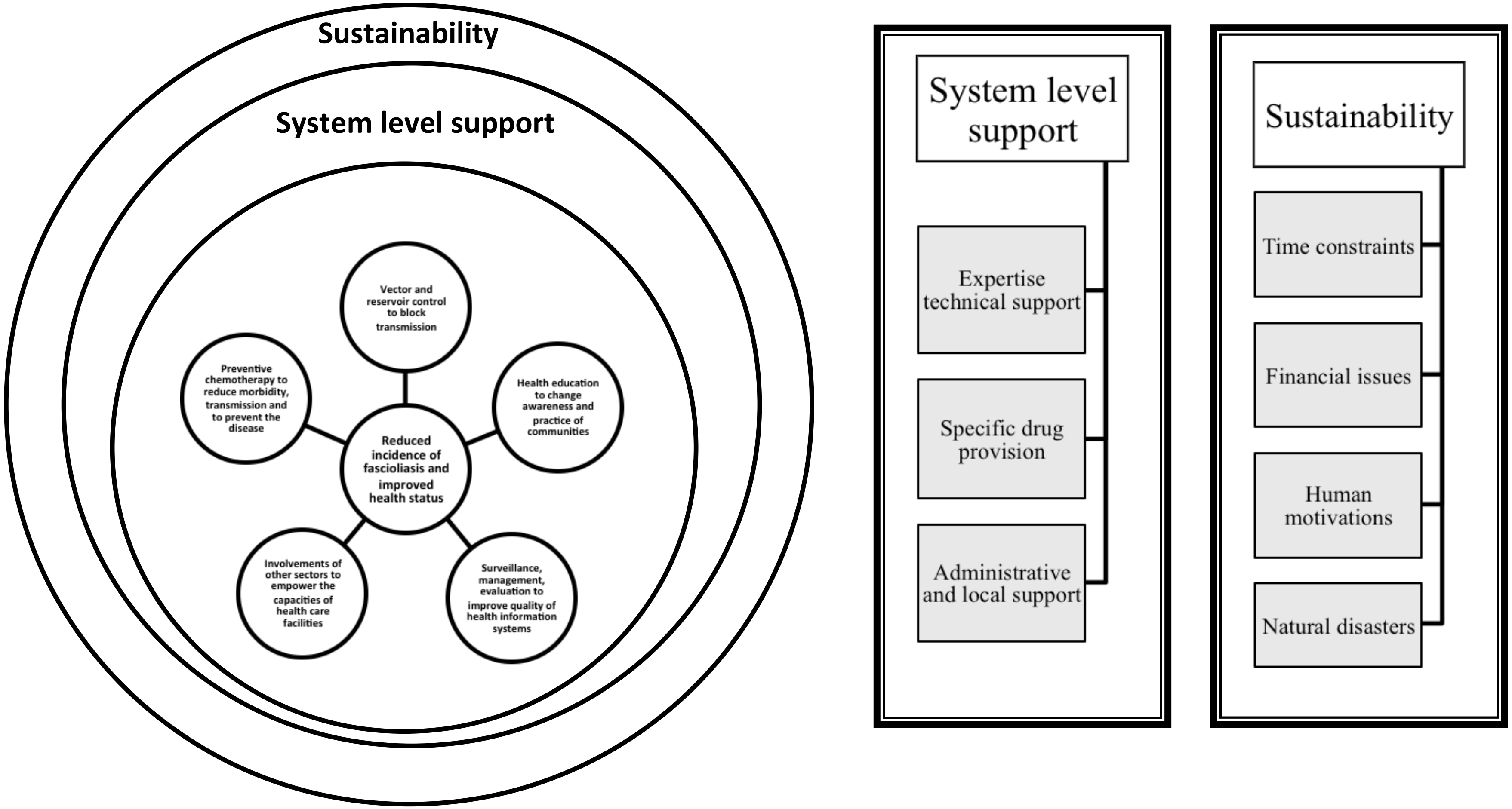

Figure 7.4 Refined model with further insights explored from qualitative study

8. DISCUSSIONS AND CONCLUSIONS

8.1 Introduction

The burden of fascioliasis is a major public health concern in Central Vietnam and comprehensive approaches of control measures against the disease have been advocated (MOH, 2006). A broadly-based, effective control program was designed and implemented in a commune with high fascioliasis seroprevalence. This research has provided important new contributions to understanding effective control strategies for this, and potentially other, vector-borne diseases.

This chapter discusses the study findings. The chapter starts with a reiteration of the disease problem and the challenges of its effective control, laying the foundations for the overall aim and objectives of the thesis. Achievement of each of the study objectives is then discussed. Discussion then focuses on further considerations arising from the research outcomes and considers the strengths and limitations of the research, including the intervention model and the evaluation approach. Finally, the overall conclusion of the thesis is provided, which is followed by recommendations for future research.

8.2 Background:

The increasing prevalence of fascioliasis in Central Vietnam indicates that the existing control measures for the disease were not effective. Review of the literature, described in Chapter two, identified the elements found to be important in controlling vector-borne diseases such as fascioliasis. These elements included chemotherapy for humans and animals, health education, co-operation of involved sectors, improvement of the health sector for fascioliasis management and surveillance, and vector control.

Unfortunately, current official control guidelines from the Ministry of Health did not include the comprehensive range of strategies found to be necessary for effective management and control of the disease. The MoH's main control strategies included clinical case management of human cases through passive case detection and decentralised treatment to district hospitals only (MOH, 2006). Increasingly, chemotherapy with (TCZ) 250mg (Egaten®) at 10mg/kg of body weight had been recommended to control the disease (MOH, 2006; WHO, 2007b). The updated strategy also included wider availability of the drug for fascioliasis treatment, improved diagnostic capacity at community levels, and increased population awareness of the disease and its prevention through IEC (information-education-communication) activities (WHO, 2007b). However, other potentially important factors for comprehensive control measures were yet to be included.

Fascioliasis is a zoonosis, involving humans and cattle in a complex pathogen-host relationship, but little has been reported on the co-ordination between human and veterinary public health sectors. Further, the IEC campaigns have been conducted by the health sectors, while overlooking the roles of other concerned bodies such as local authorities and educational, veterinary, and social organizations. There also has been a lack of an informal reporting system for fascioliasis. Data are collected at the hospitals and thus are likely to be under-reported (Trieu, 2011). More importantly, the disease is not listed in the national health target programs (www.chinhphu.vn), which is important for directing resources for control activities.

Through identifying what was required for comprehensive control strategies for fascioliasis, and recognising gaps in the current disease management guidelines, the need for the development and evaluation of a broadly-based control model was established.

8.3 Addressing the overall aim and specific objectives of the research

The overall aim of this study was "*to develop and evaluate the monitoring factors that facilitate or impede the implementation of a broadly-based control model of fascioliasis in a community with a high prevalence of fascioliasis in Central Vietnam*". The specific objectives of the research have been addressed in the respective chapters of the thesis.

8.3.1 Fascioliasis prevalence – establishing the baseline data (Chapter four)

Objective 1: To determine the seroprevalence of human fascioliasis by laboratory methods prior to the interventions.

Objective 2: To describe the risk factors associated with fascioliasis infections by conducting surveys on knowledge, attitude and practice (KAP), household observations, and snails.

Chapter four determined the seroprevalence of human fascioliasis by laboratory methods; and described the associated risks of the disease infection, based on the results of surveys regarding the knowledge, attitudes and practices (KAP), household observations, and snail collections. Findings of the baseline surveys indicated a high seroprevalence of human fascioliasis, which was accompanied by low awareness of the disease in the study areas. In addition, the frequency of high-risk behaviours was also shown in the reported and observed daily practices of people in the cohorts under study. The presence of the parasite (*Fasciola* larvae) in collected snails, though at low prevalence, supported the potential larval transmission of fascioliasis in the study areas.

The baseline results provided strong support for the need of a broadly-based control model, including chemotherapy, vector control, health education, surveillance, management, evaluation, and involvement of concerned agencies such as educational, agricultural and community organizations.

8.3.2 Broadly-based control model of fascioliasis in Central Vietnam: rationale, implementation and evaluation (Chapters five, six and seven)

> Objective three: To report on the implementation of a broadly-based control model for fascioliasis infection. The broadly-based fascioliasis control model includes chemotherapy, vector control, health education, surveillance and management, evaluation, and involvement of concerned bodies such as educational, agricultural and social organizations.

Chapter five reported on the implementation of the broadly-based control model for fascioliasis infection in Central Vietnam. The implementation of the model was based on the rationale for the model development (presented in Chapter two) with model components applied differently depending on the purpose of the study design (Chapter four).

8.3.2.1 Rationale for model development

As discussed in the literature, no comprehensive control initiatives for fascioliasis or other food-borne trematodiases were available in various parts of the world (Lustigman *et al*., 2012), including Vietnam and other neighbouring countries, where the diseases were of public health concern (Trieu, 2011; Sripa *et al*., 2015). Thus, this broadly-based approach to fascioliasis control was aligned with the selected control frameworks on neglected tropical diseases, including parasitic and trematodiasis diseases (Molyneux, 2006; Blanton, 2007; Hotez *et al*., 2008; Choffnes and Relman, 2011; Nguyen *et al*., 2011; Sripa *et al*., 2015).

The broadly-based control model of fascioliasis in Central Vietnam was based on a collection of carefully selective intervention measures or potentially effective frameworks (Molyneux, 2006; Nguyen *et al*., 2011), which were considered most appropriate to the specific context of Central Vietnam. Consequently, the most optimal model comprised five main components: chemotherapy, vector control, health education, improvement of the local health system, and involvement of concerned bodies (Figure 2.2, Chapter 2).

8.3.2.2 Implementation of the broadly-based control model of fascioliasis in Central Vietnam

As presented in the research design section of Chapter three (Table 3.1), the implementation of the model components was applied differently in three communes. Intervention 1 commune received all components of the intervention model; whereas the Intervention 2 commune adopted only the chemotherapy for human and animal de-worming activities; and only case treatment of human fascioliasis was applied to the Control commune. Overall, the components of the model were implemented as designed, with certain variations occurring during the implementation at the Intervention 1 commune.

This field-based study applied both human chemotherapy for infected cases in three studied cohorts and animal de-worming measures in two intervention communes. The nominated drug for selective treatment of human fascioliasis, triclabendazole (TCZ) 250mg (Egaten®) at 10mg/kg of body weight was recommended as the first line medication for the disease (MOH, 2006; WHO, 2007b). During the baseline and post-intervention stages, follow-ups of the seropositive cases after the treatment found only mild side-effects on participants at D0 and D1, and the disappearance of these symptoms by D7, which was similar to results from previous studies conducted in Central Vietnam (Huynh *et al*., 2007; Nguyen *et al*., 2007).

The application of chemical de-worming for animals was an important measure to prevent the transmission in both humans and animals. The one-health control measure had been suggested elsewhere (Nguyen *et al*., 2011), but no studies had yet been reported in Central Vietnam on cross-disciplinary, combined efforts of both sectors (Nguyen *et al*., 2010; Nguyen *et al*., 2011). As the funds for this study were limited, the cattle de-worming only achieved less than 40.0% coverage of the total cattle in the intervention communes; the remaining cattle and repeat de-worming activities were part of the regular activities conducted by the veterinary sector, with the payment made by farmers. However these activities were significantly disrupted by the severe typhoon and heavy flooding in late 2013, which resulted in considerable loss of cattle, and impacted the effectiveness of the veterinary fascioliasis control measure. This will be further discussed in the considerations of the outside factors affecting the model.

Health education activities in the Intervention 1 commune used various approaches and were assisted through the participation of pre-trained staff involved in health, educational, agricultural, socio-cultural, other social organisations and local authorities. Apart from the direct measure of household visits, which had been reported in previous studies (Nguyen *et al*., 2008; Nguyen *et al*., 2011; Nguyen, 2012), indirect health education was undertaken incorporating other related sectors and making use of leaflets, communal broadcasting systems, and construction of panels and mottos on fascioliasis control, which provided easy-to-read and understandable communication messages on fascioliasis control. Health education strategies were also utilised in previous studies conducted in Central Vietnam (Dang *et al*., 2011; Nguyen, 2011, 2012). However, these previous studies were not cross-disciplinary in approach and the education campaigns were conducted only by the health sector. In addition, the involvement of stakeholders and the community in these studies was not explored to evaluate their acceptance and participation in the health education campaigns.

In this model, the active participation of the concerned bodies reflected their higher level of cross-disciplinary co-ordination. This was achieved through the strong co-operative activities between health, veterinary, and educational sectors and social organisations. The health and education sectors co-ordinated to provide the school health education campaigns addressing fascioliasis. School students were provided with information about the disease, and were able to conduct health education at their own houses. In addition, cattle dung collection by school children for fund generation was an initiative that resulted from such school health campaigns.

At the community level, the co-operation between health and veterinary sectors achieved significant outcomes in fascioliasis control in both human and animals. In addition to becoming better informed about fascioliasis, farmers began to undertake better practices of fascioliasis control for themselves and their cattle, such as safer dung treatment to avoid fascioliasis infection, the avoidance of watering vegetables with fresh cattle dung, and appropriate grazing management to prevent animal infection of *Fasciola* larvae.

In other co-operative activities, social organizations contributed a great deal to health education campaigns. Their contributions included the regular delivery of fascioliasis control messages on the communal broadcasting systems and the engagement of the local authorities with social organisations, such as women's and peasant's associations, to change community awareness of fascioliasis and control practices for the disease. Such an intersectoral approach has been suggested for fascioliasis control (Hotez *et al*., 2007; Rojas *et al*., 2010), but previous studies in Central Vietnam (Nguyen, 2010; Nguyen *et al*., 2011; Nguyen, 2012) failed to reach the full involvement of other concerned bodies including veterinary and social organizations, as was achieved in this study.

An important aspect of disease control programs is the quality of surveillance and management. Improvements in surveillance of fascioliasis were achieved following training courses conducted for communal health staff and village health volunteers in the Intervention 1 commune. The training comprised guidelines on case detection, referral to highly-advanced laboratory-based health facilities for fascioliasis case confirmation, and more effective management of confirmed cases. Thus prompt treatment of the disease was made possible following timely referrals of suspected cases to advanced laboratory facilities, such as provincial general hospitals or IMPE-QN clinics. In addition, the confirmed cases were sent reminders of the next hospital visits three months after treatment of the disease.

The surveillance and management strategies in this program could be considered the best management practices for fascioliasis, as there had been no system applicable to the disease in Vietnam (MOH, 2006) and the poorly generated data on fascioliasis could not reflect the actual situation of the disease (Carrique-Mas and Bryant, 2013). In addition, the guidelines on diagnosis and treatment of human fascioliasis in Vietnam just focused on passive case detection for clinical case management (usually at hospitals only), not on a community-based prevention and control approach (MOH, 2006). The improved quality of disease surveillance and management, as presented in this study, supports the importance of increasing the capacity of grass-roots health staff in fascioliasis management.

The model adopted inexpensive and environmentally oriented vector control measures for fascioliasis, which were considered most suitable in a community-based disease control strategy in Vietnam. The implementation of evasive grazing husbandry, safer environmental sanitation, safer cattle waste treatment and regular animal de-worming activities was effective for vector control of animal fascioliasis, and they gained community-wide acceptance and practice. Alternative grazing practices for cattle was implemented, which had previously been proven effective in preventing larval infection in the tropics (Chandrawathani, Jamnah, Adnan, Waller, Larsen and Gillespie, 2004; Waller, 2006; Sargison, 2008). In addition, the mixing of cattle dung with rice stubbles, and drying the flattened dung in the sun became a common practice in most of the cattle-raising households, which was reported to have positive larvicidal effects (Suhardono *et al*., 2006a). Furthermore, the avoidance of releasing cattle on freshly-cut rice fields as suggested by Suhardono *et al*. (2006c) was gradually accepted and practised by farmers. Finally, under the guidelines of the staff, the de-worming of cattle with various drugs was performed to prevent animal fascioliasis infection and drug resistance, as had been indicated to occur in other similar situations in other reports (Wolstenholme, Fairweather, Prichard, von Samson-Himmelstjerna and Sangster, 2004; Hein and Harrison, 2005).

However, several difficulties challenged the implementation of optimal animal husbandry practices. Grazing management was dependent on the weather conditions. Although Central Vietnam is sunny for 75% of the days in a year (FAO, 2011), grazing cattle in the rainy season could result in possible animal infection as the infective larvae may be active. Also, the dung could not be dried on rainy days, and it could be swept into the water and facilitate larval development. Additionally during the period of this study heavy flooding caused significant losses in cattle herds and facilitated the dispersal of larva into their breeding areas.

8.3.2.3 Evaluation of the model's effectiveness

Objective four: To evaluate the effectiveness in reducing the seroprevalence of human fascioliasis of the broadly-based control model, comparing its impact with that of a model for treatment of humans and cattle alone, and to the treatment of humans only.

Objective five: To explore the positive and negative factors that motivate or impede the successful implementation of the broadly-based control model of fascioliasis in Central Vietnam.

Chapters six and seven reported on evaluation of the model's implementation. Impact and process evaluations were conducted through a combination of quantitative and qualitative research methods.

The evaluation of the broadly-based control model of fascioliasis in Central Vietnam was undertaken using the logic model, described in the literature (Figure 2.3, Chapter 2). As discussed in the literature and the respective chapters 6 and 7, the evaluation was focused on short-term and intermediate-term outcomes, as the model was implemented within one year. However, these outcomes could provide the initiatives for aiming for the long-term outcomes, such as policy changes for prioritizing fascioliasis control as a national target program in health, as more factors are identified, discussed and added to the refined model (Chapter 7).

Overall, the evaluation of the implementation of the broadly-based control model of fascioliasis found a significantly reduced prevalence of the disease and increased awareness, and practice management, of fascioliasis in a community with high endemicity of the disease. The qualitative inquiry provided further insights into the fascioliasis control model by elaborating on the factors which contributed to, or impeded the successful intervention measures.

The Intervention 1 commune (full intervention measures applied) reported that the prevalence of fascioliasis was reduced significantly ($p<0.05$) compared with the baseline survey; but disease prevalence was not significantly lower in the Intervention 2 commune ($p>0.05$) and even increased in the Control commune. The post-treatment cure rates of the seropositive cases of fascioliasis (125 cases in the baseline and 80 cases in the post-intervention surveys) were 97.9% and 98.2% after 6 months, respectively; and 100% after 12 months. These therapeutic outcomes reaffirmed that the recommended chemotherapy (triclabendazole 250mg, 10mg/kg body weight) was effective for selective treatment, which had been found to achieve 95.0-100% cure rates in previous studies (Nguyen, 2010; Nguyen, 2012).

Importantly the intensified active detection and prompt treatment of fascioliasis at the community level undertaken in this study, which resulted in high cure rates, would also contribute to reducing the problem of drug resistance reported in other studies (Fairweather, 2009; Olaechea *et al*., 2011; Winkelhagen *et al*., 2012; Ortiz *et al*., 2013). Current guidelines for fascioliasis diagnosis and treatment recommend selective treatment following passive detection of human fascioliasis from hospital (MOH, 2006). However, such a strategy has not been effective when compared with active detection of fascioliasis (Mas-Coma *et al*., 2014). The achievement of high cure rates provides further support for the combined efforts of health and concerned bodies to ensure a successful disease control model.

The post-intervention KAP (knowledge, attitudes and practices) surveys also indicated significant increases in the awareness of fascioliasis among the studied participants in the cohorts (in Intervention 1 commune) receiving broadly-based intervention measures, typically health education campaigns. A majority of the community participants in this commune reported the daily practices of healthy eating and drinking as a result of the education initiatives. The reporting of these behaviours was at significantly higher levels as compared with the baseline results and the other two communes (the Intervention 2 commune and the Control commune). The post-intervention findings reported only a very small proportion of respondents who still drank improperly treated water.

Personal sanitary practices were significant factors in fascioliasis management. A significantly higher proportion of respondents reported using toilets to prevent spreading *Fasciola* into the environment; non-use of toilets was a common practice before the health education strategies. The observations of household conditions confirmed that higher proportions of households used hygienic water sources (tap water and protected wells) and well-structured toilets compared with the baseline data. Such behavioural changes have also been noted and evaluated in previous studies utilising community-based approaches (Nguyen *et al*., 2008; Nguyen *et al*., 2008; Nguyen, 2011). While the previous studies found positive results consistent with those reported here, they were conducted in smaller geographical areas and their relative effectiveness in disease control in the whole region was not determined.

This study also reported positive impacts on community practices related to animal fascioliasis control activities. Shelter-based or semi-grazing forms became popular, alleviating the risks of fascioliasis transmission in the cattle. Appropriate cattle dung treatment, such as mixed dung and rice stubbles or spreading dung in the sun and animal de-worming activities, were also reported to be undertaken by cattle raising households. Such intermediate-term outcomes were reportedly as a result of closely co-ordinated work between health and veterinary sectors in this study.

The second snail surveys were implemented during the rainy season (from September to November), which provides more favourable conditions for the development of the intermediate host lymnaeid snails (GSO, 2013). Although a higher number of snails were collected during this period, significantly lower snail infection rates were indicated in the two intervention communes 1 and 2. The differences could reflect the effects of the veterinary chemotherapy (de-worming for fascioliasis control) and other intervention measures (alternative grazing, safer cattle dung treatment), which may have indirectly resulted in significantly lower fascioliasis prevalence in snails.

The quantitative findings provided evidence to support the view that in order to achieve the reduced seroprevalence and increased awareness and safer practices regarding the disease, a broadly-based control model of fascioliasis should be applied. Such integrated control measures have also been reported in previous studies to be more effective than non-integrated approaches in terms of longer-term achievement of goals (Salam, Das, Lassi, Maredia and Bhutta, 2014).

The qualitative inquiry presented in Chapter seven provided additional insight into the broadly-based control model of fascioliasis in the Intervention 1 commune. These data indicated important factors that had not been adequately considered in the model.

Positive factors included the important role of participants through increasing their awareness, thus increasing their commitment and motivation to participate in the intervention and to support the model. Negative factors or barriers to engagement which hindered the effectiveness of the interventions included time constraints, technical difficulties and extreme weather events. These subjective factors, which were not overtly included in the model's components, were considered to be key to the success of the intervention.

A key factor in building strong commitment, support, and pro-active participation of stakeholders and community representatives came from their positive awareness of fascioliasis. At the system level, key informants' positive perceptions toward fascioliasis control and its risks facilitated their motivation to address it through their professional roles and activities. These factors were considered to encourage higher levels of support, which were described in the refined model (Figure 7.4, Chapter 7). Although stakeholders were not engaged during the design of the broadly-based control model of fascioliasis in Central Vietnam (CDC, 2011), their professional roles, support and active motivation during the implementation of the model indicated that they can play their roles in any phase of the evaluation process, but most effectively in the implementation stage as in this model.

At the household level, community representatives indicated their motivation to follow positive behaviours and were well informed about the disease following the interventions. Community motivation proved to be an important indicator for success with some parasitic control strategies, including fascioliasis (WHO, 2010c). In this model, such continuous motivation and changed practices are needed as driving forces behind a sustainable fascioliasis control model in the future.

In Vietnam and other Southeast Asian countries, few studies have undertaken qualitative inquiry to provide further insights into the successful application of community-based interventions. In a community-based dengue control program, the important roles of local authorities, the community and school children as health education collaborators were emphasized as key factors to the successful implementation of the dengue program (Sinh Nam *et al*., 2012). In another community-based opisthorchiasis control project, treatment coupled with health education was suggested as the most effective measures for engaging community participation. The roles played by local health volunteers and school teachers were viewed as better than 'outside experts' in improving the community's awareness (Sripa *et al*., 2015). However, more multi-disciplinary efforts should be made to achieve more effective outcomes. In the dengue control program, it was identified that the co-ordination between the health and agricultural sectors should be strengthened to deal with the water-borne vectors of the disease. In the opisthorchiasis control project, the focus was on the relationship between the veterinary and public health surveillance systems, as fresh-water fish and snails acted as significant hosts in the transmission of the zoonosis disease (Halton *et al*., 2013).

The qualitative study component also explored the factors that acted as barriers to the successful outcomes of the fascioliasis control activities. Commonly identified challenges included technical difficulties, time and resource constraints, and other non-human factors, which were considered to be factors influencing the sustainability of the refined model (Figure 7.4, Chapter 7). Among these challenges, vector control still remained the most difficult to address effectively and it was identified that stronger co-ordination between health, veterinary, and other concerned sectors was required, as was the active engagement of the community. Time constraints were raised by local health volunteers as challenges to implementation, together with a lack of financial resources. Helminthiasis and fascioliasis control activities were not prioritised as a national control program (www.chinhphu.vn) and thus resources had not been allocated. Finally, the occurrence of extreme weather events (flooding) greatly affected the outcomes of the model's effectiveness. As monsoon rains and flooding occur regularly in areas affected by fascioliasis, the impacts of these events should be actively considered within any feasible control measures for fascioliasis.

The qualitative mixed methods findings suggested that some positive and negative factors should be added or taken into consideration in applying the broadly-based control model of fascioliasis in Central Vietnam. Coupled with the concrete model components, these factors will have a holistic effect in effectively controlling fascioliasis in Central Vietnam and informing other regions of the country of the initiatives.

8.3.3 Considerations of variation during the evaluation of the broadly-based control model of fascioliasis in Central Vietnam

Although the broadly-based control model of fascioliasis was successfully implemented in a commune with high seroprevalence in Central Vietnam, there were some factors not previously mentioned during the model implementation, which should be added to the refined model (Figure 7.4, Chapter 7).

The advent of the sudden weather events usually cannot be predicted, but they should be expected, and their severe consequences should be anticipated and evaluated. Vietnam is listed among the top 10 countries in the world which are the most vulnerable to impacts of extreme weather events in terms of fatalities and economic losses (Kreft, Eckstein, Junghans, Kerestan and Hagen, 2014). More specifically to this study, the changes in rainfall and evapotranspiration as a result of heavy flooding could facilitate more favourable conditions for the development of trematodiases, including fascioliasis. Flooding water creates standing water collections, which are new habitats for disease vectors such as lymnaeid snails-intermediate hosts of fascioliasis (Mas-Coma *et al*., 2009a). In addition, increased rainfall extends the risks of contamination by facilitating *Fasciola* larvae to develop their free-swimming stage in the water, and the vector stage in snails, which also rely on water environments (Fuentes, Valero, Bargues, Esteban, Angles and Mas-Coma, 1999; Mas-Coma *et al*., 2009a).

To alleviate the consequences of the natural events, and to eventually restrict the transmission of the disease, various measures could be applied. This study undertook the de-worming activities before the rainy season in Central Vietnam, from September to November (GSO, 2013), which should have had some preventive impact on the cattle against the new fascioliasis infections. However, this measure could not achieve full protection of the animals, as the active larvae are more adaptive to large and deep-water collections such as canals and ponds rich in aquatic vegetation (Mas-Coma *et al*., 2009a), which are especially common during the rainy season in Central Vietnam. In addition, the influence of poor financial support as the result of non-prioritized control activities for fascioliasis could render control efforts to animal and human fascioliasis ineffective.

Financial support for a program or project is another important consideration, as it can facilitate or impede the implementation of the intervention measures. This has been proven in major national disease control programs or projects that have received considerable resource inputs (Hotez *et al*., 2008; Rojas *et al*., 2010; Sinh Nam *et al*., 2012; Sripa *et al*., 2015). In this study however, the implementation of the model components were not financially supported as fascioliasis and other helminthiasis control activities were not listed as national prioritised programs (www.chinhphu.vn). This study utilised funding support from various sources, including the locally allocated budget for overall health care activities. As local support was an important factor in the success of this program, directly benefiting the community, more investment from the government on targeting tropical neglected diseases, especially fascioliasis, is warranted.

8.4 Strengths and limitations of the model intervention measures and the evaluation activities

This section provides a discussion on the strengths and limitations of the intervention measures of the model. It goes on to discuss the strengths and weaknesses of the evaluation activities, with measures for addressing the weaknesses in the methodology. These strengths and weaknesses have previously been discussed in each of the constituent chapters of the thesis. However, they are reiterated here to provide consolidated insight to inform further research into fascioliasis and its control measures in Central Vietnam.

8.4.1 Strengths and limitations of the intervention measures of the model

The outstanding strength of the thesis is the development and implementation of the broadly-based control model of fascioliasis in Central Vietnam, in the context of a lack of availability of effective control measures against the disease (Trieu, 2011). Inspired by an incomplete trial model of fascioliasis control and non-specific intervention frameworks for parasitic diseases control (Molyneux, 2006; Nguyen *et al*., 2011), the selected components in the current model were found to be most appropriate to the typical settings of Central Vietnam.

The implementation of the broadly-based control model of fascioliasis in Central Vietnam was undertaken as planned. This required careful selection of the model components from previously-proven effective approaches or frameworks (Molyneux, 2006; Nguyen *et al*., 2011), and a rationale for selecting optimal control measures against the disease based on the actual disease burden of the intervention area (Trieu, 2011). The model implementation resulted in significant changes to intended indicators (reduced seroprevalence, increased awareness and practice, and reduced prevalence of snails as intermediate hosts of fascioliasis) in a commune where full intervention measures were implemented. Compared to the other two communes applying partial intervention or control approaches (Table 3.1), significant differences were achieved. Importantly, the successful model could inform the initiatives being undertaken in other regions of the country.

However, as qualitatively discussed in chapter 7, unexpected challenges occurred during the model implementation, which should be added to the model. These challenges included time constraints, technical issues, resourcing, and extreme weather events, which significantly affected the outcomes of the intervention measures. Time constraints were thought to impede the effective health education activities because a proportional community was not reached within the reasonable time frame. In addition, vector control measures were considered to be the most difficult challenge as no formal vector control programs have been shown to be effective (Sripa *et al*., 2015). Further, resourcing difficulties, in terms of unavailable financial inputs and insufficient staffing procedures, resulted in considerably ineffective implementation activities of the model components. Last but not least, extreme weather events such as torrential rains and flooding caused a great deal of damage, not only in socio-economic losses but also to achievement of the model. Although recommended perception was expressed to minimize the impacts of the influential factors, lessons should be learnt from these challenges to achieve more effective implementation of the model in the future.

Finally, the visual presentation of the refined model, as presented at the end of Chapter 7, provided a summary of the most comprehensive strategies with connected interlinked factors (Figure 7.4). Adding these unanticipated factors to the model made an important contribution to the model's effectiveness, and informed the initiatives of other sustainable community-based control projects.

8.4.2 Strengths and limitations of the evaluation activities

The main focus of this section is on the evaluation of the strengths and limitations of the study methodology with regard to the study design, sampling, and time frame. Having been discussed in the methodology chapter (Chapter 3), this section describes the strengths and limitations of each methodology in conducting the studies.

As presented in Chapter 2, the description of the logic model for evaluating the broadly-based control model for fascioliasis in Central Vietnam was a major focus of the evaluation process (Figure 2.3). In section 2.5.3, the effectiveness of the logic model was evaluated, and it was decided that the explanatory sequential mixed-methods design was the most suitable approach for collecting quantitative and qualitative data. Findings from the quasi-experimental quantitative studies provided credible evidence (changes in statistical indicators) for the model evaluation; whereas the exploration of qualitative mixed-method (interviews and focus groups) provided further insight into the model.

This study applied the sequential explanatory mixed methods design to achieve both statistical confirmation of significant change and further insight into the model via the qualitative inquiry (Creswell and Plano Clark, 2011, p. 69). The order of this mixed methods design, the predominant quantitative followed by the qualitative components, has proven appropriate for the data collection of the study. In the current study design, the findings from the analysed quantitative data facilitated the qualitative data collection, analysis, and interpretation to answer the mixed methods questions, so as to provide realistic and relevant data to help determine initiatives for evaluating the effectiveness of the broadly-based control model of fascioliasis in Central Vietnam. This described study process (Jupp, 2006, p. 217-218) was in line with other community-based intervention approaches (Shadish, Cook and Campbell, 2002). Increasingly, the quantitative component of this study for the first time applied the manual Bonferroni adjustment (Bland and Altman, 1995) to allow multiple comparisons in the two-sample situations, while ensuring the overall confidence co-efficient (Chadha, 2006). Thus, the selection of groups for intervention and control (two intervention groups and one control group) in the pre-post design of this study provided a strong basis for comparisons of, and inferences from, the study findings.

Although there were concerns about the mismatch or integration of the quantitative-qualitative data (Bryman, 2006, 2007), the current research indicated that the findings from the two inquiries were highly supportive of each other. Evaluation found that the model was successful as significant changes were achieved; and these changes were explored to add further insight in the model. More importantly, this has been the first mixed methods design to be conducted in the research on fascioliasis in Vietnam, which also employed a 'triangulation' approach for greater validity. In this current research, 'triangulation' was found in the methodology (combined quantitative and qualitative methods), data (statistical and textual analyses), and the researchers (experts in quantitative and qualitative research) (McDaniel, Cardwell, Moeller and Gray, 2014). It is the triangulation that contributed to minimize the concerns of the integration.

The quasi-experimental quantitative design in this study may not have the same level of rigour and validity as one based on an experimental design, in which "participants [are] randomly assigned to groups that undergo various researcher-imposed treatments" (Leedy and Ormrod, 2010, p. 108). However, the non-randomized control group pre-test and post-test settings in this study design (two intervention communes and one Control commune, Figure 3.1, Chapter 3) allowed the current researcher to achieve rigour while not being affected by randomization (Bonell *et al*., 2011). In addition, the study design facilitated convenient field-based data collection, in which the natural environments were not affected by the human-controlled laboratory or clinical settings and complicated standards of participants as in the experimental design (Thompson and Panacek, 2006; Lennon-Dearing and Neely-Barnes, 2014, p. 12). Moreover, this study indicated that the three cohorts shared common ethnographic, geographic and other socio-economic characteristics; the issue of the difficulty of randomization of subjects by geographical distributions as in a highly-credible experimental approach did not affect the sampling procedures and interpretation of the study results (Harris *et al*., 2006).

The Bonferroni adjustments (adjusting statistical significance for the number of tests that have been performed on study data) for multiple tests required highly significant levels, thus more samples were required (Leon, 2004). In this quasi-experimental quantitative design, three communes were involved in KAP surveys. The significant level ($p < 0.017$) for these multiple comparisons required a minimum number of 600 participants in each study site, thus creating heavier workloads and was time consuming. In addition, the interpretation of the results heavily depended on the number of tests performed (László Zsolt, 2006).

The cross-sectional surveys were applied to separate cohorts to identify the seroprevalence of fascioliasis and to explore their knowledge and attitudes; although they came from the same commune. These could result in difficult interpretation of the study results as they did not show the direct association between the prevalence of fascioliasis (ELISA-based blood test) and the risk factors from the KAP. This study was a pilot to test the overall impacts and the feasibility of a broadly based fascioliasis intervention model. Thus the study primarily explored the risks of fascioliasis across the whole community. Further research would need to be undertaken to determine which aspects of the intervention, and of the KAP, the behaviours and environmental factors, accounted for the reduction in prevalence of fascioliasis.

The morphologically microscopic examination of lymnaeid snails as intermediate hosts of fascioliasis could not achieve highly-specific species identification, which was probably due to a lack of experience (Doanh *et al*., 2012). This could lead to incorrect interpretation of the transmission roles of the mollusc species in comparison to the highly sensitive PCR (Polymerase Chain Reaction) technique (Dung *et al*., 2013).

Finally, as the broadly-based control model of fascioliasis in Central Vietnam was implemented within one year (except for the treatment follow-ups which last for six more months to one year), the limited time could not ensure sustainable outcomes, as disease control may require a long-term commitment (Molyneux, 2006). Therefore, as this study implied, the successful implementation of the model should be able to inform the initiatives in other regions of the country in well-supported projects or programs to achieve the long-term sustainability required.

8.5 Conclusion

This thesis provides important contributions both to the design and implementation of fascioliasis control strategies and to the evaluation approach of such strategies.

The study has confirmed that a broadly-based fascioliasis control model, which includes five co-ordinated components of chemotherapy, health education, involvement of concerned bodies, improvement of surveillance and management, and vector control, can be effective in controlling fascioliasis in Central Vietnam. Although there are certain challenges influencing the outcomes of some model components, overall this has been the most comprehensive model, and has been the most effective, for fascioliasis control in Central Vietnam. This effective model could feasibly inform the initiatives in other regions of the country.

The mixed methods approach to evaluating this program's implementation has demonstrated the utility of combining qualitative and quantitative research to explore the positive components and challenges to community-based interventions to control vector-borne diseases. The quantitative quasi-experimental approach, though achieving less rigour and validity than the experimental design, provided the most current, realistic and relevant initiatives for the implementation and evaluation of the model. Qualitative mixed methods data collection provided greater insights into the model, which advocated a more comprehensive refined model for future intervention in fascioliasis and other parasitic diseases control. Moreover, the discussed limitations in terms of research methodological factors suggest that further improved design for the implementation of the model is possible.

8.6 Further considerations not covered by this research

As a result of this study, a number of recommendations have been raised for further research, including:

- In-depth research on the immunodiagnostic tools for fascioliasis should be validated to identify the most standardized test procedures, optimal test systems, and the possible cross-reaction with other food-borne trematodiases.

  Results (Chapters 4 and 6) in this thesis have indicated that although the MoH approved ELISA kits were applied for seroprevalence of fascioliasis in studied areas, the limited commercial supplies of the test kits, issues of specific antigens, and lack of a validated optimal system may challenge the immunological diagnosis in many areas in which the disease is endemic, including Vietnam.

- Morphological examinations of snails (Chapters 4 and 6) could result in low species identification of lymnaeid snail as intermediate hosts. Therefore, molecular techniques (e.g. PCR-Polymerase Chain Reaction) being the most highly-sensitive techniques, could allow for clarification of some key elements on the epidemiology of human and animal fascioliasis in Vietnam.

- This study did not undertake surveys on animal fascioliasis, which was also highly endemic in Central Vietnam as domestic animals cause contamination of the water bodies and vegetation. Results from both human and animal epidemiological studies could provide the most convincing knowledge on the local epidemiology and transmission characteristics of fascioliasis in Central Vietnam, which would help to develop appropriate intervention measures against the disease.

- Further research relevant to the associated risks of fascioliasis should include other socio-economic factors.

  The living standards and conditions of the study population are important determinants of fascioliasis transmission in Central Vietnam. When all associated risks of fascioliasis are covered, the precise overview of the disease situation could be properly evaluated.

- The sustainability of the model should be examined to inform the initiatives in other regions of the country.

  This is particularly important as the effectiveness of the long-term intervention measures may be reduced over time, especially when the investment in the model ceases. The model components should be studied for improvement or adjustment when they are expanded into a bigger project or program to secure long-term achievement.

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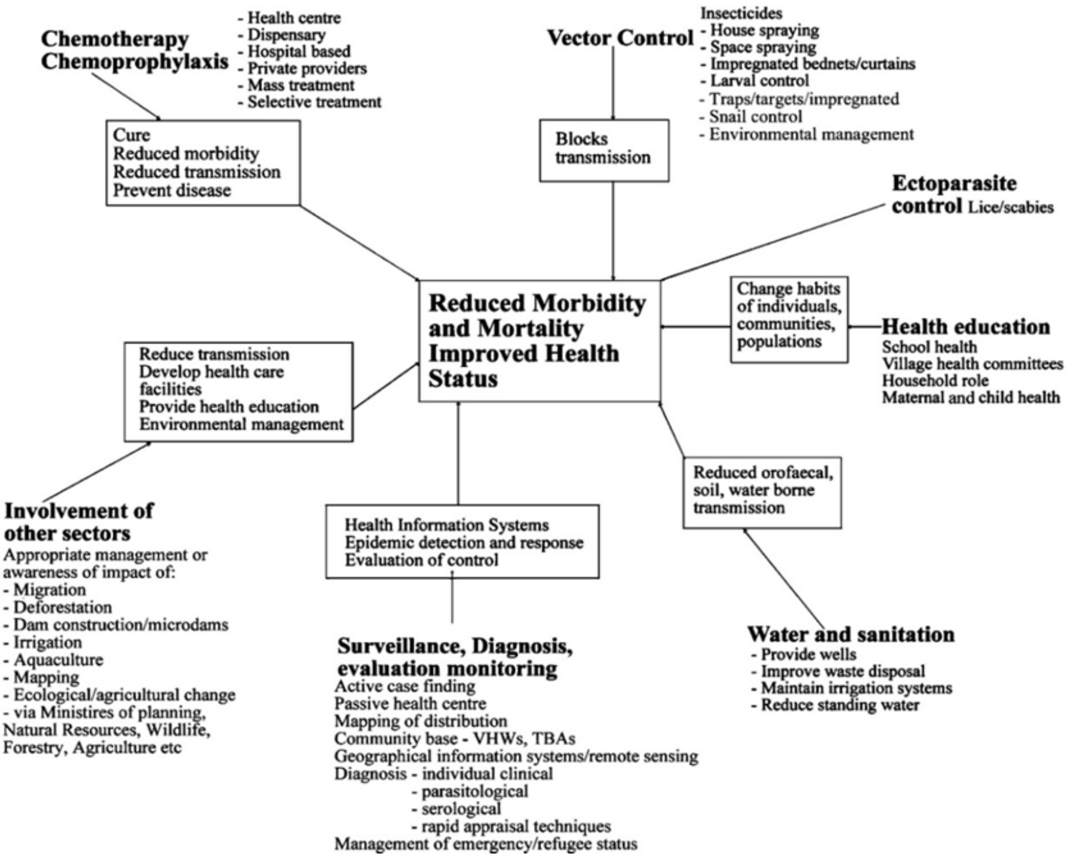
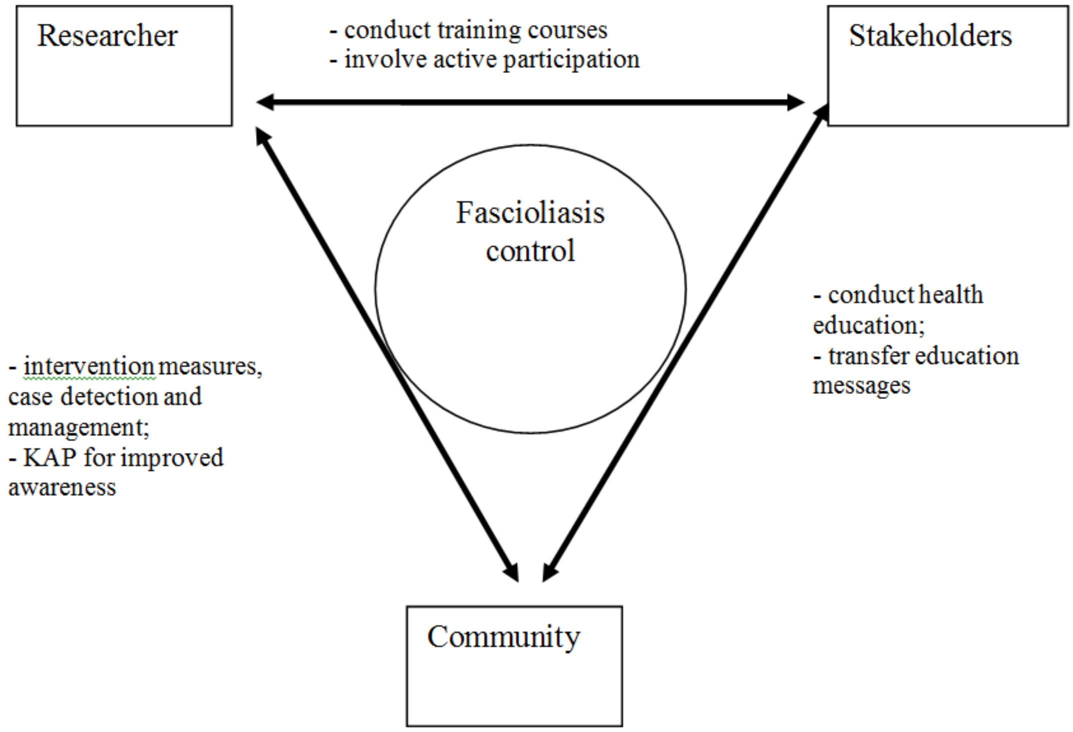
Appendix 2.1 Components of interventions against fascioliasis adapted from *Control of human parasitic diseases: context and overview* (Molyneux, 2006)



Appendix 2.2 Trial model of fascioliasis control in two communes of Phu Cat district, Binh Dinh province (Nguyen *et al.*, 2011)



Appendix 3.1 list of formulas

Formula 1. Explanations on sampling method for blood survey on fascioliasis (liver fluke)

The sample for cross-sectional study will be calculated by the formula for statistical methods for sample size determination by Lemeshow at al. (1990, p. 1), with known infection rate from previous study conducted in a neighbouring province of Khanh Hoa (Nguyen and Le, 2007).

$$n = \frac{Z^2_{(1-\alpha/2)}P(1-P)}{d^2}$$

n: minimum sample size needed

p: infection rate obtained from previous studies: the infection rate of 6.3% (P= 0.063) will be selected based on the results of previous study conducted in the neighbouring province of Khanh Hoa (Nguyen *et al*., 2007).

d: absolute percentage point of precision, in this study a 3% (d= 0.03) sampling error will be chosen to assure more precision of the sample size

$Z_{(1-\alpha/2)}$ = 1.96 at 95% CI

Therefore, the total sample for each community will be:

$n = (1.96)^2*0.063*(1-0.063)/(0.03)^2= 252$

Because this study applies cluster sampling, the design effect (DF) might be used and estimated as 2.0, in order to obtain the same precision. Therefore, twice as many as individuals must be studied; hence, the total population to be selected in each community will be 504 or rounded 500 people.

Formula 2. Explanations on sampling method for KAP surveys on fascioliasis (liver fluke)

Usually, the critical significant level is set as α= 0.05 (Type I error) for the test of null hypothesis which is in fact true, the probability of 1- α= 0.95 (not making a Type I error) will come to a not significant conclusion. If two independent events are tested for null hypotheses, the probability of not making a Type I error on tests will be:

$$0.95*0.95 = (1- 0.05)^2 = (1- \alpha)^2$$

With ten tests, the probability of not making a Type I error on all tests will be:

$$0.95^{10}= (1-0.05)^{10}=(1- \alpha)^{10}=0.599$$

Hence, the probability of wrongly rejecting the null hypothesis (probability of getting at least one significant result) is:

$$1-(1- \alpha)^{10}= 1-(1- 0.05)^{10}= 0.401$$

Therefore, if k independent events are tested at α level of null hypothesis which are all true, the probability that no significant differences occur is $(1- \alpha)^k$. This means the P values of any k test should be less than α of 0.05 to get a significant difference between the comparisons. Based on the Bonferroni method (Columb and Sagadai, 2006), since α will be smaller in larger number of tests, it can be shown that $(1- \alpha)^k \approx 1 - k\alpha$. If we put kα = 0.05, then α = 0.05/k and we will have a P values less than α if the probability of 0.05 that one of the k tests will have a P values less than α if the null hypotheses are true.

This study design involves three communities and three tests will be conducted for comparisons of parameters, and the probability of getting at least one test at significant level is α=0.05/3=0.017. This is a trade-off point for significant level of any of the independent tests, and at 99%CI, α=0.01.

Using the manual Bonferroni adjustments for multiple comparisons, the sample size for the KAP survey study on fascioliasis and the result of will be calculated using the following formula for estimating the difference between two population proportions with specified absolute precision (Two- sample situations) by Chadha (2006, pp. 60):

+ For comparison between Intervention 1 commune and Intervention 2 commune:

$$\left[n = Z^2(1-\alpha/2)\frac{[p1(1-p1)+p2(1-p2)]}{d^2} \right]$$

n: minimum sample size needed

$Z_{(1-\alpha/2)}$ = 2.576 at the confident interval (CI) of 99%

P1: proportion of population in Intervention 1 commune owning knowledge, attitude and practice against fascioliasis after the intervention, expected at 80% (p1=0.8);

p1: proportion of population in Intervention 2 commune owning knowledge, attitude and practice against fascioliasis at the end of the study, at 69% (p2=0.69) from previous survey in Binh Dinh province (Nguyen *et al*., 2011);

d: absolute percentage point of precision, in this study a 5% (d= 0.05) sampling error will be chosen to assure more precision of the sample size

Therefore, the sample size for each study site will be:

$n= (2.576)^2*[(0.69*0.31) + (0.80*0.2)]/(0.05)^2 = 426$ people.

To prevent the sample losses, an additional 20% of the sample will be added, yielding a total population for each community of 511 or rounded 510 people.

+ For comparison between Intervention 1 commune and Control commune:

$$\left[n = \quad {}^2(1 \quad\quad /2)\frac{[p1(1 \quad p1)+p3(1 \quad p3)]}{d^2} \right]$$

n: minimum sample size needed

$Z_{(1-\alpha/2)}$ = 2.576 at the confident interval (CI) of 99%

P1: proportion of population in Intervention 1 commune owning knowledge, attitude and practice against fascioliasis after the intervention, expected at 80% (p1=0.8);

P3: proportion of population in Control commune owning knowledge, attitude and practice against fascioliasis at the end of the study, at 56% (p3=0.56) from previous survey in Binh Dinh province (Nguyen *et al*., 2011);

d: absolute percentage point of precision, in this study a 5% (d= 0.05) sampling error will be chosen to assure more precision of the sample size

Therefore, the sample size for each study site will be:

n= $(2.576)^2$*[(0.56*0.44) + (0.80*0.2)]/$(0.05)^2$ = 427 people.

To prevent the sample losses, an additional 20% of the sample will be added, yielding a total population for each community of 512 or rounded 510 people.

+ For comparison between Intervention 2 commune and Control commune:

$$\left[n = Z^2_{(1-\alpha/2)} \frac{[p2(1-p2)+p3(1-p3)]}{d^2} \right]$$

n: minimum sample size needed

$Z_{(1-\alpha/2)}$ = 2.576 at the confident interval (CI) of 99%

p2: proportion of population in Intervention 2 commune owning knowledge, attitude and practice against fascioliasis after the intervention, expected at 69% (p2=0.69);

p3: proportion of population in Control commune owning knowledge, attitude and practice against fascioliasis at the end of the study, at 56% (p3=0.56) from previous survey in Binh Dinh province (Nguyen *et al*., 2011);

d: absolute percentage point of precision, in this study a 5% (d= 0.05) sampling error will be chosen to assure more precision of the sample size

Therefore, the sample size for each study site will be:

n= $(2.576)^2$*[(0.56*0.44) + (0.69*0.31)]/$(0.05)^2$ = 569 people.

To prevent the sample losses, an additional 10% of the sample will be added, yielding a total population for each community of 655 people.

In order to make easier comparisons between each community and another, a rounded number 600 people will be chosen for each community under the study.

Formula 3. Explanations on sampling method for snail survey on fascioliasis (liver fluke)

The sample size for lymnaeid snail surveys was calculated by the formula:

$$n = Z^2_{1-\alpha/2} \frac{(1-p)}{p.\varepsilon^2}$$

n: minimum sample size needed

Z(1-α/2) = 1.96 at 95% CI

p: referential infection rate of 1.7% (p= 0.017) from previous study conducted in Binh Dinh (Nguyen *et al*., 2010).

Ɛ : relative precision at 25% or 0.25

Estimated total of 3,554 snails plus 10% to account for sampling attrition or 3,909 snails were collected in each of the three study sites.

Appendix 3.2 list of invitations, responses of invitation acceptance, permission form for getting resources to identify details of participants

1. Email/telephone script – Blood and medical examination

Invitation for the participants to the research study: "Identifying the seroprevalance of fascioliasis (liver fluke) among three adult cohorts in two Central provinces of Vietnam."

Dear: (name of participant) ....

Place of work:……………………………………..

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

We are collecting information from participants regarding the seroprevalence of fascioliasis (liver fluke) in your community. This study will involve the blood examination, using the high-tech ELISA-base laboratory technique; and medical examination. The information collected will inform development of a feasible control model of this disease. We would like now to invite you to take part in the study. If you are infected, you will be provided with full treatment and appropriate follow-up care.

Your participation will be greatly appreciated and highly beneficial to the development of a broadly-based control model of fascioliasis (liver fluke) which will, if successful, be applicable to other regions of the country.

Please email your interest if you are willing to be involved via "Reply" email and we will send you further information and contact you to arrange suitable time and place for the interview (either by face-to-face, telephone or Skype).

If you have any queries regarding to the interview, do not hesitate to contact:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;
2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153
3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

2. Email/telephone script – Knowledge, attitude and practice (KAP) survey

Invitation for the stakeholders and household representatives to participate in the research study about: "What are the perspectives of the household and stakeholder representatives regarding the knowledge, attitude and practice of fascioliasis (liver fluke) in your community?"

Dear: (name of householder or stakeholder representative)

Position: .... Place of work:……………………………

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

We are collecting information from KAP surveyed participants regarding their perceived risk and awareness of control measures for fascioliasis (liver fluke) in your community. This study will involve personal interviews involving household representatives in the selected community. The information collected will inform development of a feasible control model of this disease. We would like now to invite you to share your knowledge, attitude and practice with us in the interviews.

Your participation will be greatly appreciated and highly beneficial to the development of a broadly-based control model of fascioliasis (liver fluke) which will, if successful, be applicable to other regions of the country.

Please email your interest if you are willing to be involved via "Reply" email and we will send you further information and contact you to arrange suitable time and place for the focus group (either by face-to-face, telephone or Skype).

If you have any queries regarding to the interview, do not hesitate to contact:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;
2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153
3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

3. Email/telephone script – blood surveys

Thank you for accepting the invitation to participate in the research study: "Identifying the seroprevalence of fascioliasis (liver fluke) among three adult cohorts in two Central provinces of Vietnam."

Please find the attached a Participant information sheet and a consent form. Please sign and return the consent form as soon as possible.

I would like you to attend the blood and medical examination at the communal health office

Appropriate date and time:

- Possible dates…………………………………………………………………
- Possible times:………………………………………………………………

If you have further questions, please do not hesitate to contact either of the following people:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;

2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153

3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947

4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

With regards,

Tran Minh Quy

4. Email/telephone script- KAP survey

Thank you for accepting the invitation to participate in the research study about: "What are the perspectives of the household and stakeholder representatives regarding the knowledge, attitude and practice of fascioliasis (liver fluke) in your community?"

Please find the attached a Participant information sheet and a consent form. Please sign and return the consent form as soon as possible.

I would like you to be at your house in the mean time of the set date for the KAP interivew.

The KAP will be held at your house

Appropriate date and time:

- Possible dates………………………………………………………………
- Possible times:………………………………………………………………

If you have further questions, please do not hesitate to contact either of the following people:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;

2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153

3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947

4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

With regards,

Tran Minh Quy

5. Email/telephone script - Interview

Invitation for the stakeholders to participate in the research study: "What are the perspectives of the stakeholders regarding the risk perception and awareness of control measures for fascioliasis (liver fluke) in your community?"

Dear: (name of stakeholder)..

Position: .... Place of work:……………………………………..

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

We are collecting information from interview participants regarding their perceived risk and awareness of control measures for fascioliasis (liver fluke) in your community. This study will involve interviews with health professionals, school teachers and local authorities in the selected community. The information collected will inform development of a feasible control model of this disease. We would like now to invite you to share your knowledge, skills and experiences with us in the semi-structured interviews.

Your participation will be greatly appreciated and highly beneficial to the development of a broadly-based control model of fascioliasis (liver fluke) which will, if successful, be applicable to other regions of the country.

Please email your interest if you are willing to be involved via "Reply" email and we will send you further information and contact you to arrange suitable time and place for the interview (either by face-to-face, telephone or Skype).

If you have any queries regarding to the interview, do not hesitate to contact:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;
2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153
3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

6. Email/telephone script – Focus group

Invitation for the stakeholders and household representatives to participate in the research study about: "What are the perspectives of the household and stakeholder representatives regarding the risk perception and awareness of control measures for fascioliasis (liver fluke) in your community?"

Dear: (name of householder or stakeholder representative)

Position: .... Place of work:……………………………

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

We are collecting information from focus group participants regarding their perceived risk and awareness of control measures for fascioliasis in your community. This study will involve focus groups involving health professionals, school teachers, local authorities and household representatives in the selected community. The information collected will inform development of a feasible control model this disease. We would like now to invite you to share your knowledge, skills and experiences with us in the semi-structured interviews.

Your participation will be greatly appreciated and highly beneficial to the development of a broadly-based control model of fascioliasis (liver fluke) which will, if successful, be applicable to other regions of the country.

Please email your interest if you are willing to be involved via "Reply" email and we will send you further information and contact you to arrange suitable time and place for the focus group (either by face-to-face, telephone or Skype).

If you have any queries regarding to the interview, do not hesitate to contact:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;
2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153
3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

7. Email/telephone script - Interview

Thank you for accepting the invitation to participate in the research study about "What are the perspectives of the stakeholders regarding the risk perception and awareness of control measures for fascioliasis (liver fluke) in your community?", semi-structured interview.

Please find the attached a Participant information sheet, a consent form and the interview questions. Please sign and return the consent form as soon as possible.

I would like you to indicate your preference for the most appropriate interview type at suitable time of the set date.

The interview type is either:

- Face-to-face: please indicate where you would like to conduct the interview, either:
  + In your office, address:………………………………………………
  + At other location:……………………………………………………
- Telephone: please provide your telephone number:…………………………
- Skype: please include your Skype nickname:………………………………

Appropriate date and time:

- Possible dates……………………………………………………………………
- Possible times:…………………………………………………………………

If you have further questions, please do not hesitate to contact either of the following people:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;
2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153
3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

With regards,

Tran Minh Quy

8. Email/telephone script- Focus group

Thank you for accepting the invitation to participate in the research study about “What are the perspectives of the stakeholders regarding the risk perception and awareness of control measures for fascioliasis (liver fluke) in your community?”, focus group.

Please find the attached a Participant information sheet, a consent form and the questions of focus group. Please sign and return the consent form as soon as possible.

I would like you to be at the most suitable venue in the mean time of the set date for the focus group.

The focus group will be held at the following venue:

- Place:……………………………………………………………………
- Address:…………………………………………………………..

Appropriate date and time:

- Possible dates……………………………………………………………
- Possible times:……………………………………………………………

If you have further questions, please do not hesitate to contact either of the following people:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;
2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153
3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

Thank you for your attention.

With regards,

Tran Minh Quy

9. Permission form for getting details of participants in survey

Ministry of Health
Institute of Malariology-Parasitology
and Entomology, Quy Nhon

Socialist Republic of Vietnam
Independence – Freedom – Happiness

Quy Nhon, day / month / year

No. /CV
Ref.: permission of getting details
from participants in surveys

Dear: (name of communal head)

Position: .... Place of work:………………………………

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

We are collecting information from participants to inform development of a feasible control model of fascioliasis (liver fluke). The information will be obtained from KAP surveys, interviews, focus groups and observations. We would like to ask for your permission to get the details of the participants via the communal registrar, including household book number, householders, age and place of residence.

Your help and supports will be greatly appreciated and highly beneficial to the development of a broadly-based control model of fascioliasis (liver fluke) which will, if successful, be applicable to other regions of the country.

If you have any queries, do not hesitate to contact:

1. Tran Minh Quy: email address at tmq596@uowmail.edu.au or telephone: +849.3506.0899 or +849.0595.3838;

2. Prof Heather Yeatman: hyeatman@uow.edu.au or telephone: +612.4221.3153

3. Prof Vicki Flood: vflood@uow.edu.au or telephone: +612.4221.3947

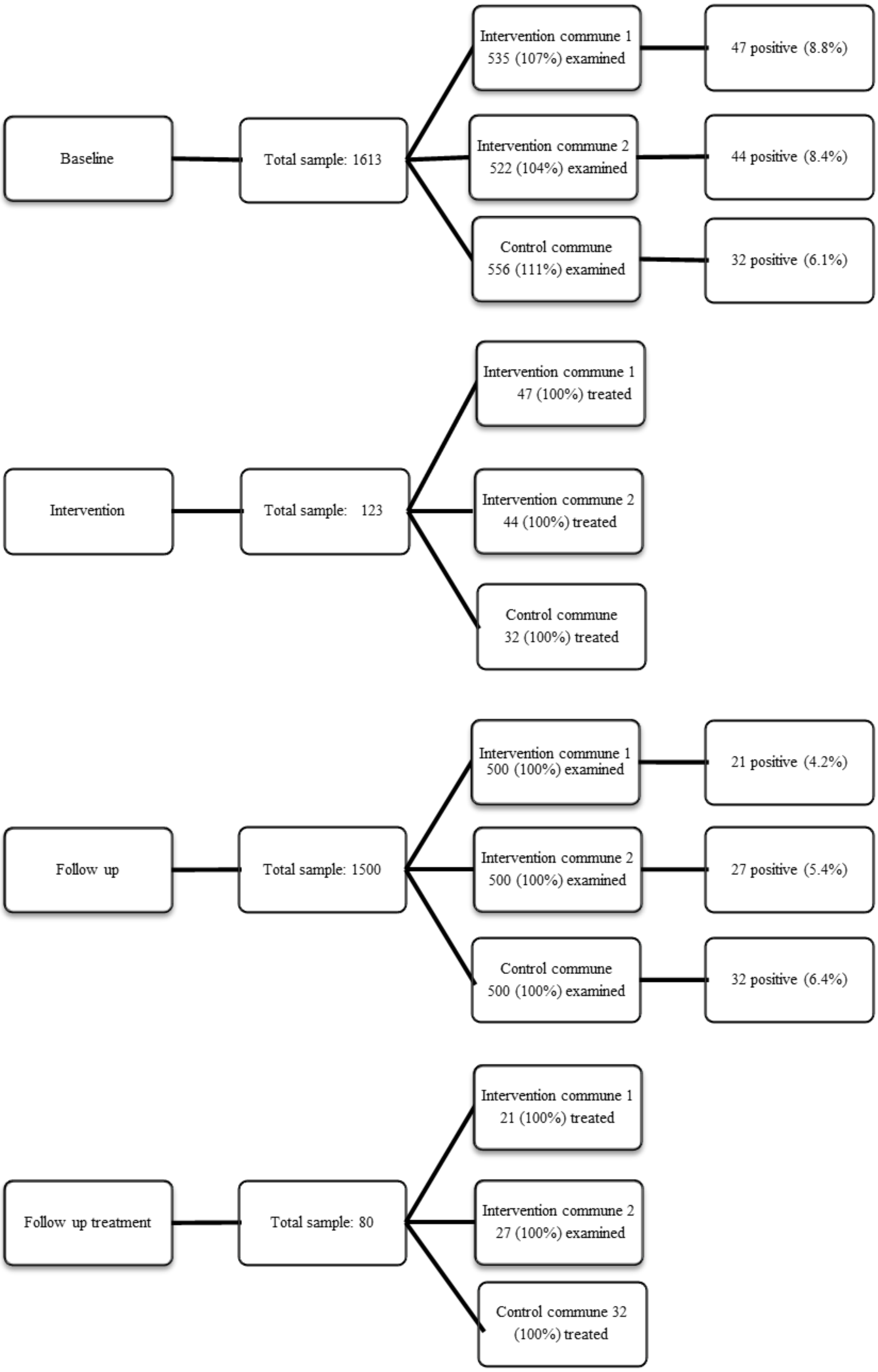
4. Nguyen Van Chuong: chuongkst@yahoo.com.vn or telephone: +84914.004.839

We are looking for your response as soon as possible, Thank you.

Researcher

Tran Minh Quy

Appendix 3.3 Population under stages of study



Appendix 3.4 Participation information sheet for participants having blood taken for laboratory examination of fascioliasis

PARTICIPANT INFORMATION SHEET FOR BROADLY-BASED CONTROL MODEL OF FASCIOLIASIS (LIVER FLUKE) IN CENTRAL VIETNAM (blood examination and medical examination)

TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

PURPOSE OF THE RESEARCH

The overall objective of the thesis is to implement and evaluate a broadly-based fascioliasis control model in a community, which is a common disease in Central Vietnam. As a part of this study, I will determine the prevalence of fascioliasis (liver fluke) in the communities by taking blood of the selected participants in households for laboratory examination. The findings are intended to design a broadly-based control model of fascioliasis (liver fluke) control in Central Vietnam, and to evaluate the effectiveness of the model after intervention.

INVESTIGATORS

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

METHODS AND DEMANDS ON PARTICIPANTS:

If you choose to be involved in the blood examination, you will have your blood taken intravenously (IV) for laboratory examination to determine the prevalence of fascioliasis (liver fluke). Your personal information will be recorded in the prepared form. The procedure will be explained clearly to you by the laboratory technicians and the blood drawing will be conducted at the communal health office. It may take approximately five minutes with about 3 milliliter of blood taken from your forearm. Then, the blood sample will be stored in coagulation tubes, labeled with the personal information of the participants, before being dispatched to the laboratory of IMPE Quy Nhon for laboratory examination. All information provided by participants will not be discussed or shown to any other people, and will only accessible to the research team. You may receive the results of your blood examination for fascioliasis infection should you request it. All data obtained will be coded and kept in secured place.

POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORT:

Taking blood is considered to have minor side effects such as: minor pain, bruising, or minor bleeding. These side effects will be explained by technician. Your participation to the blood survey is voluntary, and you have the right to decide whether to participate in this survey, and this does not affect the relationship between you and the UOW or the IMPE-QN and any other relevant organizations. In addition, you can withdraw from the blood survey at any time or ask to withdraw your data from the study without any consequence to yourself. A remuneration of about 0.25 AUD will be provided for your participation in this blood survey.

FINDINGS AND BENEFITS OF THE RESEARCH:

The blood sample will indicate if you may be infected with fascioliasis (liver fluke) or not. If the blood sample is positive, you will be contacted to make an appointment with the medical staff for a clinical examination and an ultrasound test, to confirm if you have the infection. If you are infected, you will be provided with full treatment and appropriate follow-up care.

The findings of this study, including information given by each of the participants like you, will help us in designing, implementing and evaluating the effectiveness of a broadly-based control model of fascioliasis (liver fluke) in Central Vietnam.

These findings will be presented in the student's thesis and at professional conferences of seminars, or in academic and professional journals.

ETHICS REVIEW AND COMPLAINTS:

This study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee of the Institute of Malariology-Parasitology and Entomology, Quy Nhon (IMPE-QN). If you have any concerns or complaints, or would like further information about this study, please contact the UOW Ethics Office on (+612.4221.4457) or rso-ethics@uow.edu.au or IMPE-QN Medical Ethics Office on (+8456.3847726) or chuongkst@yahoo.com.vn.

Thank you for your interest in this study.

Appendix 3.5 Consent form for adult participants having blood taken for laboratory examination of fascioliasis

UNIVERSITY OF WOLLONGONG

CONSENT FORM

STUDY TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam (blood survey)

I have been given the information sheet explaining the study titled "Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam", and discussed the research project with Tran Minh Quy, who is conducting this research as part of a Doctor of Public Health (integrated) degree, supervised by Prof Heather Yeatman and Prof Vicki Flood from the School of Health Sciences, University of Wollongong.

I have been advised by the researcher the potential risks and inconveniences upon participating in this research, which include blood examination with possible medical follow-up. In addition, I also have the opportunities to ask questions concerning the purpose of research and the rights of any participant like me by contacting any of the following researchers:

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

I understand that my participation in this research is voluntary, and I have the right to decide whether to participate in this blood survey, and this does not cause any harm if I do not participate. In addition, I can withdraw from the blood survey at any time without any consequence to myself.

I further understand that this study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee at IMPE-QN. Any concerns or complaints may be addressed to the UOW Ethics Office on (+612.4221.4457 or rso-ethics@uow.edu.au and IMPE-QN Medical Ethics Office on (+8456.384.7726) or chuongkst@yahoo.com.vn.

By signing below, I am indicating my consent to my participation in the blood survey with Mr Tran Minh Quy regarding the knowledge, attitude and practice of householder about fascioliasis (liver fluke) in Central Vietnam.

I understand that the data collected from my participation will be used as part of a course pursuing to obtain the Doctor of Public Health degree by the researcher when it is published as a thesis, in journals or presented papers at conferences, and I consent for it to be used in that manner.

Signed_________________ Date:__/__/___ Name (please print)______________

Appendix 3.6 Participation information sheet for the householders attending KAP surveys

UNIVERSITY OF WOLLONGONG

PARTICIPANT INFORMATION SHEET FOR BROADLY-BASED CONTROL MODEL OF FASCIOLIASIS (LIVER FLUKE) IN CENTRAL VIETNAM (KAP survey)

TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

PURPOSE OF THE RESEARCH

The overall objective of the thesis is to implement and evaluate a broadly-based fascioliasis (liver fluke) control model in a community, which is a common disease in Central Vietnam. As a part of this study, I will explore the risk factors associated with fascioliasis (liver fluke) infections by conducting knowledge, attitude and practice (KAP) surveys with households. The findings are intended to design a broadly-based control model of fascioliasis (liver fluke) control in Central Vietnam, and to evaluate the effectiveness of the model after intervention.

INVESTIGATORS

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

METHODS AND DEMANDS ON PARTICIPANTS:

If you choose to be involved in the KAP surveys, you will be interviewed and asked questions associated to your knowledge, attitude and practice about fascioliasis. The KAP survey will be conducted by face-to-face interview by researchers from IMPE-QN at your house. It may take up approximately 20 minutes. During the KAP survey, we will collect information and fill in the pre-prepared questionnaire. All information provided by participants will not be discussed or shown to any other people, and will only accessible to the research team. You may receive your answer information should you request it. All data obtained will be coded and kept in secured place.

POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORT:

As a twenty-minute long KAP survey, we can foresee no risks or inconveniences for you. Your participation to the survey is voluntary, and you have the right to decide whether to participate in this KAP survey, and this does not affect the relationship between you and the UOW or the IMPE-QN and any other relevant organizations. In addition, you can withdraw from the KAP survey at any time, or ask to withdraw your data from the study without any consequence to yourself. A remuneration of about 0.5 AUD will be provided for your participation in this KAP survey.

FINDINGS AND BENEFITS OF THE RESEARCH:

The findings of this study, including information given by each of the participants like you, will help us very much in designing, implementing and evaluating the effectiveness of a broadly-based control model of fascioliasis (liver fluke) in Central Vietnam.

These findings will be presented in the student’s thesis and at professional conferences of seminars, or in academic and professional journals.

ETHICS REVIEW AND COMPLAINTS:

This study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee of the Institute of Malariology-Parasitology and Entomology, Quy Nhon (IMPE-QN). If you have any concerns or complaints, or would like further information about this study, please contact the UOW Ethics Office on (+612.4221.4457) or rso-ethics@uow.edu.au or IMPE-QN Medical Ethics Office on (+8456.3847726) or chuongkst@yahoo.com.vn.

Thank you for your interest in this study.

Appendix 3.7 Consent form for participants in the KAP surveys

UNIVERSITY OF WOLLONGONG

CONSENT FORM

STUDY TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam (KAP survey)

I have been given the information sheet explaining the study titled "Broadly-based control model of fascioliasis in Central Vietnam", and discussed the research project with Tran Minh Quy, who is conducting this research as part of a Doctor of Public Health (integrated) degree, supervised by Prof Heather Yeatman and Prof Vicki Flood from the School of Health and Society, University of Wollongong.

I have been advised the potential risks and inconveniences upon participating in this research, which include face-to-face questions-answers and questionnaire filling with the researcher. In addition, I also have the opportunities to ask questions concerning the purpose of research and the rights of any participant like me by contacting any of the following researchers:

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

I understand that my participation in this research is voluntary, and I have the right to decide whether to participate in this KAP survey, and this does not cause any harm if I do not participate. In addition, I can withdraw from the KAP survey at any time without any consequence to myself.

I further understand that this study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee at IMPE-QN. Any concerns or complaints may be addressed to the UOW Ethics Office on (+612.4221.4457 or rso-ethics@uow.edu.au and IMPE-QN Medical Ethics Office on (+8456.384.7726) or chuongkst@yahoo.com.vn.

By signing below, I am indicating my consent to my participation in the KAP survey with Mr Tran Minh Quy regarding the knowledge, attitude and practice of householder about fascioliasis (liver fluke) in Central Vietnam.

I understand that the data collected from my participation will be used as part of a course pursuing to obtain the Doctor of Public Health degree by the researcher when it is published as a thesis, in journals or presented papers at conferences, and I consent for it to be used in that manner.

Signed_________________ Date:__/__/___ Name (please print)________________

Appendix 3.8 Participation information sheet for the householders involving household observation

PARTICIPANT INFORMATION SHEET FOR BROADLY-BASED CONTROL MODEL OF FASCIOLIASIS (LIVER FLUKE) IN CENTRAL VIETNAM (household observation)

TITLE: Broadly-based control model of fascioliasis in Central Vietnam

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

PURPOSE OF THE RESEARCH

The overall objective of the thesis is to implement and evaluate a broadly-based fascioliasis control model in a community, which is a highly common disease in Central Vietnam. As a part of this study, I will explore the risk factors associated with fascioliasis infections by conducting observations of household and affiliated facilities. The findings are intended to design a broadly-based control model of fascioliasis control in Central Vietnam, and to evaluate the effectiveness of the model after intervention.

INVESTIGATORS

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

METHODS AND DEMANDS ON PARTICIPANTS:

If you choose to be involved in the observation, we will conduct the observations over your house including the kitchen, toilet and cattle shelter to explore the risks of fascioliasis transmission. The observation may take up approximately 20 minutes. During the observation, we will collect information and fill in the pre-prepared observational form. All information collected from the observations will not be discussed or shown to any other people, and will only accessible to the research team. You may receive your answer information should you request it. All data obtained will be coded and kept in secured place.

POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORT:

As a twenty-minute long observation, we can foresee no risks or inconveniences for you. Your participation to the household observation is voluntary, and you have the right to decide whether to participate in this observation, and this does not affect the relationship between you and the UOW or the IMPE-QN and any other relevant organizations. In addition, you can withdraw from the observation at any time, or ask to withdraw your data from the study without any consequence to yourself.

FINDINGS AND BENEFITS OF THE RESEARCH:

The findings of this study, including information given by each of the participants like you, will help us very much in designing, implementing and evaluating the effectiveness of a broadly-based control model of fascioliasis in Central Vietnam.

These findings will be presented in the student's thesis and at professional conferences of seminars, or in academic and professional journals.

ETHICS REVIEW AND COMPLAINTS:

This study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee of the Institute of Malariology-Parasitology and Entomology, Quy Nhon (IMPE-QN). If you have any concerns or complaints, or would like further information about this study, please contact the UOW Ethics Office on (+612.4221.4457) or rso-ethics@uow.edu.au or IMPE-QN Medical Ethics Office on (+8456.3847726) or chuongkst@yahoo.com.vn.

Appendix 3.9 Consent form for participants in the household observation

UNIVERSITY OF WOLLONGONG

CONSENT FORM

STUDY TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam (household observation)

I have been given the information sheet explaining the study titled "Broadly-based control model of fascioliasis in Central Vietnam", and discussed the research project with Tran Minh Quy, who is conducting this research as part of a Doctor of Public Health (integrated) degree, supervised by Prof Heather Yeatman and Prof Vicki Flood from the School of Health and Society, University of Wollongong.

I have been advised the potential risks and inconveniences upon participating in this research, which include observations and observational form filling with the researcher. In addition, I also have the opportunities to ask questions concerning the purpose of research and the rights of any participant like me by contacting any of the following researchers:

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

I understand that my participation in this research is voluntary, and I have the right to decide whether to participate in this household observation, and this does not cause any harm if I do not participate. In addition, I can withdraw from the household observation at any time without any consequence to myself.

I further understand that this study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee at IMPE-QN. Any concerns or complaints may be addressed to the UOW Ethics Office on (+612.4221.4457 or rso-ethics@uow.edu.au and IMPE-QN Medical Ethics Office on (+8456.384.7726) or chuongkst@yahoo.com.vn.

By signing below, I am indicating my consent to my participation in the household observation with Mr Tran Minh Quy regarding the risks of fascioliasis (liver fluke) transmission in Central Vietnam.

I understand that the data collected from my participation will be used as part of a course pursuing to obtain the Doctor of Public Health degree by the researcher when it is published as a thesis, in journals or presented papers at conferences, and I consent for it to be used in that manner.

Signed_________________ Date:__/__/___ Name (please print)______________

Appendix 3.10 Participation information sheet for the stakeholders participating in the interviews

PARTICIPANT INFORMATION SHEET FOR BROADLY-BASED CONTROL MODEL OF FASCIOLIASIS (LIVER FLUKE) IN CENTRAL VIETNAM (interview)

TITLE: Broadly-based control model of fascioliasis in Central Vietnam

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

PURPOSE OF THE RESEARCH

The overall objective of the thesis is to implement and evaluate a broadly-based fascioliasis (liver fluke) control model in a community, which is a highly common disease in Central Vietnam. As a part of this study, I will explore the risk factors associated with fascioliasis infections by interviews with stakeholders. The findings are intended to design a broadly-based control model of fascioliasis control in Central Vietnam, and to evaluate the effectiveness of the model after intervention.

INVESTIGATORS

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

METHODS AND DEMANDS ON PARTICIPANTS:

If you choose to be involved in the interviews, you will be asked questions regarding your views and risk perception about fascioliasis (liver fluke). The interview will be conducted by face-to-face, or via telephone/Skype interview. It may take up to approximately 30 minutes. During the interview, we will record all the information by audio-recordings. All information provided by participants will not be discussed or shown to any other people, and will only be accessible to the research team. You may receive a transcript of your answer information should you request it. All data obtained will be coded and kept in a secured place.

POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORT:

As a thirty-minute long interview, we can foresee no risks or inconveniences for you. Your participation to the survey is voluntary, and you have the right to decide whether to participate in this interview, and this does not affect the relationship between you and the UOW or the IMPE-QN and any other relevant organizations. In addition, you can withdraw from the interview at any time or ask to withdraw your data from the study without any consequence to yourself. A remuneration of about five AUD will be provided for your participation in this interview.

FINDINGS AND BENEFITS OF THE RESEARCH:

The findings of this study, including information given by each of the participants like you, will help us very much in designing, implementing and evaluating the effectiveness of a broadly-based control model of fascioliasis (liver fluke) in Central Vietnam.

These findings will be presented in the student's thesis and at professional conferences of seminars, or in academic and professional journals.

ETHICS REVIEW AND COMPLAINTS:

This study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee of the Institute of Malariology-Parasitology and Entomology, Quy Nhon (IMPE-QN). If you have any concerns or complaints, or would like further information about this study, please contact the UOW Ethics Office on (+612.4221.4457) or rso-ethics@uow.edu.au or IMPE-QN Medical Ethics Office on (+8456.3847726) or chuongkst@yahoo.com.vn.

Appendix 3.11 Consent form for participants in the in-depth interviews

UNIVERSITY OF WOLLONGONG

CONSENT FORM

TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam (interview)

I have been given the information sheet explaining the study titled "Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam", and discussed the research project with Mr Tran Minh Quy, who is conducting this research as part of a Doctor of Public Health degree, supervised by Prof Heather Yeatman and Prof Vicki Flood from the School of Health and Society, University of Wollongong.

I have been advised the potential risks and inconveniences upon participating in this research, which include audio recorded face-to-face or via telephone/Skype interview with the researcher. In addition, I also have the opportunities to ask questions concerning the purpose of research and the rights of any participant like me by contacting any of the following researchers:

Tran Minh Quy	**Prof Heather Yeatman**	**Prof Vicki Flood**	**Dr Nguyen Van Chuong**
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

I understand that my participation in this research is voluntary, and I have the right to decide whether to participate in this interview, and this does not cause any harm if I do not participate. In addition, I can withdraw from the interview at any time without any consequence to myself.

I further understand that this study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee at IMPE-QN. Any concerns or complaints may be addressed to the UOW Ethics Office on (+612.4221.4457 or rso-ethics@uow.edu.au and IMPE-QN Medical Ethics Office on (+8456.384.7726) or chuongkst@yahoo.com.vn.

By signing below, I am indicating my consent to my participation in the interview with Mr Tran Minh Quy regarding the risk perception of stakeholders about fascioliasis (liver fluke) in Central Vietnam.

I understand the data collected from my participation will be used as part of a course pursuing to obtain the Doctor of Public Health degree by the researcher when it is published as a thesis, in journals or presented papers at conferences, and I consent for it to be used in that manner.

Signed__________________ Date:__/__/___ Name (please print)_________________

Appendix 3.12 Participation information sheet for the household representatives participating in the focus groups

PARTICIPANT INFORMATION SHEET FOR BROADLY-BASED CONTROL MODEL OF FASCIOLIASIS (LIVER FLUKE) IN CENTRAL VIETNAM (focus group)

TITLE: Broadly-based control model of fascioliasis in Central Vietnam

My name is Tran Minh Quy and I am undertaking this research as a part of the Doctor of Public Health degree at the University of Wollongong under the supervision of Prof Heather Yeatman and Prof Vicki Flood. I have a background in public health in the field of tropical medicine.

PURPOSE OF THE RESEARCH

The overall objective of the research is to implement and evaluate a broadly-based fascioliasis (liver fluke) control model in a community, which is a highly common disease in Central Vietnam. As a part of this study, I will explore views about the risk factors associated with fascioliasis infections, through focus groups discussions with stakeholders and householder representatives. The findings are intended to design a broadly-based control model of fascioliasis control in Central Vietnam, and to evaluate the effectiveness of the model after intervention.

INVESTIGATORS

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

METHODS AND DEMANDS ON PARTICIPANTS:

If you choose to be involved in the focus group, you will discuss and answer questions associated to your views and risk perception about fascioliasis. The focus group will be conducted in a group of 6-8 people at the communal health station. It may take up approximately 45 minutes to one hour. During the focus group discussion, we will record all the information by audio-recordings. The confidentiality of your responses will be assured such as: your real name will not be used in the discussion as well as in the scripts. All information provided by participants will not be discussed or shown to any other people, and will only accessible to the research team. All data obtained will be coded and kept in secured place.

POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORT:

We can foresee no risks or inconveniences for you. Your participation to the focus group discussion is voluntary, and you have the right to decide whether to participate in this focus group, and this does not affect the relationship between you and the UOW or the IMPE-QN and any other relevant organizations. In addition, you can withdraw from the focus group at any time or ask to withdraw your data from the study without any consequence to yourself. A remuneration of about one AUD will be provided for your participation in this focus group.

FINDINGS AND BENEFITS OF THE RESEARCH:

The findings of this study, including information given by each of the participants like you, will help us very much in designing, implementing and evaluating the effectiveness of a broadly-based control model of fascioliasis (liver fluke) in Central Vietnam.

These findings will be presented in the student's thesis and at professional conferences of seminars, or in academic and professional journals.

ETHICS REVIEW AND COMPLAINTS:

This study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee of the Institute of Malariology-Parasitology and Entomology, Quy Nhon (IMPE-QN). If you have any concerns or complaints, or would like further information about this study, please contact the UOW Ethics Office on (+612.4221.4457) or rso-ethics@uow.edu.au or IMPE-QN Medical Ethics Office on (+8456.3847726) or chuongkst@yahoo.com.vn.

Thank you for your interest in this study.

Appendix 3.13 Consent form for participants in the focus groups

UNIVERSITY OF WOLLONGONG

CONSENT FORM

TITLE: Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam (focus group)

I have been given the information sheet explaining the study titled "Broadly-based control model of fascioliasis (liver fluke) in Central Vietnam", and discussed the research project with Mr Tran Minh Quy, who is conducting this research as part of a Doctor of Public Health degree, supervised by Prof Heather Yeatman and Prof Vicki Flood from the School of Health and Society, University of Wollongong.

I have been advised the potential risks and inconveniences upon participating in this research, which include audio recorded group discussion with the researcher. In addition, I also have the opportunities to ask questions concerning the purpose of research and the rights of any participant like me by contacting any of the following researchers:

Tran Minh Quy	Prof Heather Yeatman	Prof Vicki Flood	Dr Nguyen Van Chuong
PhD research student	School of Health Sciences, University of Wollongong	School of Health Sciences, University of Wollongong	Institute of Malariology-Parasitology and Entomology, Quy Nhon
Tel: +84935060899	Tel: +612.4221.3153	Tel: +612.4221.3947	Tel: +84914.004.839
Email: tmq596@uowmail.edu.au	Email: hyeatman@uow.edu.au	Email: vflood@uow.edu.au	Email: chuongkst@yahoo.com.vn

I understand that my participation in this research is voluntary, and I have the right to decide whether to participate in this focus group, and this does not cause any harm if I do not participate. In addition, I can withdraw from the focus group discussion at any time without any consequence to myself.

I further understand that this study has been reviewed by the Human Research Ethics Committee (Health and Medical) of the University of Wollongong and the Human Medical Ethics Committee at IMPE-QN. Any concerns or complaints may be addressed to the UOW Ethics Office on (+612.4221.4457 or rso-ethics@uow.edu.au and IMPE-QN Medical Ethics Office on (+8456.384.7726) or chuongkst@yahoo.com.vn.

By signing below, I am indicating my consent to my participation in the focus group with Mr Tran Minh Quy regarding the risk perception of stakeholders about fascioliasis (liver fluke) in Central Vietnam.

I understand that the data collected from my participation will be used as part of a course pursued in the Doctor of Public Health degree by the researcher when it is published as a thesis, in journals or presented papers at conferences, and I consent for it to be used in those manners.

Signed_________________Date:__/__/___ Name (please print)__________________

Appendix 3.14 Questionnaire for household knowledge, attitude and practice (KAP) (Nguyen, 2011)

QUESTIONAIRE FOR HOUSEHOLD KNOWLEDGE, ATTITUDE AND PRACTICE (KAP) SURVEY ON FASCIOLIASIS (LIVER FLUKE)

I. General information

Full-name of householder:…………………………………………………………

Full-name of participant:……………..………..……………………………

Domicile: village/commune/district/province:……………………..……………………

II. Specific information

Code	Questions	Answers		Move to
I	**Background information**			
Q1	Age	_ _ years		
Q2	Gender	Male	1	
		Female	2	
Q3	Educational background	Illiterate	1	
		Primary	2	
		Secondary	3	
		High school	4	
		Post-school and above	5	
Q4	Current occupation	Farmer	1	
		Student	2	
		Government staff	3	
		Cattle slaughter	4	
		Business	5	
		Other (specify)………	6	
II	**Knowledge of fascioliasis**			
Q5	Do you know the cause of fascioliasis?	Yes	1	
		No	2	Q9
		Not known	3	Q9
Q6	What causes fascioliasis?	Viral infection	1	
		Bacterial infection	2	
		Earthworms	3	
		Liver fluke	4	

Code	Questions	Answers		Move to
		Not known/ not sure	5	
Q7	Can humans be infected with fascioliasis?	Yes	1	
		No	2	Q9
		Not known	3	Q9
Q8	What are the transmission routes of fascioliasis in humans? (not prompted)	Eat improperly washed vegetables	1	
		Drink impure water	2	
		Dirty kitchen utensils	3	
		Other (specify)……………	4	
Q9	What are the clinical symptoms of fascioliasis on humans from your knowledge? (not prompted)	Fever	1	
		Abdominal pain	2	
		Hives	3	
		Dizziness	4	
		Digestive disturbance[24]	5	
		Jaundice	6	
		Weight loss	7	
		Other (specify)…..	8	
		Not known	9	
Q10	Is fascioliasis dangerous?	Yes	1	
		No	2	Q13
		Not known	3	Q13
Q11	Is fascioliasis transmitted to humans or cattle?	humans only	1	
		Cattle only	2	
		both humans and cattle	3	
Q12	Can you identify some health effects caused by fascioliasis to humans? (not prompted)	Body weaknesses	1	
		Death	2	
		Liver diseases	3	
		Other (specify)…..	4	
III	**Attitude towards fascioliasis**			
Q13	In your opinion, can	Yes	1	

[24] vomiting, nausea, constipation, diarrhea, indigestion

Code	Questions	Answers		Move to
	fascioliasis be prevented?	No	2	Q15
		Not known	3	Q15
Q14	If yes, what control measures of fascioliasis do you know? (not prompted)	Do not eat raw vegetables	1	
		Do not drink improperly boiled water	2	
		Wash vegetables with clean water before eating	3	
		Other (specify)….	4	
Q15	Do you think that human fascioliasis is treated?	Yes	1	
		No	2	Q18
		Not known	3	Q18
Q16	If yes, by what treatment measures? (not prompted)	Medication (from _ _ _)	1	
		Herbal medicine	2	
		Other (specify)………	3	
Q17	What should you do if you are infected with fascioliasis?	Self-treatment	1	
		Go to CHS[25]	2	
		Go to DHC	3	
		Go to PGH	4	
		Go to ISC	5	
		Other (specify)…………	1	
IV	**Practice of fascioliasis control**			
Q18	What kind of water sources does your family use?	Well	1	
		pipe line	2	
		lake, pond, river, canal	3	
Q19	Do you often drink water from lake, pond, river, and canal?	Yes	1	
		No	2	Q19
		Not known	3	Q19
Q20	Do you eat raw vegetables?	Yes	1	
		No	2	Q25
Q21	If yes, what kinds of	water dropwort	1	

[25] CHS: communal health station, DHC: district health center, PGH: provincial general hospital, ISC: IMPE specialist clinic

Code	Questions	Answers		Move to
	vegetables do you often eat?	Coriander	2	
		Persicaria	3	
		water cress	4	
		water morning glory	5	
		heart leaf	6	
		lotus stem	7	
		bitter herb	8	
		Spearmint	9	
		Lettuce	10	
		Other (specify)	11	
Q22	If you notice any aquatic grown vegetables in your meal, you will…	not eat	1	
		eat when well cooked	2	
		eat when washed carefully	3	
		still eat raw	4	
Q23	If you notice in your meal any ground grown vegetables watered from lake, pond, canal, river, you will: (tick as appropriate)	not eat	1	
		eat when well cooked	2	
		eat when treated carefully	3	
		still eat raw	4	
Q24	How often do you eat raw vegetables?	Everyday	1	
		Some times per week	2	
		Some times a year	3	
Q25	Do you often eat raw cattle livers?	Everyday	1	
		Some times per week	2	
		Some times a year	3	
V	**Houshold toilet facilities**			
Q26	Does your family own any toilets?	Yes	1	
		No	2	Q29
Q27	If yes, how many do you own?	One	1	
		More than one	2	
Q28	How are the toilets built?	Sketchily	1	
		well-structured	2	
Q29	If no, how do you go to	in neighbour’s	1	

Code	Questions	Answers		Move to
	toilet?	in the open field	2	
		into the water	3	
VI	**Practice of animal fascioliasis control**			
Q30	Does your family raise any cattle?	Yes	1	
		No	2	Q40
Q31	If yes, how many cattle do you raise?	Less than 3 animals	1	
		3 or more	2	
Q32	Which kind of cattle do you raise?	only cows	1	
		only buffaloes	2	
		Both cows and buffaloes	3	
Q33	What are the purposes of cattle husbandry?	for meat	1	
		for farming	2	
		For milk	3	
		Both	4	
Q34	Which form of cattle husbandry do you practice?	shelter-based	1	
		free grazing	2	
		semi-grazing	3	
Q35	Do you often clean the cattle shelter?	Yes	1	
		No	2	Q38
Q36	If yes, what kind of water do you use to clean the shelter?	Well water	1	
		pipe line water	2	
		lake, pond, river, canal	3	
Q37	How do you treat the waste from cleaning the shelter?	waste silo	1	
		Biogas	2	
		No treatment	3	
Q38	Have you dewormed your cattle?	Yes	1	
		No	2	Q40
Q39	If yes, how often do you deworm your cattle?	once a year	1	
		twice a year	2	
		more than twice a year	3	
		one in many years	4	
Q40	What control measures do	Use toilets	1	

Code	Questions	Answers		Move to
	you think are suitable for reducing fascioliasis infection in your community? (not prompted)	Prevent cattle from freely defecating	2	
		Do not use cattle as fertiliser for rice and vegetables, as fish food	3	
		Do not use water from lakes, ponds or canals to water vegetables	4	
		All the measures mentioned above	5	

Thank you for participating in the interview

Date…../……../…….

Interviewee Interviewer

Appendix 3.15 Guided questions of in-depth interview with a representative of who office in Vietnam

IN-DEPTH INTERVIEW WITH REPRESENTATIVE OF THE WOLRD HEALTH ORGANIZATION OFFICE IN VIETNAM

1. Please describe the situation of fascioliasis in Vietnam.
2. Has the WHO office in Vietnam supported any studies or activities relating to fascioliasis control? What aspects did the WHO support?
3. Can you describe some benefits that have been achieved from the WHO support activities? What are the obstacles in gaining the positive outcomes of the fascioliasis control activities in highly endemic areas of Vietnam (Prompts: sources of drug provision, capacity of the general system for fascioliasis control, technical difficulties, reporting systems)
4. How familiar are you with the implementation of the broadly-based control model of fascioliasis in Central Vietnam? What was your role in consulting the design, implementation and evaluation of the model?
5. What are your recommendations on the model? (Prompts: strengths, weaknesses, experiences for improvements of model components, alternative control measures in addition to these model components, possibility of expansion to other regions)
6. In your opinion, how sustainable is the broadly-based model and what factors would assist or hinder its sustainability? (Probes: what aspects of sustainability have you addressed to this model?)

Appendix 3.16 Guided questions for in-depth interview with the director of the institute of malariology-parasitology entomology, Quy Nhon (IMPE-QN)

IN-DEPTH INTERVIEW WITH REPRESENTATIVE OF IMPE-QN (MOH)

1. Can you describe the situation of fascioliasis in Central Vietnam?
2. Can you describe the range of activities that the MOH has been implementing to control fascioliasis at national level?
3. What was your role in consulting in the design and implementation of the broadly-based model of controlling fascioliasis in Central Vietnam?
4. Can you describe some successful aspects of applying broadly-based control model in An Nhon district (Binh Dinh province)? (Prompts: practical values, technical appropriateness, community acceptance, ecological soundness, cost-effectiveness etc.)
5. Please describe the capacity and roles of the commune health facilities in controlling fascioliasis. (skills and knowledge, infrastructure, resources)
6. Please describe the coordination between the health sector with other sectors including education, agriculture and mass organizations in terms of fascioliasis control model at the intervention community 1.
7. Please describe the supports and contributions of the IMPE-QN as home institution of the area to the fascioliasis control model?
8. In your opinion, what aspects of the model have the potential to be expanded to other regions of the country?
9. What are the anticipated difficulties in applying this model at a nationwide level? What would need to be modified or adjusted?

Appendix 3.17 Guided questions for in-depth interview with director of provincial centre of Malariology-Parasitology and Entomology of Binh Dinh Province

IN-DEPTH INTERIVEW WITH DIRECTOR OF PROVINCIAL CENTRE OF MALARIOLOGY-PARASITOLOGY AND ENTOMOLOGY, BINH DINH PROVINCE

1. Please describe the situation of fascioliasis in your province? (Prompts: incidence, risk factors, opportunities and difficulties in fascioliasis control)
2. Please describe your involvement in the fascioliasis control activities, and to what extend did you engage in the activities. (Your satisfactory levels with opportunities for engagement, your role as the provincial level providing supports for the implementation of the model)
3. What do you consider to be the successful outcomes of the model (Prompts: practical values, technical appropriateness, community acceptance, ecological soundness, cost-effectiveness)
4. What aspects of the model do you think could be expanded to other localities in the provinces? (Prompts: motivations, opportunities and challenges for expansion)
5. Can you please describe the capacity and roles of the community services (communal health stations and district health centres) in fascioliasis control in your province? (Prompts: capacity, technical facilities, human resources, staff knowledge and skills)
6. Can you please describe the strengths and weaknesses of the coordination between the health offices from provincial, district and commune levels in terms of fascioliasis control and coordination between the health and veterinary sectors in fascioliasis control of ruminants?
7. Can you please describe the reporting system of fascioliasis control in your province? (Prompts: routes of reports, feedbacks)
8. What supports from local government are you aware of that could act as resources for the model activities?
9. Do you have any further suggestions to improve the implementation of the fascioliasis control model?

Appendix 3.18 Guided questions for in-depth interview with director of Veterinary Centre of Binh Dinh Province

IN-DEPTH INTERIVEW WITH PROVINCIAL DIRECTOR OF VETERINARY CENTRE, BINH DINH PROVINCE

1. Please describe the situation of animal fascioliasis in your province? (Prompts: incidence, causes, damages, risk factors, opportunities and difficulties in fascioliasis control)

2. What control measures have been applied to control fascioliasis control in cattle? (Prompts: vector control, chemotherapy, communication, surveillance, outcomes of the control measures)

3. What are any difficulties in controlling fascioliasis for animals in your province? Which is the most critical difficulty? (Prompts: technical difficulties, socio-cultural, economic, behavioural factors)

4. Please describe the capacity and roles of the local agricultural facilities in fascioliasis control in your province? (Prompts: capacity, technical facilities, human resources, staff knowledge and skills)

5. What was your role in consulting the design, implementation and evaluation of the broadly-based control model of fascioliasis in one community of An Nhon district, Binh Dinh province? (Prompts: your expertise in animal fascioliasis control measures)

6. Can you please describe the strengths and weaknesses in the coordination between the health and agricultural sectors in controlling fascioliasis both in humans and animals?

7. What do you consider to be the successful outcomes of the model (Prompts: practical values, technical appropriateness, community acceptance, ecological soundness, cost-effectiveness)

8. What aspects of the model do you think could be expanded to other localities in the provinces? (Prompts: motivations, opportunities and challenges for expansion)

9. What supports do you think local government could provide in terms of available resources for the model activities?

10. Do you have any further suggestions to improve the implementation of the fascioliasis control model?

Appendix 3.19 Guided questions of in-depth interview for director of district health centre of An Nhon (Binh Dinh)

IN-DEPTH INTERVIEW VIEW DIRECTOR OF DISTRICT HEATLH CENTRE OF AN NHON DISTRICT

1. Can you describe your involvement in the model activities, and to what extend did you engage in the activities? (Your satisfactory levels with opportunities for engagement, your role as the district level providing supports for the implementation of the model)
2. What do you think have been the successful outcomes of the model (Prompts: practical values, technical appropriateness, community acceptance, ecological soundness, cost-effectiveness)
3. Please describe what you consider to be the strengths and difficulties in model activities in the intervention commune of your district. (Prompts: community involvement, communal staff engagement, health education, cattle waste treatment)
4. Please describe reporting and documenting system for fascioliasis control during the model activities? (Prompts: route of report flow, feedback)
5. Please describe the allocation of staff and other resources for implementing the model activities at communal level?
6. Please describe the capacity and roles of the community services (communal health stations and district health centres) in fascioliasis control in your province? (Prompts: capacity, technical facilities, human resources, staff knowledge and skills)
7. Please describe the strengths and weaknesses of the coordination between the health offices from provincial, district and commune levels in terms of fascioliasis control and coordination between the health and veterinary sectors in fascioliasis control of ruminants?
8. In your opinion, what factors have contributed to the reduction of fascioliasis incidence at the commune? (Prompts: improved behaviour, better hygienic practice, environmental sanitation)
9. In your opinion, which activities have been successful? What activities should be improved, and in what ways?

Appendix 3.20 Guided questions of in-depth interview for head of communal health station in the intervention community 1

IN-DEPTH INTERVIEW WITH HEAD OF COMMUNAL HEALTH STATION AT INTERVENTION COMMUNITY 1

1. Please describe how people in this commune perceive the risk associated with fascioliasis.
2. Please describe some of the activities you have conducted on fascioliasis control using broadly-based measures in your commune during the implementation period.
3. What activities have you used to involve households in the commune to participate in fascioliasis control?
4. Please describe any health promotion activities that have been undertaken in the commune on fascioliasis control. When? What did the activities include?
5. Can you please describe ways in which health workers, schools, veterinary sector and women association have participated in your commune's fascioliasis control? Please describe the coordination between staff from your station and those in concerned sectors?
6. Please talk about the likelihood that people in your commune will continue to participate in the activities related to fascioliasis control? In what ways will they have perceived the benefits of the measures?
7. Please describe any barriers to gaining participation of the community in fascioliasis control model.
8. Please describe any supports or barriers from local government in terms of providing available resources for the activities.

Appendix 3.21 Guided questions of in-depth interview for chairman of communal people's committee at the intervention community 1

IN-DEPTH INTERVIEW WITH CHAIRMAN OF COMMUNAL PEOPLE'S COMMITTEE AT INTERVENTION COMMUNITY 1

1. Please describe your role in implementing the fascioliasis control model at your commune.
2. How do people in the commune perceive the risks associated with fascioliasis?
3. Can you describe some of the activities you have done on fascioliasis control at your commune?
4. As a leader of local authority in the commune, how do you involve households in the commune to participate in fascioliasis control activities?
5. Please describe any health promotion activities relating to fascioliasis control in which you have been involved. How were you involved? What did the activities include?
6. Please describe any barriers to gaining participation of the community in fascioliasis control model. (Prompts: difficulties relating to socio-cultural, economic, political factors, any other barriers)
7. Please describe any supports the local authority has provided to the fascioliasis control model at your commune.

Appendix 3.22 Guided questions for in-depth interview with communal veterinarian of the Intervention 1 commune

IN-DEPTH INTERVIEW WITH COMMUNAL VETERINARIAN AT INTERVENTION COMMUNITY 1

1. Can you tell about the animal fascioliasis in the commune such as the prevalence, the causes, effects, risk factors of animal fascioliasis control activities?
2. Can you describe some advantages and disadvantages of animal fascioliasis control activities in your community?
3. What other factors related to socio-cultural? What habits cause animal fascioliasis? (prompt: unsafe animals grazing in the rice fields right after harvest?
4. Can you describe some of the activities you have done on fascioliasis control at your commune?
5. Apart from deworming and interchanged grazing, can you tell some other control measures of animal fascioliasis conducted in the commune?
6. As a veterinarian in the commune, how do you involve households in the commune to participate in animal fascioliasis control activities? (Prompt: Do you regularly perform the surveillance on the animal deworms?)
7. Please describe any health promotion activities relating to human and animal fascioliasis control in which you have been involved. How were you involved? What did the activities include?
8. In your views, did the people in the commune accept the model? How well did they accept ?
9. Please describe any barriers to gaining participation of the community in fascioliasis control model. (Prompts: difficulties relating to socio-cultural, economic, political factors, any other barriers for animal fascioliasis control)
10. Please describe any supports from the local authority for the animal fascioliasis control at your commune.

Appendix 3.23 Guided questions for in-depth interview with school principal of Intervention 1 commune

IN-DEPTH INTERVIEW WITH SCHOOL PRINCIPAL AT INTERVENTION COMMUNITY 1

1. Please describe the current fascioliasis situation in your commune. (Prompts: disease impacts, especially on students)
2. What fascioliasis control activities at your community are you familiar with?
3. Can you describe what you consider to be the benefits of these control activities?
4. In what ways has your school been involved in the fascioliasis control activities?
5. Please describe the reasons why you and your school were motivated to get involved in this model?
6. Who from your school have been involved and what activities have been implemented by your school?
7. Which activities do you think are successful and which activities do you think could be improved, and in what ways? (Prompts: health education among students, students as communicators in their families)
8. What contributions do you think these activities have made to the prevention and control of fascioliasis?
9. What other activities do you think could be carried out to effectively control and prevent fascioliasis? (Prompts: involvement of students in environmental sanitation, dung collection to raise funds)
10. In what ways does your school coordinate with commune health station and other stakeholders during model implementation?
11. What supports has your school received from local authorities and communal health station during model implementation?
12. What do you consider to be the advantages, disadvantages and constraints of involving in this model?

Appendix 3.24 Guided questions for focus groups

GUIDED QUESTIONS FOR FOCUS GROUPS

I. Questions for Focus Group-stakeholders at intervention community 1.

1. Can you tell us about the activities that have been used to control fascioliasis in your community? (Probes: Are there any activities that are specific to your community? Are regular activities meant to take place throughout the year, or at specific times? Is there a focus on any particular aspect of fascioliasis at any stage?)
2. Are there any barriers that stop you from being engaged in fascioliasis control activities in your community? (Prompts: time? Money? Knowledge? Beliefs? Community acceptance; Probes: Why?)
3. What activities have been effective in controlling fascioliasis in your community? Why?
4. What activities do you think have not been effective and why?
5. What organizations have been particularly helpful in assisting to control fascioliasis in your community? In what ways?
6. In your opinion, given the current situation of fascioliasis in your commune, should any preventive activities be continued? Which one? And why?

II. Questions for Focus Group – Household representatives at intervention community 1

1. In what ways has your community been involved in the fascioliasis control model? (Prompts: when the program started? activities of this program?)
2. In your opinion what activities have been effective in controlling fascioliasis in your community?
3. Can you describe any changes that you or your family have made to help control the spread of fascioliasis?
4. What fascioliasis control activities do you think are difficult for families to do and why? What would make these activities easier to do?
5. What do you think are the important activities that organizations in your commune such as schools, health centre, agriculture workers, and local government should do to help reduce the spread of fascioliasis?

Appendix 3.25 Observation recording form (based on previously designed study for helminthiasis and husbandry survey (Huynh *et al.*, 2011)

OBSERVATION RECORDING FORM

(fascioliasis-liver fluke)

Full name of householder:

……………………………………………………………………….

Hamlet:……………...Commune:…………….

District:……………Province:……………

I. Household conditions

1. Structure

1.1. Walls

Bricks ☐ Wood ☐ Bamboo ☐ Others ☐

1.2. Roof

Zinc roof ☐ Tiles ☐ Leaves ☐ Flat ☐

1.3. Floor

Bricks ☐ Cement ☐ Earth ☐ Wood ☐

2. Kitchen conditions

2.1. Water sources used in the washing utensils:

Protected well ☐ unprotected well ☐ tap ☐ surface water[26] ☐

2.2. Water used for washing vegetables:

Protected well ☐ unprotected well ☐ tap ☐ surface water ☐

2.3. Water sources used for cooking:

Protected well ☐ unprotected well ☐ tap ☐ surface water ☐

3. Latrine conditions present ☐ absent ☐

3.1. Type:

Self-disposal or half self-disposal ☐ Two-compartment ☐

Decomposition and drying ☐ Digging ☐ Others ☐

3.2. Wall structure:

Brick ☐ Wood ☐ Bamboo ☐ Others ☐

3.3. Floor:

Bricks ☐ Cement ☐ earth ☐ Wood ☐

Others ☐

[26] Water taken from pond, lake, agricultural canal, river branch

3.4. Roof:

Zinc ☐ Tiles ☐ Leaves ☐ flat ☐ roofless ☐

3.5. Sanitation:

Clean ☐ Not clean ☐

II. Cattle shelter (if any):

2.1. Structure:

well-structured ☐ sparsely structured ☐ no shelter ☐

2.2. Waste disposal:

Biogas ☐ sewage ☐ into garden ☐ in to environment ☐

III. Garden (if any):

3.1. Water sources used for watering:

Protected well ☐ unprotected well ☐ tap ☐ surface water ☐

3.2. Use of cattle dung as fertilizer for garden (look at the container of the dung near the shelter or garden)

Yes ☐ no ☐

Appendix 3.26 Elisa kit and testing procedures, adapt from the procedures by tran and tran (1998)

FASCIOLA GIGANTICA ELISA IGG TEST KIT AND TEST PROCEDURES
(Produced by the Faculty of Pharmacy-University of Medicine and Pharmacy)

I. Materials provided with the kit

- P_1: *Fasciola gigantica* antigen coated wells-Microtiters wells coated with *Fasciola gigantica* antigens;
- P_2: Wash solution, concentrated (20X);
- P_3: Sample diluent, concentrated (10X);
- P_4: Enzyme conjugate-contains polyclonal anti human IgG labelled with HRP, ready to use;
- P_{5a} and P_{5b}: Chromogen substrate reagents-contain tetramethylbenzidine and hydrogen peroxide; ready to use
- P_{5c}: Stop solution-contains 1 molar hydrochloric acid, pH<1;
- P_{6a}: Positive serum control-Positive pooled sera containing anti *Fasciola gigantica* antibodies diluted in buffer which contains protein as stabilizer and Kathon CG as preservative, ready to use;
- P_{6b}: Negative control-Negative pool sera containing protein as stabilizer and Kathon CG as preservative, ready to use.

II. Specimen collection and preparation

The test kit is for use with serum. Serum should be prepared from a whole blood specimen obtained by approved aseptic technique. If testing cannot be done within an hour after sample collection (data collection in the field study), specimens should be put in ice box and refrigerated for 48 hours and returned to room temperature before testing. If prolong storage is required, samples should be stored at -20^{0}C. Avoid freeze-thaw of specimens during storage.

III. Reagents preparation

1. All reagents should be allowed to reach room temperature (22-28^{0}C) before use;
2. Dilute each of the positive serum control (P_{6a}), negative control (P_{6b}) and serum from specimen 1:20 (5µ + 95 µl) with saline solution;
3. Dilute concentrated wash solution (P_2) 1:20 with distilled water before use. 50ml of working wash solution is required (i.e. 2.5ml + 47.5ml)
4. Dilute sample diluent (P_3) 1:10 with distilled water. 2 ml is required (i.e. 0.2 ml + 1.8ml);
5. Dilute enzyme conjugate (P_4) 1:200 (4µl:800 µl) with sample diluent (P_3).

IV. Assay procedure

1. Rinse and flick microtiters (P_1) with already diluted working wash solution (P_2) 5 times;

2. Dispense the diluted sample diluent (P_3), then;

3. Dispense 10µl of positive serum control to the first well; 10µl of negative control to the second well and 10µl of prepared serum from specimen to 3rd well;

4. Mix well and leave the 3 wells with 100µl of solution, and the specimen after the dispense will finally have the dilution of 1:200;

5. Incubate the microplate wells at 37^0C for 1 hour or at 45^0C for 30 minutes;

6. Repeat step 1;

7. Add 100µl of the ready to use anti-human IgG conjugate into the microplate wells;

8. Incubate microplate wells at 370C for 1 hour or at 450C for 30 minutes;

9. Repeat step 1;

10. Dilute 800 µl of P_{5a} with 80µl of P_{5b}; then add 100µl of the diluted solution to each well. Leave the wells for 5-20 minutes to develop;

11. Add 100 µl of stop solution (P_{5c}) to the wells to stop reaction if necessary.

V. Result readings

Read absorbance at 450nm by ELISA reader (Use 630 nm filter as reference filter if it's available). The presentations of colour in each well will reflect the colour of the positive control, negative control or specimens.

+ Positive control: blue, light blue, green, yellow and so on, depending on the filter;

+ Negative control: no colour or very light colours

+ Specimens: the colours in the wells are compared with those of positive and negative control. If the colour is the same as the colour of the positive control, the positive titer is 1/12,800; if it is a little bit lighter, the titer is 1/6,400 and little more lighter, the titer is 3.200. If the colour of the specimen is the same as the colour of the negative control, it is considered negative.

Appendix 3.27 Procedure for drawing blood for laboratory examination, adapt from the WHO guidelines on drawing blood: best practices in phlebotomy (WHO, 2010a)

At all times, follow the strategies for infection prevention and control listed in Table below

Infection prevention and control practices

Do	Do not
DO carry out hand hygiene (use soap and water or alcohol rub), and wash carefully, including wrists and spaces between the fingers for at least 30 seconds (follow WHO's 'My 5 moments for hand hygiene'27) DO use one pair of non-sterile gloves per procedure or patient DO use a single-use device for blood sampling and drawing DO disinfect the skin at the venepuncture site DO discard the used device (a needle and syringe is a single unit) immediately into a robust sharps container Where recapping of a needle is unavoidable, DO use the one-hand scoop technique (see Annex G) DO seal the sharps container with a tamper-proof lid DO place laboratory sample tubes in a sturdy rack before injecting into the rubber stopper DO immediately report any incident or accident linked to a needle or sharp injury, and seek assistance; start PEP as soon as possible, following protocols	DO NOT forget to clean your hands DO NOT use the same pair of gloves for more than one patient DO NOT wash gloves for reuse DO NOT use a syringe, needle or lancet for more than one patient DO NOT touch the puncture site after disinfecting it DO NOT leave an unprotected needle lying outside the sharps container DO NOT recap a needle using both hands DO NOT overfill or decant a sharps container DO NOT inject into a laboratory tube while holding it with the other hand DO NOT delay PEP after exposure to potentially contaminated material; beyond 72 hours, PEP is NOT effective

[27] PEP, post-exposure prophylaxis; WHO, World Health Organization.

Step 1 – Assemble equipment

Collect all the equipment needed for the procedure and place it within safe and easy reach on a tray or trolley, ensuring that all the items are clearly visible. The equipment required includes:

- a supply of laboratory sample tubes, which should be stored dry and upright in a rack; blood can be collected in
  - sterile glass or plastic tubes with rubber caps (the choice of tube will depend on what is agreed with the laboratory);
  - vacuum-extraction blood tubes; or
  - glass tubes with screw caps;
- a sterile glass or bleeding pack (collapsible) if large quantities of blood are to be collected;
- well-fitting, non-sterile gloves;
- an assortment of blood-sampling devices (safety-engineered devices or needles and syringes, see below), of different sizes;
- a tourniquet;
- alcohol hand rub;
- 70% alcohol swabs for skin disinfection;
- gauze or cotton-wool ball to be applied over puncture site;
- laboratory specimen labels;
- writing equipment;
- laboratory forms;
- leak-proof transportation bags and containers;
- a puncture-resistant sharps container.

Ensure that the rack containing the sample tubes is close to you, the health worker, but away from the patient, to avoid it being accidentally tipped over.

Step 2 - Identify and prepare the patient

Where the patient is adult and conscious, follow the steps outlined below.

- Introduce yourself to the patient, and ask the patient to state their full name.
- Check that the laboratory form matches the patient's identity (i.e. match the patient's details with the laboratory form, to ensure accurate identification).
- Ask whether the patent has allergies, phobias or has ever fainted during previous injections or blood draws.
- If the patient is anxious or afraid, reassure the person and ask what would make them more comfortable.
- Make the patient comfortable in a supine position (if possible).
- Place a clean paper or towel under the patient's arm.
- Discuss the test to be performed (see Annex F) and obtain verbal consent. The patient has a right to refuse a test at any time before the blood sampling, so it is important to ensure that the patient has understood the procedure.

Step 3 – Select the site

General

- Extend the patient's arm and inspect the antecubital fossa or forearm.
- Locate a vein of a good size that is visible, straight and clear. The diagram in Section 2.3, shows common positions of the vessels, but many variations are possible. The median cubital vein lies between muscles and is usually the most easy to puncture. Under the basilic vein runs an artery and a nerve, so puncturing here runs the risk of damaging the nerve or artery and is usually more painful. DO NOT insert the needle where veins are diverting, because this increases the chance of a haematoma.
- The vein should be visible without applying the tourniquet. Locating the vein will help in determining the correct size of needle.
- Apply the tourniquet about 4-5 finger widths above the venepuncture site and re-examine the vein.

Hospitalized patients

In hospitalized patients, do not take blood from an existing peripheral venous access site because this may give false results. Haemolysis, contamination and presence of intravenous fluid and medication can all alter the results (39). Nursing staff and physicians may access central venous lines for specimens following protocols. However, specimens from central lines carry a risk of contamination or erroneous laboratory test results.

It is acceptable, but not ideal, to draw blood specimens when first introducing an in-dwelling venous device, before connecting the cannula to the intravenous fluids.

Step 4 - Perform hand hygiene and put on gloves

- Perform hand hygiene; that is
  - wash hands with soap and water, and dry with single-use towels; or
  - if hands are not visibly contaminated, clean with alcohol rub - use 3 ml of alcohol rub on the palm of the hand, and rub it into fingertips, back of hands and all over the hands until dry.
- After performing hand hygiene, put on well-fitting, non-sterile gloves.

Step 5 - Disinfect the entry site

- Unless drawing blood cultures, or prepping for a blood collection, clean the site with a 70% alcohol swab for 30 seconds and allow to dry completely (30 seconds) *(40-42)*.

  Note: alcohol is preferable to povidone iodine, because blood contaminated with povidone iodine may falsely increase levels of potassium, phosphorus or uric acid in laboratory test results (6, 7).
- Apply firm but gentle pressure. Start from the centre of the venepuncture site and work downward and outwards to cover an area of 2 cm or more.
- Allow the area to dry. Failure to allow enough contact time increases the risk of contamination.
- DO NOT touch the cleaned site; in particular, DO NOT place a finger over the vein to guide the shaft of the exposed needle. It the site is touched, repeat the disinfection

Step 6 – Take blood

Perform venepuncture as follows.

- Anchor the vein by holding the patient's arm and placing a thumb BELOW the venepuncture site.

- Ask the patient to form a fist so the veins are more prominent.
- Enter the vein swiftly at a 30 degree angle or less, and continue to introduce the needle along the vein at the easiest angle of entry.
- Once sufficient blood has been collected, release the tourniquet BEFORE withdrawing the needle. Some guidelines suggest removing the tourniquet as soon as blood flow is established, and always before it has been in place for two minutes or more.
- Withdraw the needle gently and apply gentle pressure to the site with a clean gauze or dry cotton-wool ball. Ask the patient to hold the gauze or cotton wool in place, with the arm extended and raised. Ask the patient NOT to bend the arm, because doing so causes a haematoma.

Step 7 - Fill the laboratory sample tubes

- When obtaining multiple tubes of blood, use evacuated tubes with a needle and tube holder. This system allows the tubes to be filled directly. If this system is not available, use a syringe or winged needle set instead.
- If a syringe or winged needle set is used, best practice is to place the tube into a rack before filling the tube. To prevent needle-sticks, use one hand to fill the tube or use a needle shield between the needle and the hand holding the tube.
- Pierce the stopper on the tube with the needle directly above the tube using slow, steady pressure. Do not press the syringe plunger because additional pressure increases the risk of haemolysis.
- Where possible, keep the tubes in a rack and move the rack towards you. Inject downwards into the appropriate coloured stopper. DO NOT remove the stopper because it will release the vacuum.
- If the sample tube does not have a rubber stopper, inject extremely slowly into the tube as minimizing the pressure and velocity used to transfer the specimen reduces the risk of haemolysis. DO NOT recap and remove the needle.
- Before dispatch, invert the tubes containing additives for the required number of times (as specified by the local laboratory).

Step 8 - Draw samples in the correct order

Draw blood collection tubes in the correct order, to avoid cross-contamination of additives between tubes. As colour coding and tube additives may vary, verify recommendations with local laboratories. For illustration purposes, Table 2.3 shows the revised, simplified recommended order of draw for vacuum tubes or syringe and needle, based on United States National Committee Clinical Laboratory Standards consensus in 2003 (43).

Step 9 – Clean contaminated surfaces and complete patient procedure

- Discard the used needle and syringe or blood sampling device into a puncture-resistant sharps container.
- Check the label and forms for accuracy. The label should be clearly written with the information required by the laboratory, which is typically the patient's first and last names, file number, date of birth, and the date and time when the blood was taken.
- Discard used items into the appropriate category of waste. Items used for

phlebotomy that would not release a drop of blood if squeezed (e.g. gloves) may be discarded in the general waste, unless local regulations state otherwise.

- Perform hand hygiene again, as described above.
- Recheck the labels on the tubes and the forms before dispatch.
- Inform the patient when the procedure is over.
- Ask the patient or donor how they are feeling. Check the insertion site to verify that it is not bleeding, then thank the patient and say something reassuring and encouraging before the person leaves.

Step 10 - Prepare samples for transportation

- Pack laboratory samples safely in a plastic leak-proof bag with an outside compartment for the laboratory request form. Placing the requisition on the outside helps avoid contamination.
- If there are multiple tubes, place them in a rack or padded holder to avoid breakage during transportation.

Step 11 - Clean up spills of blood or body fluids

If blood spillage has occurred (e.g. because of a laboratory sample breaking in the phlebotomy area or during transportation, or excessive bleeding during the procedure), clean it up. An example of a safe procedure is given below.

- Put on gloves and a gown or apron if contamination or bleaching of a uniform is likely in a large spill.
- Mop up liquid from large spills using paper towels, and place them into the infectious waste.
- Remove as much blood as possible with wet cloths before disinfecting.
- Assess the surface to see whether it will be damaged by a bleach and water solution.
- For cement, metal and other surfaces that can tolerate a stronger bleach solution, flood the area with an approximately 5000 parts per million (ppm) solution of sodium hypochlorite (1:10 dilution of a 5.25% chlorine bleach to water). This is the preferred concentration for large spills (44). Leave the area wet for 10 minutes.
- For surfaces that may be corroded or discoloured by a strong bleach, clean carefully to remove all visible stains. Make a weaker solution and leave it in contact for a longer period of time. For example, an approximately 525 ppm solution (1:100 dilution of 5.25% bleach) is effective.
- Prepare bleach solution fresh daily and keep it in a closed container because it degrades over time and in contact with the sun.

If a person was exposed to blood through nonintact skin, mucous membranes or a puncture wound, complete an incident report, as described in *WHO best practices for injections and related procedures toolkit*. For transportation of blood samples outside a hospital, equip the transportation vehicle with a blood spillage kit. Annex H has further information on dealing with a blood spillage.

Explaining the procedure to a patient

Introduction:

Hello, I am_________________ I work at this health-care facility.

What is your name? (Health-care worker checks first and last name against order for tests and the patient's name band if present).

I am trained to take blood for laboratory tests (or medical reasons) and I have experience in taking blood.

I will introduce a small needle into your vein and gently draw some blood for tests.

(Tell the patient the specific tests to be drawn).

Then I will label them with your name and contact details and send them off for tests to the

laboratory. The results will be returned to Dr _______ (mention the name of the clinician

who ordered the tests).

Do you have any questions? Did you understand what I explained to you? Are you willing to be tested?

Please sit down and make yourself comfortable.

Now, I will ask you a few questions so that both of us feel comfortable about the procedure.

- Have you ever had blood taken before?
- (If yes) How did it feel? How long ago was that?
- Are you scared of needles?
- Are you allergic to anything? (Ask specifically about latex, povidone iodine, tape.)
- Have you ever fainted when your blood was drawn?
- Have you eaten or drunk anything in the past two hours?
- How are you feeling at the moment?

Shall we start? If you feel unwell or uncomfortable, please let me know at once.

Disassembly of needle from syringe or other devices

Safe methods of removing the needle from the syringe or other devices are necessary to protect health workers from injury.

This procedure must be carried out close to a sharps container, and the needle must be discarded immediately.

NEVER disassemble an exposed, used needle with your bare hands.

If the needle has to be disassembled from the barrel or syringe, re-sheath using a one-hand scoop technique, then remove the needle using a removal device. Both of these procedures are explained below.

One-hand scoop technique

1. Leave the needle cap on the surface and guide the tip of the used needle tip into it using only one hand. Clean the surface with disinfectant afterward to avoid leaving blood.
2. Place the needle cap against a firm upright surface with its opening towards the phlebotomist, and place the used needle tip into it.
3. Lift the needle and syringe vertically and, once the tip is covered, use the other hand to fix the cap into place.

Use of a removal device

- Needle pliers - Hold the needle with pliers or artery forceps. Dislodge the needle by unscrewing or pulling it off. Discard immediately into a sharps container.

- Needle guard (mushroom) - Place the cap in the device. Using one hand, insert the needle tip into the cap vertically and turn firmly to fix the needle in the cap. Lift the syringe or barrel and removed the covered needle. Discard immediately.

Appendix 3.28 Official letter on inviting infected cases for treatment of fascioliasis (liver fluke) (in Vietnamese)

BỘ Y TẾ **VIỆN SỐT RÉT KST-CT** **QUY NHƠN**	**CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM** **Độc lập - Tự do - Hạnh phúc**
Số: 171/VSR-HTQT V/v Điều trị bệnh sán lá gan lớn	*Bình Định, ngày 10 tháng 5 năm 2013*

Kính gửi: - Trung tâm Y tế thị xã An Nhơn-Bình Định
- Trung tâm Y tế huyện Sơn Tịnh-Quảng Ngãi

Thực hiện đề tài "Nghiên cứu và đánh giá mô hình phòng chống bệnh sán lá gan tại hai tỉnh Bình Định và Quảng Ngãi", Viện Sốt rét KST-CT Quy Nhơn cử đoàn công tác thực hiện công tác điều trị cho bệnh nhân nhiễm sán lá gan lớn qua cuộc điều tra xét nghiệm máu và phỏng vấn đánh giá thái độ, hành vi và thực hành phòng chống bệnh sán lá gan lớn.

Nội dung:

- Thăm khám lâm sàng và điều trị cho các bệnh nhân có kết quả dương tính với kháng thể sán lá gan lớn bằng thuốc triclabendazole (Egaten) 250 mg (có danh sách kèm theo);
- Theo dõi tác dụng phụ của thuốc đến ngày thứ 7 (D7)

Thời gian và địa điểm:

- Xã Nhơn Thành (An Nhơn): 16-23/05/2013, Trạm Y tế xã Nhơn Thành
- Xã Nhơn Hậu (An Nhơn): 24-30/05/2013, Trạm Y tế xã Nhơn Hậu
- Xã Tịnh Giang (Sơn Tịnh): 01-07/06/2013, Trạm Y tế xã Tịnh Giang

Viện đề nghị các trung tâm tạo điều kiện giúp đỡ để đoàn công tác hoàn thành các nhiệm vụ được giao.

VIỆN TRƯỞNG

VIỆN SỐT RÉT KÝ SINH TRÙNG CÔN TRÙNG QUY NHƠN

Nguyễn Văn Chương

Nơi nhận:

- Như trên;
- Lưu phòng HTQT, khoa KST.

Appendix 3.29 Follow ups of side effects from drug administration of triclabendazole, adapt from guideline for monitoring treatment of human fascioliasis with triclabendazole *(WHO, 2006a)*

Monitoring treatment of human fascioliasis with triclabendazole (Egaten®)

Goal

• To assess the extent to which occurrence of adverse reactions following administration of TCZ can limit scaling up of treatment activities in communities highly endemic for human fascioliasis.

Objective(s)

• To ascertain and quantify adverse reactions that may occur following treatment of human fascioliasis with TCZ.

• To analyse the data on adverse reactions experienced by people followed up to help formulate and/or revise guidelines for the use of TCZ in fascioliasis control programmes.

Outcome

• Determination of the nature of surveillance and pharmacovigilance measures that need to be routinely put in place to monitor adverse reactions due to treatment with TCZ in a public health context.

Study type: observational

Study design: active follow-up of a cohort of individuals infected with fascioliasis and treated with TCZ (active cohort monitoring for a defined period of time).

Eligibility: age ≥5 years, both males and females.

Inclusion criteria

• Person infected with fascioliasis

• Willingness and ability to comply with the protocol for follow-up.

Exclusion criteria

• Acute or severe illness, either ongoing or during the previous week

• Chronic severe liver disease

• Pregnant or lactating

• Significant concomitant illness that would interfere with participation or assessment in this study

• Currently on treatment for another illness.

Methodology of follow-up

• Baseline (before any treatment activity, in a community where prevalence of human fascioliasis is known)

o Participants: their name, age and sex are recorded on their personal form. The form is kept by the people conducting the surveys. A treatment card bearing their name, sex and age is given to the participating individual to make recognition at follow-up easy.

o Participants are interviewed using a structured questionnaire on the occurrence of symptoms that could be confounded with adverse reactions

o Participants are asked to provide a stool sample in order to ascertain their status (non-infected, infected, intensity of infection).

• Day 0 (treatment)

o Participating individuals infected with fascioliasis are weighed and the appropriate dose of TCZ (10 mg/kg) is calculated and reported on their personal form and on the treatment card.

o TCZ is administered, (ideally) with a fatty meal or milk, on presentation of the treatment card.

• Day 1 (24 hours after administration of TCZ)

o Participating individuals are interviewed on the occurrence of new symptoms since treatment (1st follow-up).

• Day 4 (96 hours after administration of TCZ)

NB: follow-up at day 4 OPTIONAL

o Participating individuals are interviewed on the occurrence of new symptoms since treatment (2nd follow-up).

• Day 7 (1 week after administration of TCZ)

o Participating individuals are interviewed on the occurrence of new symptoms after the last interview (2nd follow-up – 3rd if participating individuals have been followed-up at day 4).

Participants form

Name: Personal identification number:

Surname:

Sex:

Age:

Signature

BASELINE (BEFORE ANY TREATMENT)

(DATE: dd / mm / yy)

1. Confounding symptoms

Are you currently suffering from any of the following symptoms, or have you experienced any of them over the past seven days?

Symptom			
Biliary colic (pain in the right			

2. Personal history

Do you ...?

A. Drink surface water?
B. Eat aquatic or semi-aquatic vegetables?
C. Wash dishes with surface water?
D. Use latrines?
E. Defecate out in the open?
F. Keep domestic animals (cattle, buffaloes, goats) inside the household?

a. If yes: as far as you know, are any of these animals affected by fascioliasis?

G. Have a kitchen garden?

Where do you get your water?

□ tap □ protected well □ unprotected well □ surface water (pond/stream/canal)

DAY 0 (TREATMENT DAY)

(DATE: dd / mm / yy)

1. Treatment WEIGHT:

NUMBER OF TABLETS of EGATEN® 250 mg ADMINISTERED:

DAY 1
(DAY FOLLOWING TREATMENT)

(DATE: dd / mm / yy)

1. 1st follow-up on adverse reactions
(Patient to be interviewed around 24 hours after treatment)
Are you currently suffering from any of the following symptoms, or have you experienced any of them since you received treatment?

Symptom	**Severity**		
	Mild	**Moderate**	**Severe**
Biliary colic (pain in the right upper abdominal quadrant)			
Other abdominal pain			
Vomiting			
Diarrhoea			
Fever			
Skin rash			
Jaundice			
Fatigue			
Others			

DAY 7
(ONE WEEK AFTER TREATMENT)

(DATE: dd / mm / yy)

1. 2nd follow-up on adverse reactions
(Patient to be interviewed around one week after treatment)
Are you currently suffering from any of the following symptoms, or have you experienced any of them since your last interview?

Symptom	**Severity**		
	Mild	**Moderate**	**Severe**
Biliary colic (pain in the right upper abdominal			
Other abdominal pain			
Vomiting			
Diarrhoea			
Fever			
Skin rash			
Jaundice			
Fatigue			
Others			

Additional questions:
1. Do you feel better now?

If YES: which improvement did you experience?

2. If you were sick again, would you take the treatment again?

Appendix 3.30 Ethic approvals for the study

Ethic approval by IMPE-QN (in Vietnamese)

BỘ Y TẾ
VIỆN SỐT RÉT KST-CT
QUY NHƠN
Số: 364/CV-VSR
V/v Chấp thuận Y đức
cho nghiên cứu sinh

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

Bình Định, ngày 04 tháng 10 năm 2012

Kính gửi:
- GS. Heather Yeatman, ĐH Tổng hợp Wollongong;
- GS. Vicki Flood, ĐH Tổng hợp Wollongong;
- NCS. Trần Minh Quý.

Hội đồng Đạo đức trong nghiên cứu Y sinh học Viện Sốt rét-Ký sinh trùng và côn trùng Quy Nhơn (Bộ Y tế) đã nhận đơn xin chấp thuận Y đức của đề tài nghiên cứu "***Nghiên cứu đánh giá mô hình phòng chống bệnh Sán lá gan lớn tổng hợp tại khu vực miền Trung-Tây Nguyên***".

Hội đồng Đạo đức Viện Sốt rét-Ký sinh trùng và côn trùng Quy Nhơn đã xem xét các văn bản và tài liệu liên quan của đề cương nghiên cứu và đã chấp thuận cho tiến hành đề tài này tại các điểm nghiên cứu thuộc khu vực miền Trung-Tây Nguyên.

Nơi nhận:
- Như trên;
- Lưu VT, HĐ.

HỘI ĐỒNG ĐẠO ĐỨC TRONG NGHIÊN CỨU Y SINH HỌC
CHỦ TỊCH

KT/VIỆN TRƯỞNG
PHÓ VIỆN TRƯỞNG

VIỆN SỐT RÉT KÝ SINH TRÙNG CÔN TRÙNG QUY NHƠN

TS.Hồ Văn Hoàng

Ethic approval by the University of Wollongong

UNIVERSITY OF WOLLONGONG

INITIAL APPLICATION APPROVAL
In reply please quote: HE12/405
Further Enquiries Phone: 4221 3386

6 March 2013

Associate Professor Heather Yeatman
Room 41.253, School of Health Sciences
University of Wollongong

Dear Associate Professor Yeatman,

Thank you for your letter dated 1 March 2013 responding to the HREC review of the application detailed below. I am pleased to advise that the application has been approved.

Ethics Number:	HE12/405
Project Title:	Evaluation of a broadly-based control model of fascioliasis (liver fluke disease) in Central Vietnam.
Name of Researchers:	A/Professor Heather Yeatman, A/Professor Vicki Flood, Dr Van Chuong Nguyen, Mr Minh Quy Tran
Documents Approved:	1. Appendix 2.1 Email/telephone script – Interview received 1 March 2013 2. Appendix 2.2 Email/ telephone script – Focus Group received 1 March 2013 3. Appendix 2.3 Email/ telephone script – Interview received 1 March 2013 4. Appendix 2.4 Email / telephone script – Focus Group received 1 March 2013 5. Appendix 2.5 Permission form for getting details of participants in survey received 1 March 2013 6. Appendix 3 Participant Information Sheet for Broadly-Based Control Model of Fascioliasis (Liver Fluke) in Central Vietnam (KAP survey) received 1 March 2013 7. Appendix 3.1 Participant Information Sheet for Broadly-Based Control Model of Fascioliasis (Liver Fluke) in Central Vietnam (household observation) received 1 March 2013 8. Appendix 4 Consent Form for participants in the KAP survey received 1 March 2013 9. Appendix 4.1 Consent Form for participants in the household observation received 1 March 2013 10. Appendix 5 Participant Information Sheet for Broadly-Based Control Model of Fascioliasis (Liver Fluke) in Central Vietnam (blood examination) received 1 March 2013

Ethics Unit, Research Services Office
University of Wollongong NSW 2522 Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web: www.uow.edu.au

11. Appendix 6 Consent Form for adult participants having blood taken for laboratory examination of fascioliasis received 1 March 2013
12. Appendix 7 Participant Information Sheet for Broadly-Based Control Model of Fascioliasis (Liver Fluke) in Central Vietnam (interview) – stakeholders received 1 March 2013
13. Appendix 8 Consent Form for participants in the in-depth interviews received 1 March 2013
14. Appendix 9 Participant Information Sheet for Broadly-Based Control Model of Fascioliasis (Liver Fluke) in Central Vietnam (focus group) – household representatives received 1 March 2013
15. Appendix 10 Consent Form for participants in the focus groups received 1 March 2013
16. Response - Evaluation of a broadly-based control model of fascioliasis (liver fluke disease) in Central Vietnam received 1 March 2013

Documents Noted/ Approved:

- Initial Application
- Appendix 1: List of formula
- Appendix 11: Questionnaire for household knowledge, attitude and practice (KAP) (Nguyen 2011)
- Appendix 12: Guided questions of in-depth interview with a representative of WHO office in Vietnam
- Appendix 13: Guided questions for in-depth interview with the director of the Institute of Malariology-Parasitology Entomology, Quy Nhon (IMPE-QN)
- Appendix 14: Guided questions for in-depth interview with the director of provincial centre of malariology-parasitology and entomology of Binh Dinh province
- Appendix 15: Guided questions for in-depth interview with director of veterinary centre of Binh Dinh province
- Appendix 16: Guided questions of in-depth interview for director of district health centre of An Nhon (Binh Dinh)
- Appendix 17: Guided questions of in-depth interview for head of communal health station in the intervention community 1
- Appendix 18: Guided questions for in-depth interview with chairman of communal people's committee at interventional commune
- Appendix 19: Guided questions for in-depth interview with school principal of project commune
- Appendix 20: Guided questions for focus groups
- Appendix 21: Observation recording form (based on previously designed study for helminthiasis and husbandry survey (Huynh et al. 2011)
- Appendix 22: Elisa Test kit and testing procedures, adapt(ed) from the procedures by Tran and Tran (1998)
- Appendix 23: Procedure for drawing blood for laboratory examination, adapt(ed) from the WHO guidelines on drawing blood: best practices in phlebotomy (WHO 2010)
- Appendix 24: Leaflet of health education for fascioliasis control

UNIVERSITY OF WOLLONGONG

- Appendix 25: Course map for training communal stakeholders of intervention community 1
- Appendix 26: Follow ups of side effects from drug administration of triclabendazole, adapt(ed) from guideline for monitoring treatment of humanfascioliasis with triclabendazole (WHO 2006)
- Application in Vietnamese language
- Ministry of Health Institute of Malariology-Parasitology and Entomology, Vietnam, Medical Ethics Committee approval letter (Vietnamese and English translation)
- Cover letter - Application for Approval to Undertake Research Involving Human Participants (Vietnamese and English translation).

Approval Date: 4 March 2013

Expiry Date: 3 March 2014

The University of Wollongong/ISLHD Health and Medical HREC is constituted and functions in accordance with the NHMRC *National Statement on Ethical Conduct in Human Research*. The HREC has reviewed the research proposal for compliance with the *National Statement* and approval of this project is conditional upon your continuing compliance with this document.

A condition of approval by the HREC is the submission of a progress report annually and a final report on completion of your project. The progress report template is available at http://www.uow.edu.au/research/rso/ethics/UOW009385.html. This report must be completed, signed by the appropriate Head of School and returned to the Research Services Office prior to the expiry date.

As evidence of continuing compliance, the Human Research Ethics Committee also requires that researchers immediately report:

- proposed changes to the protocol including changes to investigators involved
- serious or unexpected adverse effects on participants
- unforseen events that might affect continued ethical acceptability of the project.

Please note that approvals are granted for a twelve month period. Further extension will be considered on receipt of a progress report prior to expiry date.

If you have any queries regarding the HREC review process, please contact the Ethics Unit on phone 4221 3386 or email rso-ethics@uow.edu.au.

Yours sincerely,

Associate Professor Sarah Ferber
Chair, UOW & ISLHD Health and Medical
Human Research Ethics Committee

Ethics Unit, Research Services Office
University of Wollongong NSW 2522 Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web: www.uow.edu.au

Appendix 3.31 Registration for circulation of medical device manufacturing in Vietnam

Trong quá trình lưu hành sản phẩm đơn vị có trách nhiệm:
In the products' circulation and business activities, it is required to strictly obey the following obligations:

1. **Phải chịu trách nhiệm về chất lượng sản phẩm đã đăng ký.**
Have full responsibility on quality of the product registered.
2. **Chấp hành đầy đủ các quy định về quản lý trang thiết bị y tế của Bộ y tế.**
Conform to the S.R. Vietnam Ministry of Health's regulations on management of medical equipment.
3. **Thông báo cho Bộ Y tế trước 30 ngày trong các trường hợp sau:**
Inform to the Ministry of Health in advance (30 days) in the following cases:
– Thay đổi địa chỉ *(Any change of Manufacturer's address)*
– Mọi sự thay đổi liên quan đến sản phẩm *(Any change of the registered product)*
– Tách, sáp nhập, đổi tên hoặc chấm dứt hoạt động sản xuất kinh doanh *(Any split, merge, rename and interruption of the product's production and bussiness)*
4. **Giấy chứng nhận này có giá trị 03 (ba) năm kể từ ngày ký. Trước khi hết hạn 30 (ba mươi) ngày, đơn vị phải làm thủ tục xin gia hạn đăng ký nếu vẫn tiếp tục lưu hành sản phẩm trên.**
This Certification has a validity of three (03) years starting from the signing date. Before its expiration date of thirty (30) days, it is required to renew the validity of certification if the product is continuing circulation in Vietnam.

TL. BỘ TRƯỞNG
KT. VỤ TRƯỞNG
VỤ TRANG THIẾT BỊ - CÔNG TRÌNH Y TẾ
PHÓ VỤ TRƯỞNG
FOR MINISTER OF HEALTH
DEPARTMENT OF MEDICAL EQUIPMENT & CONSTRUCTION
Deputy Director

Nguyễn Minh Tuấn

CHỨNG THỰC BẢN SAO ĐÚNG VỚI BẢN CHÍNH
Số chứng thực: 009211
Quyển số 03 SCT/BS
Ngày 04 tháng -06- năm 2013
PHÓ CHỦ TỊCH UBND P.9 - Q.5

Hồ Lộ Đơn

CỘNG HOÀ XÃ HỘI CHỦ NGHĨA VIỆT NAM
SOCIALIST REPUBLIC OF VIETNAM

BỘ Y TẾ
MINISTRY OF HEALTH

GIẤY CHỨNG NHẬN
ĐĂNG KÝ LƯU HÀNH SẢN PHẨM TRANG THIẾT BỊ Y TẾ SẢN XUẤT TẠI VIỆT NAM

CERTIFICATE

REGISTRATION FOR CIRCULATION OF MEDICAL DEVICE MANUFACTURING IN VIETNAM

BỘ Y TẾ
Số (No) 19/2010/BYT-TB-CT

Hà Nội, ngày (date): 21/10/2010

GIẤY CHỨNG NHẬN
ĐĂNG KÝ LƯU HÀNH SẢN PHẨM TRANG THIẾT BỊ Y TẾ SẢN XUẤT TẠI VIỆT NAM

CERTIFICATE
REGISTRATION FOR CIRCULATION OF MEDICAL DEVICE MANUFACTURING IN VIETNAM

- Căn cứ Luật Chất lượng sản phẩm, hàng hoá ngày 21/11/2007.
Based on Law on Quality of products and goods dated November 21, 2007.
- Căn cứ Thông tư số 07/2002/TT-BYT ngày 30/5/2002 của Bộ Y tế về hướng dẫn đăng ký lưu hành sản phẩm Trang thiết bị y tế.
Based on Circular Letter 07/2002/TT-BYT dated May 30, 2002 of the Ministry of Health on guiding for circulation registration of medical device.
- Xét hồ sơ và đơn đề nghị cấp số đăng ký lưu hành sản phẩm của đơn vị.
Having examination of documentation and application letter for circulation of medical device submitted by the applicant.

BẢN SAO

BỘ Y TẾ CHỨNG NHẬN
MINISTRY OF HEALTH CERTIFIES THAT

Đơn vị (Company): C.TY TNHH SẢN XUẤT THƯƠNG MẠI HOÁ CHẤT VIỆT SINH

Địa chỉ (Address): 71 Ỷ Lan, phường Hiệp Tân, quận Tân Phú TP. Hồ Chí Minh

Điện thoại (Tel): 08.38801991 Fax: 08.39573240

ĐƯỢC PHÉP LƯU HÀNH TẠI VIỆT NAM SẢN PHẨM
HAS A PERMISSION TO CIRCULATE THE FOLLOWING MEDICAL DEVICE IN VIETNAM

- Tên sản phẩm: (Name of the product): BỘ XÉT NGHIỆM ELISA PHÁT HIỆN NHIỄM KÝ SINH TRÙNG
- Ký mã hiệu sản phẩm: (Model and Serial number)
- Tiêu chuẩn công bố: (Conform to the Standards of): 07209/SPCĐ-ĐK, 07309/SPCĐ-ĐK, 07409/SPCĐ-ĐK
- Số đăng ký lưu hành được cấp: (Registered number): 19/2010/BYT-TB-CT

Appendix 3.32 Excerpt from the IMPE-QN handbook on safe laboratory procedures (in Vietnamese)

BỘ Y TẾ
VIỆN SỐT RÉT KST-CT
QUY NHƠN

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập – Tự do – Hạnh phúc

VIỆC TẨY UẾ, TIỆT TRÙNG VÀ XỬ LÝ CHẤT THẢI

VIỆC TẨY UẾ

Việc tẩy uế bằng hoá chất là tiêu diệt hoặc loại bỏ các sinh vật ra khỏi các vật thể hoặc bề mặt bằng cách sử dụng một tác nhân hoá học.

Có nhiều loại hoá chất tẩy uế như axít, kiềm, halogen, những kim loại nặng, các hợp chất amoni bậc bốn, các andehit, các xeton, các loại cồn, các loại amin và peroxit.

Các chất khử khuẩn thích hợp nhất cho phòng xét nghiệm là:

- Phenon
- Hypochlorit
- Andehit
- Cồn

Mức độ hiệu quả của chất khử khuẩn thay đổi tùy theo:

- Nồng độ
- Thời gian tiếp xúc
- Độ pH
- Nhiệt độ
- Độ ẩm
- Sự hiện diện của những vật chất hữu cơ

Không có chất tiệt khuẩn nào sẽ phát huy tác dụng trừ phi nó được sử dụng thích hợp và đúng cách.

Việc sử dụng đúng các chất khử khuẩn:

CÁC LOẠI RÁC SẠCH

Giấy hoặc những thứ chưa tiếp xúc với những đồ vật bị nhiễm khuẩn có thể vất đi theo cách thông thường trong những thùng rác đặc chủng.

THỦY TINH VỠ VÀ ĐỒ THỦY TINH KHÔNG DÙNG LẠI ĐƯỢC

Nên bỏ những thứ này vào trong một đồ chứa cứng không rò rỉ và hấp hơi trước khi đưa ra khỏi phòng xét nghiệm để hủy.

CÁC BỆNH PHẨM

Nước tiểu, máu và các dịch cơ thể khác:

- Nên được hấp hơi, đóng gói theo quy định trước khi đưa ra khỏi phòng xét nghiệm để bỏ đi.
- Các mẫu máu còn lại không được để trong phòng thí nghiệm sau 72 tiếng đồng hồ

Phân:

- Nên được giữ thật an toàn trong các túi không rò ri và
- Nhân viên phòng xét nghiệm nên kiểm tra việc hủy bằng cách đốt. (Khi hấp hơi phân sẽ tạo ra mùi rất khó chịu!)

NHỮNG ĐỒ THỦY TINH DÙNG LẠI ĐƯỢC

Các pipette thủy tinh chuẩn

- Đây là những dụng có độ chuẩn xác cao và thủy tinh sẽ bị ảnh hưởng nếu nó bị tiếp xúc với nhiệt độ cao trong một khoảng thời gian dài.
- Bỏ các ống pipette thủy tinh này vào trong một dung dịch khử khuẩn thích hợp qua một đêm.
- Phải bảo đảm rằng chúng đã chìm hoàn toàn vào trong dung dịch và không có sự hiện diện của những bọt khí.
- Rửa bằng nước thật nóng rồi dùng trở lại

Các ống nghiệm, ống pipette Pasteur và lam kính

- Bỏ vào trong một chất khử khuẩn thích hợp ngay sau khi sử dụng
- Phải bảo đảm rằng chúng được phủ hoàn toàn

Appendix 4.1 Published journal article

ORIGINAL RESEARCH

Prevalence and risks of fascioliasis among adult cohorts in Binh Dinh and Quang Ngai provinces-central Viet Nam

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ABSTRACT

Fascioliasis (liver fluke disease) has raised significant public health concerns in the[15] regional provinces of Central Vietnam, accounting for 93% of the national incidence of the disease. No control measures to date have proven effective. Annual reports show increasing incidence of fascioliasis but they are incomplete. This cross-sectional study was conducted to identify the prevalence of fascioliasis and to describe its associated risks in three communes in Central Vietnam. 500 human blood samples were examined (ELISA); and a survey of knowledge, attitude and practice (KAP) was conducted for 600 randomly selected adults per commune. The findings suggest that overall seroprevalence was 7.75% (95%CI 6.54-9.16%). Among the infected cases, people aged from 18-59 years (85.6%) and farmers (68.0%) accounted for majority of infection. Less than half of participants in all three communes (24.6% - 46.0%) knew the causes of fascioliasis; and considerable proportions ate improperly boiled vegetables (28.2-33.8%), drank unboiled water (23.5-42.5%), and did not own a household toilet (14.2-20.5%). Relatively high prevalence and risks of fascioliasis were found in Central Vietnam, supporting the need for comprehensive intervention measures including selective treatment, health education, and multisectoral approaches to reduce the morbidity associated with fascioliasis and thus improve the health status of the people.

Keywords: *Blood survey, Central Vietnam fascioliasis, F. hepatica, F. gigantica, KAP, prevalence, risk factors,*

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INTRODUCTION

Fascioliasis (liver fluke disease) is the parasitic disease caused by two food-borne species. Fasciola hepatica (F. hepatica) and Fasciola gigantica (F. gigantica) are classified as liver flukes (trematodes) and belong to the genus Fasciola[1]. Among the digenerean species, F. hepatica has a wide distribution in all continents[2,3], whereas F. gigantica is restricted to the low altitudes in tropical regions of Africa, Asia and the Middle East[4,5]. In addition, the two fasciolids can infect a wide range of final hosts, including water buffaloes, bovines, goats, sheep and humans[6,7]. Snails belonging to the Lymnaeid species are known for their intermediate hosts of Fasciola[8]. The spread of fascioliasis to new environments and geographical areas reflects the marked adaptation of the parasites to the Lymnaeid snails and expansion of the existing snail populations[9]. Increasingly, recent molecular tools have reported the prevalence of the two fasciolids to be overlapping[10], possibly because they are very adaptive with Lymnaeid snails as their intermediate hosts[11]. It is the distribution and adaptability of the aquatic Lymnaeid snails to a wide range of environmental niches that have resulted in the recent expansion of fascioliasis transmission in Europe, South America, Africa, Asia and the Middle East[12-15].

Since the mid-1990s fascioliasis has been considered a secondary emerging/re-emerging zoonotic disease[16] and it is posing negative impacts on public health systems and livestock industries worldwide[17, 6]. With the annual prediction of 35,000 DALYs lost[18], human fascioliasis is reportedly affecting about 180 million people and infecting from 2.4 to 17 million others in 51 countries worldwide[1, 19, 20], Recent outbreaks of human fascioliasis have made the disease a major public health problem in developing parts of the world and it is listed by WHO as a priority of neglected tropical diseases (NTDs)[8, 21, 22]. In addition, various studies[23-27] report significant reduction or losses in production of milk and meat products attributed to fascioliasis.

In Vietnam, fascioliasis has raised significant public health concerns.The National Institute of Malariology-Parasitology and Entomology (NIMPE) reported a total incidence of 15,761 cases between 2006 and mid-2010 in 47 of 63 provinces nationwide[28]. Central Vietnam, with favourable geographical and weather conditions for parasitic diseases, is the area most affected by fascioliasis[29]. Recent studies[30, 31] reported the emergence of the disease in all 15 regional provinces, accounting for 93% of the total national incidence. Other studies[32, 33] have indicated human fascioliasis infection rates ranging from 5.6% to 11.1% in coastal provinces of Binh Dinh, Phu Yen, and Khanh Hoa. However, studies conducted previously have not provided detailed understanding of fascioliasis as the potential public health problem in Central Vietnam, and annual reports documenting increasing incidence are incomplete.

In the absence of a more comprehensive exploration of the prevalence of fascioliasis and the detailed description of the associated risks of the disease, this study was conducted to determine the prevalence of fascioliasis by laboratory methods and to describe the risk factors associated with fascioliasis infections in three adult cohorts.

METHODS

The study was undertaken in Nhon Hau and Nhon Thanh communes (An Nhon town-Binh

Dinh province) and Tinh Giang commune (Son Tinh district-Quang Ngai province) in Central Vietnam between March and May 2013 (Figure 1). The selection of the actual communes in the two different provinces was based on the convenience of accessibility (transports, health system facilities, and engagement of local authority), and site distance (control commune away from the influences of the intervention communes). The study duration was at beginning of the dry season in two provinces, with the measured meteorological data at the Binh Dinh station for three months of temperaturesat 26.9°C, 28.3°C, and 28.9°C; rainfalls of 22.1, 38.9, and 255.6 millimetres; and sunshine duration of 269.6, 242.9, and 307.2 hours, respectively[34]. A cross-sectional descriptive design comprising human blood survey and knowledge, attitudes and practices (KAP) survey was applied in this study. In each commune, randomly-selected 500 adults (aged from 18 years old) had their blood samples examined (ELISA); and 600 randomly selected adults (household representatives) were involved in the KAP survey on fascioliasis. In addition, snail surveys were undertaken to evaluate the prevalence of fascioliasis in the intermediate hosts in the aquatic biotopes of the three communes.

Equation 1. Formula 1 for sample size calculation used in blood survey

$$n = \frac{Z^2_{(1-\alpha/2)} P(1-P)}{d^2}$$

n: minimum sample size needed
p: referential infection rate of 6.0% (P= 0.06) from the study conducted previously[35].
d: absolute percentage point of precision, 2.3% (d= 0.023)
Z(1-α/2) = 1.96 at 95% CI

Equation 2. Formulas for sample size calculations used in KAP survey

$$n = Z^2(\alpha,\beta)\frac{[p1(1-p1)+p2(1-p2)]}{(p1-p2)^2} \qquad n = Z^2(\alpha,\beta)\frac{[p1(1-p1)+p3(1-p3)]}{(p1-p3)^2}$$

$$n = Z^2(\alpha,\beta)\frac{[p2(1-p2)+p3(1-p3)]}{(p2-p3)^2}$$

n: minimum sample size needed
Z(1-α/2) = 2.576 at the confident interval (CI) of 99%
Z(1-β) = 0.84 when 1-β = 80%; $Z^2(\alpha,\beta)$ = 11,669
- p1: proportion of population in intervention commune 1 owning knowledge, attitude and practice against fascioliasis after the intervention, expected at 80% (p1= 0.84);
- p2: proportion of population in intervention commune 2 owning knowledge, attitude and practice against fascioliasis after the intervention, expected at 69% (p2= 0.69);
- p3: proportion of population in control commune owning knowledge, attitude and practice against fascioliasis after the intervention, expected at 56% (p3=0.59).

The seroprevalence of fascioliasis in three communities was determined by laboratory-based blood ELISA and comparing the eosinophilia counts with the guidelines of diagnosis and treatment of fascioliasis by the Ministry of Health, Vietnam[36]. Determining the prevalence of fascioliasis in the community settings can be based on either of two main diagnostic methods: the classical coprology and serology[37]. The coprological examination provides a direct measure of the infection but has low sensitivity and is not routinely conducted in Vietnam[38, 39]. In this study, serological ELISA (Enzyme-Linked Immunosorbent Assay) was used to indirectly detect the antibodies specific to *Fasciola spp.* (IgG) in human sera. This study used the test kits (FASCELISA), specific for *F.gigantica* infection, which were produced and distributed by the Viet Sinh Chemical Producing & Trading Co., Ltd (formerly the Faculty of Pharmacy-Ho Chi Minh City University of Medicine and Pharmacy-Vietnam). The test kits were previously proven to have high sensitivity and specificity[40], and the protocol had been approved for use by the Ministry of Health.

The sample for cross-sectional study was calculated (formula 1) for statistical methods for sample size determination by Lemeshow et al.[41], with known referential infection rate from previous study conducted in a neighbouring province of Khanh Hoa[42]. The total sample population in each selected commune was 428 people. To assure the desired number of participants an additional 20% or 85 more people were added in case of loss to follow-up or inaccessibility, resulting in a total sample population in each commune of 504 (rounded to 500 people). As the prevalence of fascioliasis among children in the area had been found in recent studies to be low[43-45], only adults aged from 18 were selected for this study. Households were randomly selected from the records available at the communal registrar's office, applying a 5-household interval, until the required number of households was reached. One adult member of each household was invited to participate.

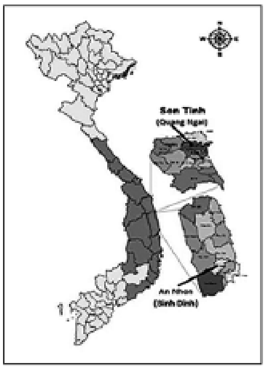

Fig1. Map of Vietnam showing the studied sites in Binh Dinh and Quang Ngai provinces

The blood samples were used for ELISA to identify if a person was infected with fascioliasis and for eosinophilia evaluation as a supplementary indicator of positive case[36].

The results of the assays were calculated by dividing the optical density (OD) reading of each sample well of the plate by the cut-off value (determined by the mean OD negative controls plus 3 standard deviations). Any result from 1.0 was considered positive, and results less than 1.0 were recorded as negative[40].

As the KAP survey involved adult cohorts in three communes, the manual Bonferroni adjustment was used to allow for multiple comparisons to be made while assuring the overall confidence coefficient[46]. The sample size for the study was calculated for estimating the difference between two population proportions with specified absolute precision (Two-sample situations) by Chadha[47], with equal sample size in each pair of three comparisons (formula 2). Previous proportions of knowledge were used as referential indicators[48] and the average samples were calculated for each pair of comparisons (p1 and p2, p1 and p3, and p2 and p3). Accordingly, the total sample population in each commune (plus 10 of sample in case of attrition) was 600 people. All adults (aged from 18 and above) in every second household participating in the blood survey were invited to undertake the KAP survey.

As a result, 1,800 representatives (usually householders) aged from 18 years old were invited to participate in the KAP survey. The KAP surveys were administered by face-to-face interviews at the householder's residence, taking approximately 20 minutes.

Participation of individuals for blood and KAP surveys was on voluntary basis. Participants had the choice of participating or not in the study and could discontinue the interviews at any time without bearing any consequences.

Equation 3. Formula 3 for sample size calculation used in Lymnaied snail surveys

$$n = Z^2_{1-\alpha/2} \frac{(1-p)}{p.\varepsilon^2}$$

n: minimum sample size needed
p: referential infection rate of 1.7% (p= 0.017) from previous study conducted in BinhDinh49.
ε: relative precision at 25% or 0.25,
Z(1-α/2) = 1.96 at 95% CI

Surveys of *Lymnaeid* snails as intermediate hosts of fascioliasis were conducted at all rice fields, lakes, ponds, agricultural canals or small streams of three study sites to identify the prevalence of fascioliasis infection in the snail (Equation 3). Estimated total of 3,554 snails plus 10% to account for sampling attrition or 3,909 snails were collected in each of the three study sites. The snails were collected from the aquatic habitats using paddles with 1.5 metre-long wooden handle and 15 by 15 cm net size. The collected snails were then put into plastic, screw capped containers with an amount of water and transferred to the laboratory of IMPE-QN. Before examination, the *Lymnaeid* snails were identified by snail taxonomy[50]. Each of the snails was crushed and smeared on microscopic slides for the presence of *Fasciola* larvae (radiae and cercariae) using microscope (40X) and with the taxonomy of *F.gigantica* cercariae[51]. The infection rate was calculated in percentage by the amount of *Lymnaeid snails* infected by the larvae.

The results from ELISA for blood samples were entered in the EpiData 3.1 and transferred into SPSS (Statistical Package for Social Sciences) version 19.0. Descriptive statistical analyses were undertaken, such as overall prevalence of fascioliasis in the population and distribution of the disease according to gender, age, education background and occupation. With the statistical χ^2 and Fisher's exact tests being used, statistical significances were reached if the p-values were less than 0.05. The associated risks of fascioliasis among three adult cohorts were evaluated using the data obtained from the knowledge, attitude and practice surveys in three communes. Data entry and statistical analyses of the KAP data were similar to procedures applied to blood survey data. Descriptive analyses were undertaken: ethnographical characteristics were compared between variables to explore the risks among the communities in terms of their knowledge, attitude and practice of fascioliasis. As the Bonferroni adjustment was used to allow multiple comparisons in the two-sample situations[47] in this survey, significant differences from χ^2 and Fisher's exact tests were reached if the p-values were less than 0.017.

The research protocol was approved by the Bio-medical Ethics Committee at the Institute of Malariology-Parasitology and Entomology, Quy Nhon (approval number 364/VSR-CV) and by the Human Research Ethics Committee at the University of Wollongong (Approval number HE 12/405).

RESULTS

Prevalence of fascioliasis among adult cohorts in two Central provinces of Viet Nam

A total of 1,612 participants aged from 18 years old and above were involved in the cross-sectional study by ELISA-based blood surveys. The seroprevalence of fascioliasis in three communes of Nhon Hau, Tinh Giang and Nhon Thanh was 8.8%, 8.4% and 6.1%, respectively; and the overall infection rate was 7.8% (Table 1).The descriptions of clinical and para-clinical characteristics of infected cases, as recommended in the guidelines as supplementary indicators of a fascioliasis case confirmation[36], are presented in Table 1. At each location the majority of the people with infection reported abdominal pains in the right upper quadrant (ranging from 66.0% to 82.4%), followed by fatigue (68.4%-79.4%), urticarial (skin rash) (40.4%-76.5%), and fever (49.0%-52.9%). Digestive system disturbance (36.2%-47.1%) and other symptoms such as nausea and anorexia (36.2%-41.2%) were less reported. In Nhon Hau commune, 57.4% of the infected cases had eosinophilia; followed by those in Tinh Giang (56.8%) and Nhon Thanh communes (52.9%). With the 95% CI of the mean eosinophils in three cohorts of 7.0-8.4, 7.5-9.8, and 7.3-10.3, these were not significantly different.

No significant differences were indicated in fascioliasis infection rate by gender. Infection rates of different age groups were not significantly different in Nhon Hau and Nhon Thanh communes. In Tinh Giang commune, the infection rate of fascioliasis among people aged from 40-49 years was significantly higher (p<0.05) than in those within the age ranges of 18-29, 50-59 and 60+ years. Participants with lower education background (secondary level and under) in Nhon Hau commune accounted for high infection rate (10.1%), whereas lower infection (4.2%) was found among those with higher education background; and the difference was significant (p<0.05). In the other two communes, no difference was found in infection rates across education levels. Across the occupations, farmers in our study represented the highest incidence of infection in the three communes, (72.3% in Nhon Hau, 70.5% in Tinh Giang, and 58.8% in Nhon Thanh communes, respectively) (data not shown). Other occupational groups had relatively low infection rates (typical infection proportions of other occupations not shown); but no significant differences was found among the groups (p>0.05).

Table 1. Prevalence of fascioliasis in three cohorts under study

Characteristics	Nhon Hau (n=535)		Tinh Giang (n=522)		Nhon Thanh (n=555)	
	Number (%)	p	Number (%)	p	Number (%)	p
Infected cases (7.8%)	**47(8.8)**		**44(8.4)**		**34(6.1)**	
Clinical symptoms						
Pain in RUQ[1]	34 (72.3)	NS	31 (66.0)	NS	28/(82.4)	NS
Fever	24 (51.1)		25 (48.9)		18 (52.9)	
Digestive disturbance	22 (46.8)		17 (36.2)		16 (47.1)	
Urticaria	31 (66.0)		19 (40.4)		26 (76.5)	
Fatigue	35 (74.5)		30 (63.8)		27 (79.4)	
Vomiting, anorexia	26 (55.3)		17 (36.2)		14 (41.2)	
Eosinophilis						
No. ≥ 8.0%[2]	27 (57.4)	NS	25 (56.8)	NS	18 (52.9)	NS
Min-max	2-14		2-17		2-22	
% mean ±SD	7.7±2.3		8.6±3.8		10.5±4.3	
95% CI	7.0-8.4		7.5-9.8		7.3-10.3	
Gender						
Males	15/180 (8.3)	NS	21/216 (9.7)	NS	16/221 (7.2)	NS
Females	32/357 (9.0)		23/306 (7.5)		18/334 (5.4)	
Age (mean±SD)	**(47.7±12.1)**		**(44.8±12.5)**		**(46.2±13.2)**	
18-29	0/39	NS	2/65 (3.1)	<0.05	3/62 (4.8)	NS
30-39	12/98 (12.2)		10/118 (8.5)		9/113(8.0)	
40-49	13/152 (8.6)		20/120(16.7)	<0.05	9/141 (6.4)	
50-59	18/148 (12.2)		9/157 (5.7)	<0.05	11/145 (7.6)	
60+	4/94 (4.1)		3/62 (6.8)		2/94 (2.1)	
Education level						
Secondary & under	42/417 (10.1)	<0.05	34/365 (9.4)	NS	25/402 (6.2)	NS
High school & above	5/118 (4.2)		10/157 (17.5)		9/153 (5.9)	
Occupation						
Farmers	34/342 (9.9)	NS	31/313 (9.9)	NS	20/300 (6.7)	NS
Others	13/193 (6.7)		13/209 (6.2)		14/255 (5.5)	

[1] RUQ: right upper quadrant of the abdomen

[2] Recommended by the MOH (2006) as a supplementary indicator of a positive case confirmation

Perception and practice in relation to risks of fascioliasis infection in studied cohorts

General perceptions of fascioliasis wereexplored in the three cohorts under study. The overall findings indicated low awareness (less than 50%) of the participants in the three communes in terms of their knowledge of fascioliasis (Table 2). Participants in Nhon Hau commune had significantly higher awareness of the disease than those in Tinh Giang and Nhon Thanh communes (p<0.001). Among participants who knew about the disease in the three communes, more than 50% stated the correct answers of the transmission routes such as eating improperly treated* vegetables and drinking unboiled water; however, less than 50% of them knew about the signs and symptoms of fascioliasis infection. Disparities were found across the communes in the participants' knowledge of whether fascioliasis was curable: more participants in Nhon Hau commune than those in Tinh Giang commune agreed the disease was curable ($\chi 2=7.2$, $p<0.01$) but no significant difference was indicated in comparison with participants in Nhon Thanh commune ($p>0.017$).

In the three communes, 28.2% to 33.8% of the participants reportedly ate improperly treated vegetables, with no significant differences found between the communes. Regarding the practice of drinking water, significance differences were found as participants in Nhon Hau commune reported better practice of drinking properly treated water than the two other communes ($p<0.01$). In addition, although a majority of households in the three surveyed communes owned toilets, significantly lower household toilet ownership was reported in Tinh Giang commune in comparison to Nhon Thanh commune ($p<0.01$). Without a toilet, more than half of the participants reported defecating outdoors such as on sand banks, in rice fields or into surface water sources such as canals, streams or rivers. The contaminated water sources were then used for watering vegetables or cooking, hence posing high risks of fascioliasis transmission, especially in the rainy seasons.

Snail surveys

Table 2. Description of cohorts' knowledge, attitude and practice of fascioliasis

Item	NhonHau[a]	TinhGiang[b]	NhonThanh[c]	χ^2, p
	Number /total (%)	Number /total (%)	Number /total (%)	
Know about fascioliasis	276/600 (46.0)	148/600 (24.6)	224/600 (37.3)	a-b: 59.8;<0.01 a-c: 22.5;<0.01 b-c: 9.3; NS
Know transmission routes	n=276	n=148	n=224	
Eat improperly treated vegetables	173 (62.7)	91 (61.5)	141 (62.9)	a-b: 0.2; NS
Drink unboiledwater	165 (59.8)	95 (64.2)	129 (57.6)	a-c: 0.1; NS b-c: 0.5; NS
Know signs & symptoms	121 (43.8)	56 (37.8)	102 (45.5)	a-b: 1.4; NS a-c: 0.2; NS b-c: 2.2; NS
Know it is controllable	144 (52.2)	81 (54.7)	111 (49.6)	a-b: 0.3; NS a-c: 0.4; NS b-c: 1.0; NS
Know it is curable	145 (52.5)	59 (40.0)	97 (43.3)	a-b:6.2; <0.01 a-c: 4.2; NS b-c: 0.4; NS
Behaviours:				
Eat improperly treated vegetables	169/600 (28.2)	197/600 (32.8)	203/600 (33.8)	a-b: 3.1; NS a-c:4.5; NS b-c: 0.1; NS
Drink unboiled water	141/600 (23.5)	255/600 (42.5)	220/600 (36.7)	a-b:49.0; <0.01 a-c:24.7; <0.01 b-c: 4.3; NS
Don't own household toilets	104/600 (17.3)	85/600 (14.2)	123/600 (20.5)	a-b: 2.3; NS a-c: 2.0; NS b-c: 8.4; <0.01
Outdoor defecation[d]	65/104 (62.5)	66/85 (77.6)	90/123 (73.2)	a-b: 5.1; NS a-c: 3.0; NS b-c: 0.5; NS

[d] Sand banks, rice fields, hilly areas and surface water such as streams, canals or river banks.

During April-May, 2013, a total number of 2,669 *Lymnaeid* spp. snails were collected at various aquatic habitats such as rice fields, canals and small streams; considered as appropriate habitats of the snails. More snails were caught from rice fields than in streams and canals, but the number of fascioliasis infected snails collected from the latter was higher than the former. Laboratory examination for species identification was performed at IMPE. The major species found

Table 3. Fascioliasis infection in collected Lymnaeid spp. snails (April-May, 2013)

Aquatic habitats	Nhon Hau	Tinh Giang	Nhon Thanh
	No./total (%)	No./total (%)	No./total (%)
Rice fields	4/849 (0.47)	4/656 (0.61)	3/684 (0.44)
Streams, canals	1/164 (0.61)	1/154 (0.65)	1/162 (0.62)
Total	5/1,013 (0.49)	5/810 (0.62)	4/846 (0.47)

** treated – dipped in potassium permanganate, acetic acid (vinegar), or sodium chloride before being washed under running water* was *L. viridis* (2,189 snails, 82.1%), followed by *L. swinhoei* (480 snails, 17.9%). These *Lymnaeid* snails were then further examined to identify the infection of Fasciola larva. The snail infection rates of Fasciola larva in Nhon Hau, Tinh Giang and Nhon Thanh communes were 0.49%, 0.62% and 0.47%, respectively.

DISCUSSION

The overall human seroprevalence as determined by ELISA was 7.75%, which categorised Central Vietnam as the mesoendemic area of fascioliasis. Although a variety of infection was indicated in the ethnographic characteristics, no differences were significant within the variables and across the communes.

The KAP survey revealed important gaps in knowledge and practices, resulting in considerable risks of fascioliasis transmission among the cohorts under the study. Low proportions of participants in the three communes were aware of fascioliasis. In addition, although more than half of those in three communes who were aware of fascioliasis stated the correct transmission routes of the disease, less than half of them did not know the signs and symptoms of fascioliasis. Considerable proportions of participants reported they ate improperly treated and raw vegetables, except for the cohort in Nhon Hau who performed good practice of drinking boiled water.

Considerable numbers of participants lived in households without a toilet and went to defecate outdoors, presenting further potential risks of fascioliasis transmission. The overall prevalence of fascioliasis in three cohorts found in this study (7.75%); was higher than some studies previously conducted in some Central provinces of Quang Nam (3.2%) Quang Ngai and Gia Lai (3.4%), Khanh Hoa (3.7%), Binh Dinh (6.0%), and Gia Lai (7.1%), and Phu Yen (7.1%)[35, 48, 52, 53], and lower than in others such as Quang Ngai (8.7%) and Gia Lai (10.2%)[54-56]. The differences might be attributed to the different time frames of surveys and or the use of different ELISA kits.

The serological surveys of this study were conducted in March 2013, which is at the end of the rainy season in Central Vietnam, and hence after the development season of *Lymnaied* snails as intermediate hosts of *Fasciola*. In other studies conducted in Central Vietnam, higher prevalence of human fascioliasis was found in summer-autumn months[45,48,56]; and lower morbidity of the disease was reported in other months of the year[33,52,53]. In addition, the seasonal transmission of fascioliasis is dependent on geographical characteristics, the adaptability of the intermediate host snails and the parasite itself[57].

In some previous studies researchers[32, 56] have used different test kits, produced by the National Institute of Veterinary Research-Ministry of Agriculture and Rural Development. Neither of these test kits have been assessed for validity for use in Vietnam, especially in the context of reported cross reactivityand suspected overlapped *Fasciola* species[15, 58-61]. In addition, studies on cross reactivity between fascioliasis and other trematodiasis in the region have not been reported.

Although this studyused the same test kits (FASCELISA) as other studies[40], the results may have differed as the interpretations of the test results were based on different criteria. In this study the results were based on the quantified OD readings, while other researchers read the results on the basis of the antibody titres at 1/1600 and 1/3200 (positive results range from 1/3200-1/12800)[52-54, 62].

Most of the studies conducted in other countries use the ELISA-based serological rather than the manual coprological (stool) tests to identity the infection of fascioliasis in the human antibody because of its higher specificity and sensitivity. Particularly in the field-based settings the ELISA serological blood test provides conclusive immuno diagnosis as it possesses low cut-off sensitivity at all stages of the liver fluke life cycle, especially during the invasive or acute phases[63-65]. However, serological results may detect past infections, as the fluke antibodies may remain in the human body for a long period post-treatment and even after the elimination the flukes from the recipient's body[66]. In addition, it should be noted that limited commercial supplies of test kits, issues of specific antigens, test procedures, and lack of a validated optimal test system may challenge the serological diagnosis in many areas in which the disease is endemic, including Vietnam[67].

Clinical examinations reported abdominal pains in the right upper quadrant was the most complaint symptom among infected patients, followed by fatigue, urticarial (skin rash), and fever as among the signs recommended by the MoH as the guidelines on diagnosis and treatment of fascioliasis[36]. Similar results were also reported in previous studies conducted in some provinces of Central region[35, 56, 68], with colic pain in the right upper quadrant being the predominant symptoms of fascioliasis. However, the fluctuated proportions of reported symptoms in these studies might come from different number of reported cases, patients' recalls, and interpersonal skills of medical staff during clinical examinations[52]. Considered an important sign of fascioliasis, eosinophilia occurs in infected patients during the acute stage, with high concentrations of the white blood cells in peripheral vessels and liver granulomas as a result of the host defences against the infection[21, 69-71]. Subsequently, the MoH[36] recommended the use of elevated eosinophils as good indicators of suspected fascioliasis at the peripheral health facilities.

The findings in this survey of no difference in rates of fascioliasis infection between genders is consistent with other studies conducted in Central Vietnam[30,43,45,52,55,72]. An explanation for this may be that in study areas, women were more often to contact with Fasciola larvae than men in daily household activities such as housekeeping, washing vegetables, preparing meals, washing clothes and grazing cattle[52,73,76].

With respect to infection of fascioliasis by education level, the study reported that participants with education background up to secondary level presented much higher infection proportion than those with high school education and above; however, the only significant difference was found in Nhon Hau commune ($p<0.05$). The results in this study are consistent with reported results in previous studies, yet the differences might come from the different samples sizes and study localities[45, 52].

By occupation, farmers represented a higher proportion of infection in comparison with other occupations; however, no significant differences were indicated. Similar findings were reported in other studies, which were probably conducted in the rural areas with farmers as major attendants, whose typical career is related to exposing risks of fascioliasis infection[45,52, 54, 77].

Parasitological diagnosis of fascioliasis was not conducted in this study due to pragmatic considerations. However, it has been recognized that animal reservoirs may play an important role in the transmission of fascioliasis[49,78,79]. In this study an assumption was made that the relationship between human and animal fascioliasis would correlate at a basic level[10]. Thus the study included consideration of those factors thought to contribute to the high prevalence in both human and animal fascioliasis, including low awareness of fascioliasis, unsafe living habits and high-risk daily practices.

In this study, less than 50% of the participants in the three communes had knowledge of fascioliasis. Among participants having the awareness of fascioliasis, although more than 50% knew the transmission routes of the disease, less than 50% did not know the symptoms and signs. Previous studies conducted in Central Vietnam indicated similar results[48, 56].

Noticeable proportions of participants in the communes reported eating raw and improperly treated vegetables, a common practice of Vietnamese people. Vegetables improperly treated prior to consumption or previously fertilized with cattle manure can lead to fascioliasis transmission in humans[80]. In Central Vietnam, studies[35, 45] have reported that some aquatic plants were contaminated with fasciola larvae, with rates varying from 0.40 to 1.34 metacercaria per kilogram of vegetable. Another study reported significant relationship between human fascioliasis and eating raw lettuce, a popular plant in mixed vegetables[54]. In Cuba, China, Japan, Thailand and elsewhere in the world, various studies reported similar connection between fascioliasis and raw consumption of vegetables such as watercress, houttuynia, and lettuce[22, 80-83]. Water-borne parasites including *Fasciola* larvae utilise water bodies as direct habitats for their intermediate and final hosts and for transmission of diseases[84]. Although some authors[54,55] reported no relationship between drinking unboiled water and fascioliasis transmission, others indicated the proportional infections of fascioliasis among unboiled water drinkers in Central provinces[52, 54, 55].

Humans also can facilitate fascioliasis transmission through their living habits. For example, outdoor and indiscriminate defecation, a common practice in developing countries, facilitates egg shedding[19, 85-87]. In this study, a high percentage of participants lived in households without toilets and went to defecate outdoors (on the hills, sand banks, rice field or into the river banks or other water sources), which spread the *Fasciola* eggs into the environments, facilitating the transmission risks of fascioliasis in the community.

Snails belonging to the *Lymnaeid* species are known for their intermediate hosts of *Fasciola*[8]. Increasingly, wide adaptation of the parasites to the existing *Lymnaeid* snail population in a new geographical areas contributes to the spread of fascioliasis[9]. In endemic areas of Europe, South America, Africa, Asia and the Middle East, the expansion of fascioliasis transmission in recent years has been reported to be the result of the distribution and ability of the aquatic *Lymnaeid* snails to adapt to a wide range of environmental niches[12-15]. In Central Vietnam there aret wo *Lymnaeid* snails (*L. viridis* and *L. swinhoei*)[88, 89]. In this study, the collection of *Lymnaeid* snails was conducted in May, the end of rice harvest and beginning of summer. This might explain a majority of *L.viridis* (prefer to live in rice field) caught in comparison with *L. swinhoei* (prefer large water body habitats). In addition, as a result of the dry season, not many snails were caught in the aquatic biotopes. However, the appearance of *Fasciola* larvae in two snail species proves the capacity of larval transmission of fascioliasis even in the least favourable season of the year.

CONCLUSIONS

The high rate of fascioliasis infection, poor knowledge of the disease and frequency of high-risk behaviours supports the need for intervention measures to increase disease awareness and appropriate behaviours and practices in the community. Comprehensive fascioliasis control strategies are required. This study provides strong support that a broadly-based control model, including chemotherapy, vector control, health education, surveillance and management and evaluation, and involvement of the range of concerned agencies such as education, agriculture and community organizations, can be effective in the control and management of fascioliasis.

CONFLICT OF INTERESTS

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

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Appendix 5.1 Animal chemoprevention in Intervention 1 and 2 communes

Commune	Intervention 1 commune	Intervention 2 commune
Cattle raising households	534	561
Households conducting deworming for cattle (%)	210 (39.5)	189 (33.7)
Total cattle heads	1,621	1,398
Cattle dewormed (%)	650 (40.1)	469 (33.5)

Appendix 5.2 Course map for training communal stakeholders of intervention community 1

Course: Strengthening the capability of communal stakeholders to manage fascioliasis effectively in Central Vietnam

General Objective: At the end of the training, the participants will be able to provide detect, diagnose, refer suspected cases of fascioliasis to upper levels for confirmation examination, and perform actively health education campaigns

Learning Objectives: By the end of the session, the learner will:

1. Understand the cause, effects and control measures of fascioliasis in the community;
2. Provide early clinical diagnosis of fascioliasis case using the guideline issued by the Ministry of Health with an accuracy of 80%;
3. Conduct differential diagnosis with other diseases;
4. Refer all fascioliasis cases to proper health facility for confirmation examinations and treatment;
5. Implement health education campaigns for fascioliasis control at community level.

Topic	Objectives	Content	Activities	Materials	Admin	Assess./Eval. Measure	Time
Pre-test	To qualify the input of the participants before the training course		Individual paper tests	Test papers	Prepare test papers Deliver and collect paper tests when finished	Marking	7.30-8.00 (30 mins)
Situation of fascioliasis in Vietnam and Central VN	1. To understand the causes, effects and control measures of fascioliasis	Causes and effects of fascioliasis on humans and animals	- ML[28] on fascioliasis - LGD on control measures of fascioliasis on humans and cattle - Group presentation - Debrief	- PPT presentation - Pens - Flipcharts	- provide HOs - Prepare flipchart, pens	Direct questions; ILL, LGD, observations and feedback	8.00-8.45 (45 mins)
Clinical diagnosis of fascioliasis	2. To provide diagnosis for suspected fascioliasis cases	2.1 Taking the patient's history: - definition - steps in history taking	- ML on definition of history taking - LGD on steps to good history taking (ask questions for obtaining information) - Group presentation - Debrief	- HO (SOP) - PPT presentation - Flipcharts; - Paper - Marker pens - guidelines of MOH	- Make copies of HOs - Prepare flipchart, paper, pens, stethoscope Sphygmomanometer, thermometer	Direct questions; ILD, SCG, LGD, Observation and Feedback	8.45-9.30 (30 mins)

[28] ML = mini lecture, ILD = instructor-led discussion, ILL = illustrated mini-Lecture, SGD = small group discussion
LGD = large group discussion, PM = participant manual, HO= hand-out

Topic	Objectives	Content	Activities	Materials	Admin	Assess./Eval. Measure	Time
		2.2 Conducting physical examination Definition Discuss terms: Inspection, palpation, percussion, auscultation, general exam. systematic exam	- ML on physical examination - ILD-Go around, ask and discuss - Role play	- HO - PPT presentation - Guidelines - Stethoscope - sphygmomanometer - Thermometer	- Make copies of HO - Prepare guidelines, stethoscope, Sphygmomanometer, thermometer	Direct question, ILD, observation and feedback	9.30-10.15 (45 mins)
TEA-BREAK							10.15-10.30
	3. To conduct differential diagnosis with other diseases	Differentiating the signs and symptoms of fascioliasis with other diseases: Discuss common mistakes of fascioliasis with other liver diseases	- ML on list the symptoms and signs of a typical fascioliasis clinical case - Group discussion of differential diagnosis between fascioliasis with other liver diseases; common mistakes with other liver diseases - Debrief	PPT presentation		SGD Observation and Feedback	10.30-11.15 (45 mins)
LUNCH							11.15-13.30
Management and referral of fascioliasis cases	4. To refer all suspected cases of fascioliasis to upper levels for diagnosis and treatment	Explanation of reasons why to refer suspect cases to upper levels for diagnosis and treatment of fascioliasis	- SGD to list the typical signs and symptoms of fascioliasis - Group presentation - Debrief	- Flipcharts; - Marker pens	Prepare white board; marker pens; paper	SGD Observation and Feedback	13.30-14.00 (30 mins)

Topic	Objectives	Content	Activities	Materials	Admin	Assess./Eval. Measure	Time
Health education in fascioliasis control	5 To introduce education strategies of fascioliasis control	5.1 the importance of health education in reducing the impacts of fascioliasis. Discuss the roles of communal people's committee, agriculture, schools and mass association in fascioliasis control	- ML - SGD on the roles of health education; each kind of stakeholders with their roles in reducing the impacts of fascioliasis; coordination between health, agricultural, education sectors and mass organizations in fascioliasis control; advantages and disadvantages of the coordination	- PPT presentation - Pens - Flipcharts	Prepare white board; marker pens; paper	SGD Observation and Feedback	14.00-15.00 (60 mins)
		5.2 Commonly used measures of health education for fascioliasis control at community level	- SGD on various measures of health education; comments on each kind of measure; select the optimal one; discuss the combination of measures - group presentation	- Pens - Flipcharts	Prepare white board; marker pens; paper	SGD Observation and feedback	15.00-15.45
TEA-BREAK							15.45-16.00
Post-test	To qualify the input of the participants at the end of the training course		Individual paper tests	Test papers	Prepare test papers Deliver and collect paper tests when finished	Marking	16.00-16.30
Closing	To summarize the contents of the training course	Discuss the contents of the training course; provide feedback	LGD	Feedback forms	Prepare feedback forms		16.30-17.00

Appendix 5.3 Leaflet of health education for fascioliasis (liver fluke) control

mặt trước

BỆNH SÁN LÁ GAN LỚN (FASCIOLASIS) Ở NGƯỜI VÀ ĐỘNG VẬT

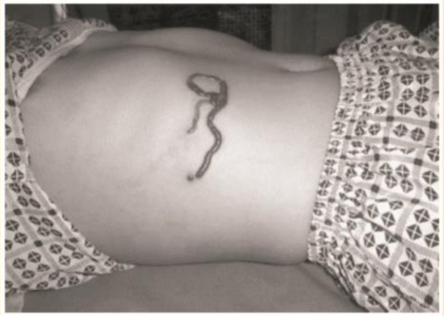
Vật gây bệnh: Sán lá gan lớn (SLGL)-*Fasciola gigantica*; Đối tượng bị hại: động vật có sừng, người và một số động vật khác

I. BỆNH SÁN LÁ GAN LỚN Ở NGƯỜI

+ Bệnh SLGL ở người là bệnh do ăn phải thực vật thuỷ sinh có nang ấu SLGL.

+ Bệnh SLGL có 2 thể:
1. Ký sinh ở gan, mật, dễ nhầm với một số bệnh khác về gan như viêm gan, xơ gan, SLGL trưởng thành, thải trứng ra ngoài;
2. Sán non có thể ký sinh ở bất kỳ cơ quan nào trong cơ thể (ký sinh lạc chỗ)

+ Người nhiễm sán lá gan lớn có biểu hiện đau vùng gan, đau hạ vị, sốt thất thường, có các ổ áp xe trong gan; nếu không được chẩn đoán và điều trị, người bệnh có thể bị vỡ gan v.v.



Đường di chuyển lạc chỗ của *Fasciola gigantica* trên một bệnh nhân nữ ở miền Trung-Việt Nam

II. CHU TRÌNH PHÁT TRIỂN CỦA SLGL

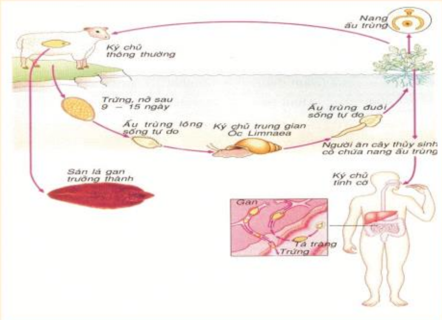
+ Sán lá trưởng thành (ở gan, mật động vật có sừng, người) thải trứng theo phân ra ngoài môi trường.

+ Trứng ở nước phát triển, nở thành vĩ ấu (Miracidium), bơi được nhờ các tiêm mao.

+ Vĩ ấu chui vào ốc *Lymnaea* và phát triển qua một số giai đoạn, tăng về số lượng và trở thành ấu trùng cảm nhiễm-Cercaria.

+ Cercaria chui khỏi ốc tự do trong nước hoặc nang hóa thành nang ấu (Aldolescaria) bám vào thực vật thuỷ sinh: rau, cỏ

+ Người, động vật uống phải nước có cercaria hoặc ăn thực vật có nang ấu bám vào sẽ bị nhiễm SLGL.



Chu trình phát triển chung của SLGL

III. BỆNH SLGL Ở ĐỘNG VẬT

+ SLGL gây bệnh chủ yếu ở trâu, bò, ký sinh ở gan, mật. Động vật bị nhiễm SLGL do uống nước có cercaria, ăn rau, cỏ có nang ấu.

+ Trứng SLGL được thải qua phân trâu, bò. Do vậy giảm bớt nguồn phân có chứa trứng SLGL và quản lý, xử lý phân trâu, bò đóng vai trò rất quan trọng trong việc phòng, trừ SLGL.

+ Trâu, bò bán chăn thả ở các bờ ruộng, bờ ao rất dễ bị nhiễm SLGL và tạo điều kiện thuận lợi cho các mầm bệnh SLGL phát tán và lưu hành.

+ Trâu, bò bị SLGL chậm lớn, gầy yếu, giảm sức đề kháng, khả năng sinh sản, nhiều khi tử vong.

Thương tổn do SLGL gây ra ở các ống dẫn mật trong gan gia súc

mặt sau

PHÒNG VÀ TRỪ BỆNH SÁN LÁ GAN LỚN (FASCIOLASIS) Ở NGƯỜI VÀ ĐỘNG VẬT

PHÒNG, CHỐNG BỆNH SLGL CHO NGƯỜI

Bệnh sán lá gan lớn là bệnh lây truyền giữa người và động vật (trâu, bò, dê, cừu.).

Trâu, bò nhiễm sán lá gan lớn từ 35-70%. Nuôi thả rong, phóng uế bừa bãi, phát tán trứng sán ra môi trường và phát triển thành nang ấu trùng bám vào lá, rau thủy sinh.

Ở Việt Nam, nguy cơ người bị bệnh SLGL rất cao vì có tập quán ăn rau thủy sinh sống hoặc chưa nấu chín.

Phòng bệnh:

+ Không sử dụng nước ao, hồ để rửa rau, nấu ăn, rửa bát đũa và thực phẩm;
+ Không ăn sống hoặc tái các thực vật thuỷ sinh;
+ Quản lý, xử lý tốt nguồn phân trâu, bò, dê, cừu;
+ Thực hiện tốt công tác truyền thông, giáo dục sức khỏe trong cộng đồng làm thay đổi nhận thức, hành vi của từng người đối với bệnh SLGL.

Điều trị bệnh:

+ Khi người dân ở vùng có nhiều người nhiễm SLGL có các triệu chứng lâm sàng như: đau vùng hạ sườn phải, hoặc đau vùng gan, sốt, sút cân… cần phải đến ngay bệnh viện để khám, xét nghiệm máu, siêu âm gan, mật.. chẩn đoán và điều trị sớm.
+ Nếu nhiễm SLGL phải điều trị sớm bằng thuốc triclabendazole (Egaten®) theo hướng dẫn của Bộ Y tế ban hành.

Rau ngổ-một loại rau thuỷ sinh dễ có nang ấu của SLGL

Chuồng trại không hợp vệ sinh phát tán trứng sán ra môi trường

PHÒNG, TRỪ BỆNH SLGL CHO TRÂU, BÒ

Khi trâu, bò còn bị nhiễm SLGL có nghĩa là nguồn bệnh còn tồn tại, lưu trữ mầm bệnh và còn khả năng lây truyền. Do vậy phải có các biện pháp phòng, trị tốt SLGL ở trâu, bò.

Phòng bệnh:

+ Quản lý và xử lý tốt nguồn phân trâu, bò:
1. Vệ sinh chuồng, trại hàng ngày;
2. Thu, gom và ủ phân;
3. Hạn chế tối đa việc để trâu, bò thải phân ở bãi chăn thả, bờ ruộng, bờ thuở;
4. Không cho trâu, bò uống nước ở ruộng, ao, mương, khe nước nhỏ.

+ Hạn chế số lượng ốc vật chủ trung gian của SLGL ở ngoài môi trường:
1. Dùng vịt, cá ăn ốc thả tại các ao, hồ có ốc *Lymnae*;
2. Phơi khô ruộng ở những thời gian không canh tác.

+ Vệ sinh môi trường:
1. Ở các vùng chăn thả trâu, bò không cho rau, cỏ tiếp xúc với môi trường nước;
2. Những vùng có thực vật thuỷ sinh thì hạn chế tối đa sự tiếp xúc nguồn phân, trâu, bò với nước của vùng đó;
3. Thực hiện luân canh chăn nuôi các bãi chăn thả.

+ Có biện pháp tăng cường sức đề kháng của trâu, bò.

Điều trị bệnh:

+ Tẩy định kỳ SLGL bằng thuốc cho trâu, bò:
1. Nhiễm ít và vừa-1 lần/năm;
2. Nhiễm nặng-2 lần/năm (vào tháng 4-5 hoặc tháng 9-10 hàng năm).

Appendix 6.1 Adverse reactions following the administration of triclabendazole at 10mg/kg body weight on infected patients of fascioliasis, follow-up surveys (N=80) (WHO, 2007b)

Symptoms	Baseline – administration of drug			Day 1 after drug treatment			Day 7 after drug treatment		
	Mild (%)	Moderate (%)	Severe (%)	Mild (%)	Moderate (%)	Severe (%)	Mild (%)	Moderate (%)	Severe (%)
Biliary colic (pain in the RUQ[29])	22 (27.5)	6 (7.5)	0	11 (13.8)	1 (1.3)	0	0	0	0
Other abdominal pain	19 (23.8)	4 (5.0)	0	9 (11.3)	1 (1.3)	0	0	0	0
Vomiting	17 (21.3)	8 (10.0)	0	8 (10.0)	2 (2.5)	0	0	0	0
Diarrhoea	16 (20.0)	2 (2.5)	0	9 (11.3)	1 (1.3)	0	0	0	0
Fever	11 (13.8)	5 (6.3)	0	7 (8.8)	0	0	0	0	0
Skin rash	13 (16.3)	2 (9.6)	0	4 (5.0)	0	0	0	0	0
Jaundice	7 (8.8)	1 (1.3)	0	2 (2.5)	0	0	0	0	0
Fatigue	17 (21.3)	6 (7.5)	0	5 (6.3)	1 (1.3)	0	0	0	0
other[30]	14 (17.5)	2 (2.5)	0	2 (2.5)	0	0	0	0	0

[29] RUQ: right upper abdominal quadrant

[30] Includes: digestive disturbance, dizziness, chest pain, sweating, cough, difficult breathing