Community-directed intervention against liver fluke and soil-transmitted helminths in endemic areas of southern Laos

Inauguraldissertation

zur

Erlangung der Würde eines Doktors der Philosophie

vogelegt der

Philosophisch-Naturwissenschaftlichen Fakultät

der Universität Basel

von

Khampheng Phongluxa

aus Vientiane, Lao People's Democratic Republic

Basel 2014

Genehmigt von der Philosophisch-Naturwissenschaftlichen Fakultät auf Antrag von Prof. Dr. Marcel Tanner, PD Dr. Peter Odermatt und Prof. Dr. Brigit Obrist.

Basel, den 10. Dezember 2013

Prof. Dr. Jörg Schibler
Dekan

Dedication

This work is dedicated to the Ministry of Health of Lao People's Democratic Republic (Lao PDR) for the control of liver fluke in an endemic area of Lao PDR.

It is also dedicated to my beloved family and relatives who have always stood by me and dealt with all of my absence from many family occasions with a smile.

Table of content

List of abbreviations

CCA	Cholangiocarcinoma
CDD	Community drug distributor
CDI	Community-directed intervention
CDTi	Community-directed treatment ivermectin
CI	Confidence interval
CLE	Center for Laboratory and Epidemiology
CMPE	Center for Malariology, Entomology, and Parasitology
DALYs	Disability adjusted life years
DHO	District Health Office
EMIC	Explanatory Model Interview Catalogue
EPG	Egg per gram
FBT	Food-borne trematode
FGD	Focus group discussion
IEC	Information, Education and Communication
KAP	Knowledge, attitudes and practices
Lao PDR	Lao People's Democratic Republic, Laos
LF	Lymphatic filariasis
MCH	Mother and child health
MDA	Mass drug administration
MIF	Minute intestinal fluke
MOH	Ministry of Health
NECHR	National Ethic Committee on Health Research
NTDs	Neglected tropical diseases
NIOPH	National Institute of Public Health
OR	Odds ratio
PHC	Primary health care
PHD	Provincial Health Department
PZQ	Praziquantel
SD	Standard deviation
SES	Socio-economic status
STH	Soil-transmitted helminth
SwissTPH	Swiss Tropical and Public Health Institute

VHC	Village health committee
VHV	Village health volunteer
WHO	World Health Organization
WHO ERC	World Health Organization Ethic Review Committee

Acknowledgements

A research partnership between the National Institute of Public Health (NIOPH), Ministry of Health, Lao PDR and Swiss Tropical and Public Health Institute (SwissTPH), Basel, Switzerland has provided a productive collaboration in conducting public health research in Lao People's Democratic Republic (Lao PDR, Laos) and building up and strengthening the capacity of human resource for health research for Lao PDR. This PhD work was conducted under the umbrella of this partnership.

For the accomplishment of this PhD thesis I am indebted to many people and institutions that contributed to this work and to whom I wish to acknowledge and thank:

I wish to thank, first and foremost, to the authorities of the Ministry of Health, Lao PDR; Prof. Dr. Boungnong Boupha, former Director General of the National Institute of Public Health (NIOPH), current Vice-President of Commission for Foreign Affair, Lao National Assembly and Parliamentary Member 1st Constituency of Vientiane Capital. Assoc. Prof. Dr. Kongsap Akkhavong, Director General of NIOPH, and Dr. Souraxay Phrommala, Deputy Director of NIOPH, Ministry of Health; and Prof. Dr. Marcel Tanner, Director of SwissTPH, Basel, Switzerland for valuable guidance, supports and outstanding contribution to this work.

I am indebted to my supervisor, PD Dr. Peter Odermatt, from the Department of Epidemiology and Public Health, SwissTPH, who has experience in Southeast Asia for several years, and initiated a novel approach, community-directed intervention (CDI), for controlling of liver fluke infection in Lao PDR. I am profoundly grateful for his excellent and skilful guidance, inputs, discussions and support, sharing information and ideas, and great contribution to this intervention and to my PhD works from the beginning up to its accomplishment. His valuable guidance helps me to achieve my scientific goals. I also appreciate his working capacity with high ownership and responsibility. I wish to continue the collaboration with him for research projects in Laosin the future. My words of thanks are addressed to his family, Dr. Sophie Odermatt and all children, for heartily and warmly welcoming me to their place every time when I was in Basel.

I owe my deepest gratitude to my co-supervisor, Dr. Peter van Eeuwijk, from the Institute for Social Anthropology, University of Basel, Basel, Switzerland for his valuable and

thoughtful comments, inputs, discussions, and supports, despite of his tight working schedule. They helped me to improve my capacity in conducting the social science research and fulfil this thesis. I admired his expertise in social science research for several years in Southeast Asia. I am thankful for his annual visit to the community-directed intervention site in Saravane province, southern Lao PDR, and his perfect supervision and monitoring. His visit made the intervention meaningful. I hope to have a chance to keep up the collaboration with him in the future.

I consider it an honour to work with Prof. Dr. Brigit Obrist from the Institute for Social Anthropology, University of Basel, Basel, Switzerland. I am thankful for the great and valuable inputs and contribution at the initial stage of this work to the community-directed intervention against liver fluke in endemic areas of southern Lao PDR and my thesis, and her hospitality to welcome me in her place during my stay in Basel.

At Swiss TPH, Basel, Switzerland I would like to thank to Ms. Margrit Slaoui, Ms. Christine Mensch, Ms. Christine Walliser, Ms. Heidy Immler and all staff in the library, all staff at accountant, Ms. Dagma Batra, other administrative staff, and IT helpdesk staff, for their kind supports and assistance.

My words of thanks are addressed to my colleagues at the Swiss TPH: Dr. Phonepasong Ayé Soukhathammavong, Dr. Somphou Sayasone, Dr. Youthanavanh Vonghachack, Dr. Virack Khiew, Dr. Leornore Lovis, Dr. Tippi Mark, Dr. Phuc Pham Duc, Dr. Angel Dillip, Dr. Caroline Kathoni, Dr. Vasudeo Paralikar, Dr. Mercy Ackumey, Dr. Christian Schaetti, Dr. Angelina Lutambi, Dr. Fabian Schär, Dr. Sara Rajkumar, Dr. Federica Giardina, Ms. Armelle Forrer for discussing our work, sharing experiences, assistance, and social gathering outside our work.

My special thanks are addressed to Dr. med. Vilavanh Xayaseng for her great assistance and devotion her time for this Saravane Intervention study. Especially in 2012 she leaded the project because I was absence for my family purposes. I would also like to thank to research team members: Dr. med. Dalaphone Sitthideth, Dr. med. Khouanechay Soundavong, Mr. Pan Phanthavong, Dr. med. Boupha Thongmalaivong, Mr. Bounthan Chongvilay, and Dr. med. Dalouni Bouakhasit, and laboratory technician: Mr. Lay Souksavath, Ms. Phousavan, Chanthone, and Ms. Kingkeo, and other NIOPH staff for their valuable contributions. In addition my special thanks are addressed to Dr.

Phonepasong Ayé Soukhathammavong for the follow up of the adverse effects after treatment with praziquantel and lead of the Saravane Intervention Study in 2013.

This work would not have been possible without the support from the following institutions at central and provincial levels, which contributed to the smooth performance of the activities: National Center for Malariology and Entomology, Center for Laboratory and Epidemiology, National University of Health Sciences, Saravane Provincial Health Department, Saravane District Health Office including health centres, Saravane Provincial Hospital, and Champasak Provincial Malaria Station (Dr. med. Keoka Taixaiyavong).

In Saravane province, I wish to thank to Dr. med. Khoudala Vongsaravane (Director of Saravane Provincial Health Department (PHD)), Dr. med. Kaseumsouk (Deputy Director of Saravane PHD), Dr. med. Akhom Lamhvichit (Deputy Director of Saravane PHD), Mr. Saosali, Dr. med. Inpong, Dr. med. Khamkhai Khamsingsavath, Mr. Somphan Silavi, Dr. med. Phitsamay Khemvilay (Director of Saravane District Health Office (DHO)), Mr. Keo Khamsingsavath (Deputy Director of Saravane DHO), Mr. Sengdeuane Meaungchanh (Deputy Director of Saravane DHO), and Dr. med. Sengathit Douangchanh and other Saravane DHO staffs for their great collaboration, support, and facilitation of our field work. Moreover, I cannot find words to express my gratitude to the vice-Saravane district governors for devoting his valuable time for being a chair of a one-day training course in 2010 and 2012 and to encouraging local authorities to actively contribute to this intervention study. I wish to thank all local authorities, and communities who participated in this work.

Last but not least, I am indebted to my late parents, husband and all children, sister, brother, and relatives who always stood by me with a smile and dealt with all of my absence from many family occasions. With this support, I have had a chance to concentrate on my work and overcome many difficulties. My special thanks are also addressed to my relatives in Saravane district, Saravane province for their great assistance when I was conducting my field work in this province.

It is with immense gratitude that I acknowledge the support of the Rudolf Geigy Foundation the stiftung für freiheitlidre Medizin and the City of Basel for financial support to my PhD at SwissTPH, Basel, Switzerland. The community-directed intervention

against liver fluke and soil-transmitted helminth (STH) in liver fluke endemic areas in Saravane district, Saravane province was funded by the World Health Organization (WHO) in Geneva and the SwissTPH, Basel, Switzerland.

Summary

Background: Food-borne trematodiasis (FBT) and soil-transmitted helminth (STH) are neglected tropical diseases (NTDs) and threat human health in Southeast Asia. An estimate 67.3 million people are at risk of FBT caused by *Opisthorchis viverrini* (*O. viverrini*). Human infected with this parasite by consumption raw or insufficiently cooked fish dishes. Poor sanitation spreads the infection in environment. High burden of infection cause hepatobiliary diseases and with a longstanding of infection leads to develop cholangiocarcinoma (CCA). Liver fluke, *O. viverrini*, and STH are major public health problems in Laos. Over two million people are infected with *O. viverrini* mostly in central and southern Laos. An estimate 1,646,000 people are at risk for the STH. Hookworm is the most predominant species among the STH. Mass treatment alongside with health education is prioritized by Lao Ministry of Health for helminth control. However it is mainly implemented via vertical program that means leaving affected community having passive role for the helminth control. In addition this implementation requires substantial amount of human resource and fund to run the intervention which is challenging for Lao government to support for long-term intervention particularly intervention against liver fluke. In the work of this PhD thesis we developed, implemented and evaluated a community-directed intervention against the liver fluke and STH in southern Lao PDR. It has inspired by the community-directed treatment intervention (CDTi) of onchocerciasis in Western Africa.

Objectives: The main goal of this thesis is to develop an innovative approach, CDI, for the control of liver fluke and STHin southern Laos. Specific objectives were: 1.) to update the knowledge on helminth infection in the last four decades in Laos and the current helminth infection in liver fluke endemic areas in southern Laos; 2.) to understand helminth infections in relation to local community's knowledge, attitudes and practices regarding worm infections; 3.) to deepen our understanding on consumption of raw fish dishes in relation to liver fluke infection in liver fluke endemic areas of southern Laos; 4.) to assess the community's perception regarding the deworming intervention in endemic areas of *schistosoma mekongi (S. mekongi)* and high prevalence of multiparasitism; 5.) to evaluate the effectiveness of the community-directed intervention against liver fluke and STHin southern Laos; and 6.) to identify factors associated with compliance to the intervention (CDI).

Methods: Five studies in this PhD thesis were community-based investigations and one was a literature review. A cross-sectional study designs was applied and using both quantitative and qualitative research techniques. Quantitative technique included stool examination to assess the prevalence and intensity of helminth infection, and structured interview with heads of households and household members. Qualitative methods comprised of semi-structured interviews, in-depth interviews, focus group discussions (FGD), and observations. Quantitative data were entered twice in Epidata software version 3.1 and analyzed in Stata software version 10.1. Conversations were transcribed from notes and tape-recorders and MAXQDA software version 10 was used for qualitative content analysis. For the literature review, data were obtained from international publications between 1970 and 2013 mainly searching through PubMed database.

Results: Review on helminth infection in the last four decades of Lao PDR showed that currently ascariasis, trichuriasis, and hookworm infection rates are relatively low compared to the 1990s. But this not true for the mountainous and highland areas; hookworm is still a highly prevalent STH. *O. viverrini* infection rate remains high and even currently higher than before. The advance diagnosis using multiple stool sampling and multiple Kato Katz slides per a stool explains some of the increase. Multiparasitism together with liver flukes infections was observed. The habit of consumption of raw or insufficiently cooked fish dishes and open defecation is common practice in Laos thus it might keep infection and re-infection with *O. viverrini* in community. However possibilities to intervene on this habit are limited. Nowadays, in endemic area of *S. mekongi* the infection re-emerged, and children at 5 years of age were found already infected.

A baseline survey conducted in 10 villages of liver fluke endemic areas of Saravane district southern Laospointed at very high infection prevalence of helminth infection but low level of awareness regarding worm infection. For instance, of 574 subjects the prevalence of *O. viverrini*, hookworm, *Trichuris trichiura, Ascaris lumbricoides* and *Taenia* sp. was 88.7%, 86.6%, 32.9%, 9.8%, and 11.5%, respectively. Most individuals were co-infected with *O. viverrini* and hookworm (77.3%). More men had multiple helminth infections than women. Of 130 heads of household, one third heard about liver fluke before, of which 59.2% associated it with eating raw fish dishes. Among the STH, roundworm was the most well-known (70.8%) but most people linked it with consumption of raw food (91.3%). Consumption of raw fish dishes was most commonly practiced

(75.4%); few households possessed a latrine (16.1%); less than half mentioned health benefits from latrine use and personal hygiene. FGD participants had poor awareness on worm infections; more men liked eating raw fish than women; some disliked using latrine because they did not get used to it and due to its bad smell. Poor personal hygiene practices and village hygiene were observed.

Our result on consumption of raw fish dishes in relation to liver fluke infection in liver fluke endemic areas southern Laoswas heterogeneous. The majority of FGD participants considered fish flesh that had been prepared with weaver ant extract (giving sour juice) and that then turned to white colour to be safe for consumption. Visual appearance, taste, smell and personal preference were given as reasons for consumption of raw fish dishes. Moreover, participants considered it a traditional way of food preparation, and practiced for generations in Laos. Ten different fish dishes that use raw or fermented fish were identified. All FGD participants reported to consume raw fish dishes.

In endemic areas of *S. mekongi* in southern Laos where also multiparasitism prevails, we found that opinion leaders and villagers were well aware of taking deworming during MDA in village. Leaders perceived the effectof MDA against severe schistosomiasis (big belly and patient ended up with vomit a lot of blood) and appreciated that it was provided free of charge in their village. They encouraged villagers to attend and take the drug. Anticipated adverse effect of praziquantel was a barrier for participation. Most leaders purchased deworming (except praziquantel) in a local pharmacy for deworming when MDA was absent in their villages (19/21). Most leaders (20/21) had a good knowledge on severe schistosomiasis though only a few of them (5/21) described its cause correctly. They knew little about the disease consequences of liver fluke (3/21) and STH (4/21) infections but more about their causes. A high risk for worm infection was observed in community: consumption of raw or insufficiently cooked fish dishes (100%), frequent physical contacts with Mekong River water (76.0%) and few latrines in village (14.5%).

In Saravane province, after implementing two rounds of CDI against liver fluke and STH we found that the prevalence of *O. viverrini*, hookworm, roundworm, and whipworm infection was reduced by 26.4%, 38.1%, 45.9%, and 30.3%, respectively. The frequency of multiparasitism was also reduced. Household heads had better knowledge on liver fluke, hookworm, and whipworm infection, means for prevention of liver fluke, and

correct association between risk factors with hookworm and whipworm infection. Misconception on acquiring roundworm infection through eating any raw food was frequent. Few heads of households consumed raw fish dishes which was consistent with FGD participants discussed that after taking treatment they felt not eating raw fish dishes anymore and some were afraid of getting liver fluke again. Participants viewed that intervention was effective against liver fluke and other worm infection and prevented diseases. Community leaders had ownership in conducting the intervention.

The factor associated with the compliance to intervention (CDI) was assessed. We found that of 600 interviewees, 46.5% reported to have taken treatment during the mass treatment in village. Those who took treatment were mostly from poor households ($p=0.013$), aware of intervention ($p<0.001$), knew that intervention provided treatment for liver fluke ($p<0.001$) and abdominal pain ($p=0.028$) and saw the tapeworm in their stool ($p=0.016$). The majority of respondents heard about liver fluke and roundworm. The compliance with MDA was associated with poverty: very poor (OR=2.13, $p=0.018$) and poor (OR=2.07, $p=0.022$), knowing the effectiveness of intervention against liver fluke (OR=1.57, $p=0.035$) and recognizing about tapeworm infection (OR=2.95, $p=0.037$). CDDs performed their task quite well though supervision was rarely made by trained health center staff.

In conclusion: We conclude that beside the high prevalence of *O. viverrini* and STH, community leaders and community members have poor knowledge regarding worm infection and the role of MDA. Risk behaviour for worm infection is observed: eating raw or insufficiently cooked fish does exist due to people loved its taste, smell and look; perceived preparation technique is safe to eat and it is a traditional way, and practiced since generations; poor practice of hand-washing; barefoot walking; poor sanitation and less use latrine due to bad smell and they did not used to it. We also conclude that a new approach CDI is effective against worm infections and corrects community's knowledge, attitudes and practices regarding worm infections and mass treatment. Community leaders have ownership and capacity in conducting the CDI. Hence, it is possible to scale up this CDIto other liver fluke endemic areas of Saravane province and later to all southern Laosfor the control of liver fluke and co-infected worms.

ບົດສະຫລຸບຫຍໍ້

ປະຫວັດຄວາມເປັນມາ: ພະຍາດໃບໄມ້ທີ່ຕິດມາຈາກອາຫານ (Food-borne trematodiasis) ແລະ ພະຍາດແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນ (soil-transmitted helminth) ແມ່ນບັນດາພະຍາດທີ່ບໍ່ໄດ້ຮັບການເອົາໃຈໃສ່ (NTDs) ແລະ ຂົ່ມຂູ່ສຸຂະພາບຂອງມະນຸດຢູ່ອາຊີຕາເວັນອອກສ່ຽງໃຕ້. ປະມານ 67.3 ລ້ານຄົນ ແມ່ນມີຄວາມສ່ຽງຕໍ່ການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບ ສາຍພັນ *Opisthorchis viverrini* (*O. viverrini*). ຄົນສາມາດຕິດເຊື້ອພະຍາດດັ່ງກ່າວນີ້ຍ້ອນການກິນປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ. ການທີ່ບໍ່ຖ່າຍໃສ່ວິດພາໃຫ້ເຊື້ອພະຍາດໃບໄມ້ໃນຕັບແພ່ລະບາດໄປສູ່ສິ່ງແວດລ້ອມ (ຕົວສື່ສົ່ງເຊື້ອ ຄື: ຫອຍ ແລະ ປາ). ການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບທີ່ຮຸນແຮງພາໃຫ້ເກີດເປັນພະຍາດຕັບ ແລະ ທໍ່ສົ່ງນ້ຳບີ ແລະ ຖ້າມີການຕິດເຊື້ອຮຸນແຮງ ແລະ ແກ່ຍາວ ພະຍາດດັ່ງກ່າວຈະພັດທະນາກາຍເປັນມະເຮັງທໍ່ສົ່ງນ້ຳບີ. ພະຍາດໃບໄມ້ໃນຕັບ ແລະ ພະຍາດກາຝາກທີ່ຕິດມາຈາກໜ້າດິນແມ່ນເປັນບັນຫາສາທາລະນະສຸກ ຢູ່ ສປປ ລາວ. ຫລາຍກວ່າ 2 ລ້ານຄົນໄດ້ຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບ ແລະ ສ່ວນຫລາຍແມ່ນອາໄສຢູ່ພາກກາງ ແລະ ພາກໃຕ້. ປະມານ 1,646,000 ຄົນແມ່ນມີຄວາມສ່ຽງຕໍ່ການຕິດເຊື້ອພະຍາດກາຝາກທີ່ຕິດມາຈາກໜ້າດິນ, ໃນນັ້ນ ພະຍາດແມ່ທ້ອງປາກຂໍແມ່ນເປັນສາຍພັນທີ່ນຳໜ້າໃນບັນດາພະຍາດແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນ. ກະຊວງສາທາລະນະສຸກ ສປປ ລາວ ໄດ້ຖືເອົາການປິ່ນປົວທົ່ວປວງຊົນໄປຄຽງຄູ່ກັບການໃຫ້ການສຸຂະສຶກສາເປັນບຸລິມະສິດໃນການຄວບຄຸມພະຍາດແມ່ກາຝາກ ຢູ່ ສປປ ລາວ, ແຕ່ວ່າການຈັດຕັ້ງປະຕິບັດສ່ວນໃຫຍ່ແມ່ນຜ່ານຕາມໂຄງການສາຍຕັ້ງ ຊຶ່ງເຮັດໃຫ້ຜູ້ທີ່ໄດ້ຮັບຜົນກະທົບຈາກພະຍາດດັ່ງກ່າວໄດ້ມີບົດບາດ ແລະ ມີສ່ວນຮ່ວມໃນການຄວບຄຸມພະຍາດດັ່ງກ່າວໃນທາງອ້ອມ, ນອກນັ້ນ ການຈັດຕັ້ງປະຕິບັດດັ່ງກ່າວຍັງໄດ້ໃຊ້ຊັບພະຍາກອນ ແລະ ງົບປະມານຫລາຍ ສະນັ້ນ ມັນຈຶ່ງເປັນສິ່ງທ້າທາຍໃຫ້ ລັດຖະບານ ສປປ ລາວ ທີ່ຈະສະໜອງການຈັດຕັ້ງປະຕິບັດໂຄງການຄວບຄຸມພະຍາດແມ່ກາຝາກໃນໄລຍະຍາວ ໂດຍສະເພາະແມ່ນໂຄງການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ. ສະນັ້ນ ບັນດາກິດຈະກຳທີ່ຢູ່ໃນບົດວິທະຍານິພົນປະຣິນຍາເອກນີ້ ຈຶ່ງໄດ້ອອກແບບ, ຈັດຕັ້ງປະຕິບັດ, ແລະ ປະເມີນ ວິທີການແບບໃໝ່ໃນການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ ແລະ ພະຍາດແມ່ກາຝາກທີ່ຕິດມາ

ຈາກໜ້າດິນ ຢູ່ພາກໃຕ້ຂອງ ສປປ ລາວ. ວິທີການແບບໃໝ່ນີ້ໄດ້ຖືກພັດທະນາຂຶ້ນບົນພື້ນຖານບົດຮຽນ ແລະ ປະສົບການຈາກໂຄງການຄວບຄຸມພະຍາດໜອນຕາຢູ່ບັນດາປະເທດຕາເວັນຕົກທີ່ນອນຢູ່ໃນທະວີບ ອາຟຣິກາ.

ວັດຖຸປະສົງ: ເປົ້າໝາຍຫລັກຂອງບົດວິທະຍານິພົນປະຣິນຍາເອກນີ້ແມ່ນເພື່ອພັດທະນາວິທີການແບບໃໝ່ໃນ ການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບຢູ່ເຂດທີ່ມີຄວາມສ່ຽງໃນການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບສູງ ຄື ໂຄງການປະຕິບັດການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບໂດຍຊຸມຊົນເປັນເຈົ້າການໃນການຢາຍຢາເພື່ອປິ່ນປົວ ພະຍາດໃບໄມ້ໃນຕັບ ແລະ ແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນຢູ່ຊຸມຊົນ (Community-Directed Intervention [CDI]) ພາກໃຕ້ຂອງ ສປປ ລາວ. ວັດຖຸປະສົງສະເພາະມີ: 1.) ເຂົ້າໃຈກ່ຽວກັບສະພາບ ພະຍາດແມ່ກາຝາກຢູ່ໃນສີ່ທົດສະຫວັດຜ່ານມາ ຢູ່ ສປປ ລາວ ແລະ ສະພາບພະຍາດໃບໄມ້ໃນຕັບ ຢູ່ ພາກໃຕ້ຂອງ ສປປ ລາວ; 2.) ເພື່ອເຂົ້າໃຈກ່ຽວກັບພະຍາດແມ່ກາຝາກທີ່ພົວພັນກັບຄວາມຮູ້, ທັດສະນະ ຄະຕິ ແລະ ການປະຕິບັດຕົວຈິງຂອງຊຸມຊົນກ່ຽວກັບພະຍາດແມ່ກາຝາກ; 3.) ເພື່ອເຮັດໃຫ້ພວກເຮົາ ເຂົ້າໃຈເລິກເຊິ່ງກ່ຽວກັບການບໍລິໂພກອາຫານປະເພດປາທີ່ປຸ່ງແຕ່ງບໍ່ສຸກດີ ທີ່ກ່ຽວພັນກັບການຕິດເຊື້ອ ພະຍາດໃບໄມ້ໃນຕັບ ຢູ່ເຂດທີ່ມີການລະບາດຂອງພະຍາດໃບໄມ້ໃນຕັບ ຂອງພາກໃຕ້ຂອງ ສປປ ລາວ; 4.) ປະເມີນຄວາມຮັບຮູ້ແລະຄວາມເຂົ້າໃຈຕໍ່ກັບການຈັດຕັ້ງປະຕິບັດໂຄງການຄວບຄຸມພະຍາດແມ່ກາຝາກ ຢູ່ໃນບັນດາເຂດທີ່ມີການລະບາດພະຍາດໃບໄມ້ດູດເລືອດ (*Schistosoma mekongi*, [*S. mekongi*]) ແລະ ການຕິດເຊື້ອພະຍາດແມ່ກາຝາກຫລາຍຊະນິດສູງ; 5.) ເພື່ອປະເມີນປະສິດທິຜົນຂອງການຈັດຕັ້ງ ປະຕິບັດວິທີການແບບໃໝ່ໃນການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບແລະກາຝາກທີ່ຕິດຈາກໜ້າດິນ (CDI) ຢູ່ ພາກໃຕ້ຂອງ ສປປ ລາວ; 6.) ເພື່ອກຳນົດປັດໃຈທີ່ພົວພັນກັບການເຂົ້າຮ່ວມກິນຢາປິ່ນປົວພະຍາດແມ່ກາ ຝາກໃນເວລາຊຸມຊົນເປັນເຈົ້າການໃນການຢາຍຢາປິ່ນປົວພະຍາດແມ່ກາຝາກຢູ່ຊຸມຊົນ.

ວິທີວິທະຍາການຄົ້ນຄວ້າ: ການສຶກສາ 5 ຫົວຂໍ້ ທີ່ຢູ່ໃນບົດວິທະຍານິພົນປະຣິນຍາເອກນີ້ແມ່ນເປັນການ ເດີນການສຳຫລວດຢູ່ຊຸມຊົນ ແລະ ອີກໜຶ່ງຫົວຂໍ້ແມ່ນເປັນການສຶກສາແບບທົບທວນເອກະສານ. ໄດ້ນຳໃຊ້

ການສຶກສາແບບພັນລະນານະຈຸດເວລາໃດໜຶ່ງ ຊຶ່ງລວມມີທັງການສຶກສາແບບປະລິມານ ແລະ ຄຸນນະພາບ. ການສຶກສາແບບປະລິມານແມ່ນລວມມີ ການກວດອາຈົມເພື່ອປະເມີນການຕິດເຊື້ອຂອງພະຍາດແມ່ກາຝາກ ແລະ ຄວາມຮຸນແຮງຂອງການຕິດເຊື້ອ, ສຳພາດຫົວໜ້າຄົວເຮືອນ ແລະ ສະມາຊິກໃນຄົວເຮືອນໂດຍນຳໃຊ້ແບບສອບຖາມແບບໂຄງສ້າງ. ການສຶກສາແບບຄຸນນະພາບລວມມີ ການສຳພາດໂດຍນຳໃຊ້ແບບຟອມແບບເຄິ່ງໂຄງສ້າງ, ການສຳພາດລົງເລິກ, ການສົນທະນາກຸ່ມ ແລະ ການສັງເກດການ. ຂໍ້ມູນແບບປະລິມານໄດ້ຕີເຂົ້າຖານຂໍ້ມູນໂດຍໃຊ້ ເອປີດາຕາ ຊອບແວ (Epidata software version 3.1) ແລະ ວິເຄາະຢູ່ສຕາຕາ ຊອບແວ (Stata software version 10.1). ຂໍ້ຄວາມການສົນທະນາໄດ້ຂຽນອອກຈາກປຶ້ມບັນທຶກ ແລະຈາກການບັນທຶກສຽງ ແລະ ນຳໃຊ້ຊອບແວ MAXQDA version 10 ເພື່ອວິເຄາະເນື້ອໃນ. ສຳລັບການທົບທວນເອກະສານ ແມ່ນ ໄດ້ທົບທວນເອກະສານຈາກວາລະສານສາກົນ ແຕ່ປີ 1970 ເຖິງ 2013 ຜ່ານການຊອກຄົ້ນຜ່ານຖານຂໍ້ມູນປັບແມັດ (PubMed database).

ຜົນການຄົ້ນຄວ້າ: ການທົບທວນເອກະສານກ່ຽວກັບພະຍາດແມ່ກາຝາກ ໃນສີ່ທົດສະວັດຜ່ານມາ ຢູ່ ສປປ ລາວ ສະແດງໃຫ້ເຫັນວ່າ ປະຈຸບັນອັດຕາການຕິດເຊື້ອພະຍາດແມ່ທ້ອງກົ້ມ, ແມ່ທ້ອງແສ້ມ້າ, ແລະ ແມ່ທ້ອງປາກຂໍ ຫລຸດລົງຖ້າສົມທຽບໃສ່ໃນຊຸມປີ 1990, ແຕ່ຢູ່ໃນເຂດທີ່ເປັນພູເຂົາ ແລະ ເຂດທີ່ເປັນໂນນສູງ ການຕິດເຊື້ອພະຍາດດັ່ງກ່າວແມ່ນຍັງສູງ; ການຕິດເຊື້ອພະຍາດແມ່ທ້ອງປາກຂໍແມ່ນຍັງສູງກວ່າການຕິດເຊື້ອແມ່ທ້ອງກົ້ມ ແລະ ແມ່ທ້ອງແສ້ມ້າ. ການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບເຫັນວ່າສູງ ແລະ ປະຈຸບັນແມ່ນສູງກວ່າທີ່ຜ່ານມາ. ຄວາມກ້າວໜ້າທາງດ້ານການບົ່ງມະຕິພະຍາດໂດຍນຳໃຊ້ຕົວຢ່າງອາຈົມຫລາຍຄັ້ງ ແລະ ການກວດແບບຫລາຍແຜ່ນລາມຕໍ່ໜຶ່ງຕົວຢ່າງອາຈົມ ໄດ້ໃຫ້ຄວາມກະຈ່າງແຈ້ງຕໍ່ກັບການເພີ້ມຂຶ້ນຂອງການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບ. ການສຶກສາພົບວ່າ ມີການຕິດເຊື້ອພະຍາດແມ່ກາຝາກຫລາຍຊະນິດລວມທັງການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບ. ພຶດຕິກຳການບໍລິໂພກປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ແລະ ການຖ່າຍຊະຊາຍ ຍັງປະຕິບັດກັນເປັນປະຈຳ ຢູ່ ສປປ ລາວ ສະນັ້ນ ມັນຈຶ່ງເຮັດໃຫ້ມີການແຜ່ລະບາດຂອງພະຍາດໃບໄມ້ໃນຕັບຢູ່ຊຸມຊົນ, ແຕ່ຄວາມເປັນໄປໄດ້ໃນການປະຕິບັດການເພື່ອຄວບຄຸມພຶດຕິກຳສ່ຽງ

ດັ່ງກ່າວພັດຍັງຈຳກັດ. ປະຈຸບັນ ຢູ່ເຂດທີ່ເຄີຍມີການແພ່ລະບາດຂອງພະຍາດໃບໄມ້ດູດເລືອດ ກໍ່ໄດ້ມີການແພ່ລະບາດອີກຄືນໃໝ່ ແລະ ເດັກອາຍຸ ຕ່ຳກວ່າ 5 ປີ ກໍ່ໄດ້ມີການຕິດເຊື້ອພະຍາດໃບໄມ້ດູດເລືອດ.

ການສຳຫລວດເບື້ອງຕົ້ນ ຢູ່ 10 ບ້ານເປົ້າໝາຍ ທີ່ເມືອງ ສາລະວັນ ແຂວງສາລະວັນ ພາກໃຕ້ຂອງ ສປປ ລາວ ໄດ້ຊີ້ບອກເຖິງການຕິດເຊື້ອພະຍາດແມ່ກາຝາກສູງ ແຕ່ກົງກັນຂ້າມຄວາມຮູ້ກ່ຽວກັບພະຍາດ ແມ່ກາຝາກພັດຍັງຕ່ຳ. ຕົວຢ່າງ ໃນປະຊາກອນຕົວຢ່າງ 574 ຄົນ ອັດຕາການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນ ຕັບ, ແມ່ທ້ອງປາກຂໍ, ແມ່ທ້ອງແສ້ມ້າ, ແມ່ທ້ອງໂຕກົມ ແລະ ແມ່ທ້ອງໂຕແປ ແມ່ນ 88.7%, 86.6%, 32.9%, 9.8%, ແລະ 11.5% ຕາມລຳດັບ. ປະຊາກອນສ່ວນໃຫຍ່ຕິດເຊື້ອແມ່ກາຝາກ ທັງສອງຢ່າງ ໄປພ້ອມໆກັນຄື ພະຍາດໃບໄມ້ໃນຕັບ ແລະ ແມ່ທ້ອງປາກຂໍ (77.3%),. ເພດຊາຍຕິດເຊື້ອພະຍາດ ແມ່ກາຝາກຫລາຍຊະນິດຫລາຍກວ່າເພດຍິງ. ໃນຈຳນວນຫົວໜ້າຄົວເຮືອນທີ່ໄດ້ສຳພາດທັງໝົດ 130 ຄົນ ໜຶ່ງສ່ວນສາມບອກວ່າເຄີຍຮູ້ຍິນກ່ຽວກັບພະຍາດໃບໄມ້ໃນຕັບ, ໃນນັ້ນ 59.2% ຮູ້ວ່າການຕິດເຊື້ອພະຍາດ ໃບໄມ້ໃນຕັບແມ່ນພົວພັນກັບການກິນປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ. ໃນບັນດາພະຍາດ ແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນ, ສ່ວນຫລາຍແມ່ນແມ່ທ້ອງໂຕກົມເປັນທີ່ຮັບຮູ້ກັນດີກວ່າໝູ່ (70.8%) ແລະ ຜູ້ຕອບສຳພາດເຂົ້າໃຈວ່າ ການຕິດເຊື້ອແມ່ທ້ອງກົມແມ່ນພົວພັນກັບການບໍລິໂພກອາຫານດິບ (91.3%). ພຶດຕິກຳໃນການບໍລິໂພກປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີແມ່ນພົບເຫັນເລື້ອຍທີ່ສຸດ (75.4%), ຈຳນວນຄົວ ເຮືອນທີ່ມີວິດຖ່າຍແມ່ນຈຳກັດຫລາຍ (16.1%), ຫົວໜ້າຄົວເຮືອນໜ້ອຍກວ່າເຄິ່ງໜຶ່ງຮູ້ຜົນປະໂຫຍດຈາກ ການນຳໃຊ້ວິດຖ່າຍ ແລະ ການອະນາໄມສ່ວນບຸກຄົນ. ຈາກການສົນທະນາກຸ່ມເຫັນວ່າ ຄວາມຮູ້ກ່ຽວກັບ ພະຍາດແມ່ກາຝາກຂອງຜູ້ເຂົ້າຮ່ວມການສົນທະນາກຸ່ມແມ່ນຍັງຈຳກັດ, ເພດຊາຍມັກກິນປາທີ່ປຸງແຕ່ງບໍ່ສຸກ ດີຫລາຍກວ່າເພດຍິງ, ຫົວໜ້າຄົວເຮືອນຈຳນວນໜຶ່ງບໍ່ມັກໃຊ້ວິດຖ່າຍ ຍ້ອນບໍ່ລ້ຳຖ່າຍໃສ່ວິດ ແລະ ຍ້ອນມີ ກິ່ນເໝັນ. ຈາກການສັງເກດບ້ານທີ່ໄດ້ດຳເນີນການສຳຫລວດພົບວ່າ ການອະນາໄມສ່ວນບຸກຄົນ ແລະ ການອະນາໄມພາຍໃນບ້ານແມ່ນຍັງຈຳກັດ.

ຜົນການສຳຫລວດກ່ຽວກັບການບໍລິໂພກປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ ກັບ ການຕິດເຊື້ອ ພະຍາດໃບໄມ້ໃນຕັບ ຢູ່ພາກໃຕ້ ຂອງ ສປປ ລາວ ເຫັນວ່າມີຄວາມຫລາຍຫລາຍ. ຜູ້ເຂົ້າຮ່ວມການ ສົນທະນາສ່ວນໃຫຍ່ເຂົ້າໃຈວ່າ ການປຸງແຕ່ງຊີ້ນປາດິບປະສົມກັບໝົດສົ້ມ ແລະ ໃນເວລາທີ່ຊີ້ນປາດິບ ກາຍເປັນສີຂາວເໝື້ນນັ້ນແມ່ນມັນມີຄວາມປອດໄພສຳລັບທີ່ຈະບໍລິໂພກ (ສາມາດກິນໄດ້ບໍ່ຕິດເຊື້ອ). ການ ສຶກສາພົບວ່າ ສາຍເຫດທີ່ພາໃຫ້ກິນປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ ແມ່ນຍ້ອນ ສີສັນໜ້າຕາຂອງ ອາຫານ, ລົດຊາດ, ແລະ ກິ່ນຫອມ ແລະ ຄວາມມັກໃນການກິນອາຫານປະເພດນີ້ ແລະ ອີກຢ່າງໜຶ່ງ ກໍ່ ແມ່ນຍ້ອນ ວິທີການປຸງແຕ່ງອາຫານຊຶ່ງມັນເປັນແບບພື້ນບ້ານ ແລະ ເຄີຍປຸງແຕ່ງມາແຕ່ລຸ້ນປູ່ຍ່າຕານາຍ ຫລາຍເຊັ່ນຄົນ. ນອກນັ້ນການສຶກສາພົບວ່າ ມີອາຫານປະເພດປາທີ່ປຸງແຕ່ງແບບສຸກໆດິບໆທີ່ຫລາກ ຫລາຍ. ຜູ້ເຂົ້າຮ່ວມການສົນທະນາທຸກຄົນບອກວ່າໄດ້ກິນປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ.

ການສຳຫລວດຢູ່ເຂດທີ່ມີການລະບາດຂອງພະຍາດໃບໄມ້ດູດເລືອດ (*S. mekongi)* ທາງພາກໃຕ້ ຂອງ ສປປ ລາວ ບ່ອນທີ່ມີການຕິດເຊື້ອແມ່ກາຝາກຫລາຍຊະນິດໄປພ້ອມກັນ ໄດ້ສັງເກດເຫັນວ່າ ຜູ້ນຳຊຸມຊົນ (ນາຍບ້ານ, ອສບ, ຫົວໜ້າແມ່ຍິງ, ຫົວໜ້າຊາວໜຸ່ມ) ແລະ ຊາວບ້ານ ໄດ້ຮູ້ກ່ຽວກັບການຢາຍຢາທົ່ວປວງ ຊົນຢູ່ພາຍໃນບ້ານ. ຜູ້ນຳຊຸມຊົນໄດ້ມີຄວາມຮັບຮູ້ ແລະ ເຂົ້າໃຈກ່ຽວກັບປະສິດທິຜົນຂອງການຢາຍຢາທົ່ວ ປວງຊົນຕໍ່ກັບບັນດາອາການຮຸນແຮງຂອງພະຍາດທີ່ເກີດມາຈາກພະຍາດໃບໄມ້ດູດເລືອດ (ເຊັ່ນ: ທ້ອງປຸ້ງ, ຮາກອອກເລືອດ, ແລະ ເສຍຊີວິດຍ້ອນຮາກອອກເລືອກ) ແລະ ມີຄວາມປິຕິຊົມຊື່ນຕໍ່ກັບການຢາຍປາທົ່ວ ປວງຊົນ ຍ້ອນວ່າ ໄດ້ກິນຢາແບບບໍ່ໄດ້ເສຍຄ່າ (ກິນຢາຟຣີ) ແລະ ຢາຍຢູ່ກັບບ້ານ. ນອກນັ້ນ ເຂົາເຈົ້າໄດ້ ແນະນຳໃຫ້ຊາວບ້ານໄປກິນຢາໃນເວລາມີການຢາຍຢາທົ່ວປວງຊົນຢູ່ຊຸມຊົນ. ອາການຂ້າງຄຽງທີ່ເກີດມາ ຈາກການກິນຢາປລາຊີກັງແຕນເຫັນວ່າເປັນອຸປະສັກຕໍ່ການມາເຂົ້າຮ່ວມກິນຢາຂອງຊຸມຊົນ. ໃນເວລາທີ່ບໍ່ມີ ການຢາຍຢາທົ່ວປວງຊົນຢູ່ພາຍໃນບ້ານ ຜູ້ນຳຊຸມຊົນສ່ວນໃຫຍ່ບອກວ່າ ໄດ້ໄປຊື້ຢາຕາມຮ້ານຂາຍຢາມາ ຂ້າແມ່ທ້ອງດ້ວຍຕົນເອງ (19/21) ສ່ວນຫລາຍແມ່ນຢາ ເມແບັນດາໂຊນ (ແບັນດາ 500 mg) ຫຼື ອານ ແບັນດາໂຊນ. ຜູ້ນຳຊຸມຊົນສ່ວນໃຫຍ່ ມີຄວາມຮູ້ກ່ຽວກັບຄວາມຮຸນແຮງຂອງພະຍາດທີ່ເກີດມາຈາກ ພະຍາດໃບໄມ້ດູດເລືອດ (20/21) ແຕ່ມີພຽງຈຳນວນໜ້ອຍດຽວເທົ່ານັ້ນ ຮູ້ເຖິງສາຍເຫດທີ່ພາໃຫ້ເກີດ

ພະຍາດໃບໄໝ້ດູດເລືອດ (5/21). ຄວາມຮູ້ກ່ຽວກັບຜົນກະທົບຕໍ່ສຸຂະພາບທີ່ເກີດມາຈາກການຕິດເຊື້ອ ພະຍາດໃບໄໝ້ໃນຕັບ (3/21) ແລະ ພະຍາດແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນ (4/21) ຍັງຈະກັດຫລາຍ ແຕ່ຄວາມຮູ້ກ່ຽວກັບສາຍເຫດທີ່ພາໃຫ້ຕິດເຊື້ອພະຍາດໃບໄໝ້ໃນຕັບ ແລະ ພະຍາດແມ່ກາຝາກທີ່ຕິດຈາກ ໜ້າດິນແມ່ນສູງ. ນອກນັ້ນ ໄດ້ສັງເກດເຫັນວ່າ ມີປັດໃຈສ່ຽງສູງຕໍ່ການຕິດເຊື້ອພະຍາດແມ່ກາຝາກຢູ່ຊຸມຊົນ ຄື ຫົວໜ້າຄົວເຮືອນທຸກຄົນບອກວ່າໄດ້ກິນປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ (100%), ມີການສໍາ ພັດກັບແມ່ນ້ໍາຂອງເປັນປະຈໍາບ່ອນທີ່ສາມາດຕິດເຊື້ອພະຍາດໃບໄໝ້ດູດເລືອດ (76.0%), ແລະ ຄົວເຮືອນ ທີ່ມີວິດຖ່າຍແມ່ນມີຈໍານວນຈໍາກັດທີ່ສຸດ (14.5%).

ຢູ່ ແຂວງສາລະວັນ, ພາຍຫລັງໄດ້ຈັດຕັ້ງປະຕິບັດໂຄງການປະຕິບັດການແບບໃໝ່ເພື່ອຄວບຄຸມພະຍາດໃບ ໄໝ້ໃນຕັບ ແລະ ພະຍາດແມ່ກາຝາກທີ່ຕິດຈາກໜ້າດິນ ເປັນຈໍານວນ 02 ຄັ້ງ ຜົນການປະເມີນຜົນສະແດງ ໃຫ້ເຫັນວ່າ ອັດຕາການຕິດເຊື້ອພະຍາດແມ່ກາຝາກໃບໄໝ້ໃນຕັບ, ແມ່ທ້ອງປາກຂໍ, ແມ່ທ້ອງກົ້ມ, ແມ່ທ້ອງ ແສ້ມ້າ ໄດ້ຫລຸດລົງ ເຖິງ 26.4%, 38.1%,45.9%, 30.3% ຕາມລໍາດັບ. ອັດຕາການຕິດເຊື້ອພະຍາດ ແມ່ກາຝາກຫລາຍຊະນິດກໍ່ຫລຸດລົງ. ຫົວໜ້າຄົວເຮືອນມີຄວາມຮູ້ດີຂຶ້ນກວ່າເກົ່າ ຕົວຢ່າງຄວາມຮູ້ກ່ຽວກັບ ພະຍາດໃບໄໝ້ໃນຕັບ, ແມ່ທ້ອງປາກຂໍ, ແລະ ແມ່ທ້ອງແສ້ມ້າ, ມາດຕະການໃນການຄວບຄຸມພະຍາດໃບ ໄໝ້ໃນຕັບ, ສາຍພົວພັນລະຫວ່າງປັດໃຈສ່ຽງກັບການຕິດເຊື້ອແມ່ທ້ອງປາກຂໍ ແລະ ແມ່ທ້ອງແສ້ມ້າ. ຄວາມເຂົ້າໃຈແບບຜິດພາດກ່ຽວກັບການຕິດເຊື້ອແມ່ທ້ອງກົ້ມ ຄື ເຂົ້າໃຈວ່າມັນຕິດເຊື້ອມາຈາກການກິນ ອາຫານດິບທຸກປະເພດໄດ້ຖືກປັບປຸງໃຫ້ດີຂຶ້ນ, ມີຫົວໜ້າຄົວເຮືອນຈໍານວນນ້ອຍໜຶ່ງບອກວ່າໄດ້ກິນປາດິບ ຫຼື ປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ ຊຶ່ງຂໍ້ມູນດັ່ງກ່າວແມ່ນສອດຄ່ອງກັບຂໍ້ມູນທີ່ໄດ້ມາຈາກການ ສົນທະນາກຸ່ມ ຄື ເຂົາເຈົ້າສົນທະນາວ່າ ຫລັງຈາກໄດ້ກິນຢາປິ່ນປົວພະຍາດໃບໄໝ້ໃນຕັບຢູ່ຊຸມຊົນແລ້ວ ເຂົາເຈົ້າຮູ້ສຶກບໍ່ຢາກກິນປາດິບ ຫຼື ປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ ແລະ ຈໍານວນໜຶ່ງກໍ່ບອກວ່າ ຍ້ອນຢ້ານຕິດເຊື້ອພະຍາດໃບໄໝ້ໃນຕັບຄືນອີກ. ຜູ້ເຂົ້າຮ່ວມການສຶກສາມີທັດສະນະວ່າ ໂຄງການຄວບຄຸມ ພະຍາດໃບໄໝ້ໃນຕັບແລະແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນທີ່ກໍາລັງປະຕິບັດຢູ່ນີ້ ແມ່ນມີປະສິດທິຜົນດີໃນ

ການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ, ແລະ ແມ່ກາຝາກອື່ນໆ ແລະ ພ້ອມທັງສາມາດປ້ອງກັນພະຍາດອື່ນໆ ອີກ. ຜູ້ນຳຊຸມຊົນໄດ້ມີຄວາມເປັນເຈົ້າການໃນດ້ານດຳເນີນການຢາຍຢາຢູ່ຊຸມຊົນ.

ນອກນັ້ນ ໄດ້ປະເມີນບັນດາປັດໃຈທີ່ພົວພັນກັບການເຂົ້າຮ່ວມກິນຢາໃນເວລາທີ່ມີການຢາຍຢາຢູ່ຊຸມຊົນ ໂດຍຊຸມຊົນເປັນເຈົ້າການ ຂອງໂຄງການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ ແລະ ກາຝາກທີ່ຕິດຈາກໜ້າດິນທີ່ ກຳລັງດຳເນີນຢູ່ໃນປະຈຸບັນ ພົບວ່າ ໃນຈຳນວນ 600 ຄົນທີ່ໄດ້ສຳພາດ, 46.5% ບອກວ່າ ໄດ້ເຂົ້າຮ່ວມ ກິນຢາໃນເວລາມີການຢາຍຢາຢູ່ໃນຊຸມຊົນ. ຜູ້ທີ່ເຂົ້າຮ່ວມກິນຢາສ່ວນຫລາຍແມ່ນ ມາຈາກຄອບຄົວທີ່ທຸກ ຍາກ (p=0.013), ມີຄວາມເຂົ້າໃຈກ່ຽວກັບໂຄງການປະຕິບັດການຄວບຄຸມຄຸມພະຍາດໃບໄມ້ໃນຕັບ ແລະ ກາຝາກທີ່ຕິດຈາກໜ້າດິນທີ່ກຳລັງປະຕິບັດຢູ່ຊຸມຊົນ (p<0.001), ຮູ້ວ່າໂຄງການນີ້ໄດ້ໃຫ້ການປິ່ນປົວ ພະຍາດໃບໄມ້ໃນຕັບ (p<0.001), ແລະ ປິ່ນປົວອາການເຈັບທ້ອງ (p<0.028), ແລະ ໄດ້ເຫັນແມ່ທ້ອງ ແປອອກມານຳອາຈົມ (p=0.016). ຜູ້ເຂົ້າຮ່ວມສ່ວນໃຫຍ່ເຄີຍຮູ້ຍິນກ່ຽວກັບພະຍາດໃບໄມ້ໃນຕັບ ແລະ ແມ່ທ້ອງກົມ. ການເຂົ້າຮ່ວມກິນຢາໃນຊຸມຊົນ ແມ່ນພົວພັນກັບ ຄວາມທຸກຍາກ: ທຸກຫລາຍ (OR=2.13; p=0.018) ແລະ ທຸກທຳມະດາ (OR=2.07; p=0.022), ຄວາມເຂົ້າໃຈກ່ຽວກັບປະສິດທິຜົນຂອງ ໂຄງການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ (OR=1.57; p=0.035), ຮັບຮູ້ກ່ຽວກັບພະຍາດແມ່ທ້ອງແປ (OR=2.95; p=0.037). ຜູ້ຢາຍຢາຢູ່ໃນຊຸມຊົນປະຕິບັດໜ້າທີ່ໄດ້ດີ ເຖິງແມ່ນວ່າ ສ່ວນຫລາຍບໍ່ໄດ້ຮັບ ການຊີ້ນຳຕິດຕາມຈາກພະນັກງານສຸກສາລາທີ່ຜ່ານການຝຶກອົບຮົມ.

ສະຫລຸບ: ພວກຂ້າພະເຈົ້າສະຫລຸບວ່າ ໄປຄຽງຄູ່ກັບການຕິດເຊື້ອພະຍາດໃບໄມ້ໃນຕັບ ແລະ ກາຝາກທີ່ ຕິດຈາກໜ້າດິນສູງ, ຜູ້ນຳຊຸມຊົນ ແລະ ຊຸມຊົນເອງມີຄວາມຮູ້ຈຳກັດກ່ຽວກັບພະຍາດແມ່ກາຝາກ ແລະ ບົດບາດໃນການຢາຍຢາທົ່ວປ່ອງຊົນ. ການສຶກສາພົບເຫັນມີຄວາມສ່ຽງກ່ຽວກັບການຕິດເຊື້ອພະຍາດແມ່ກາ ຝາກ: ການກິນປາດິບ ຫຼື ປາທີ່ປຸງແຕ່ງບໍ່ສຸກດີ ຫຼື ແບບສຸກໆດິບໆ ເນື່ອງຈາກວ່າເຂົາເຈົ້າມັກລົດຊາດ, ກິ່ນ, ແລະ ໜ້າຕາຂອງອາຫານ, ຮັບຮູ້ ແລະ ເຂົ້າໃຈກ່ຽວກັບເຕັກນິກໃນການປຸງແຕ່ງປະເພດປາດິບແບບ ພື້ນບ້ານວ່າມີຄວາມປອດໄພໃນການບໍລິໂພກ, ແລະ ເຄີຍກິນອາຫານປະເພດນີ້ມາຫລາຍໆເຊັ່ນຄົນ; ແລະ

ນອກນັ້ນ ໄດ້ສັງເກດເຫັນວ່າ ການລ້າງມືກ່ອນກິນເຂົ້າຍັງຈຳກັດ, ຍ່າງບໍ່ໃສ່ເກີບ, ບໍ່ຖ່າຍໃສ່ວິດຍ້ອນບໍ່ຊິ້ນເຄີຍ ແລະ ຍ້ອນມີກິ່ນເໝັນ. ພວກຂ້າພະເຈົ້າຍັງສະຫລຸບວ່າ ວິທີການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ ແລະ ແມ່ກາຝາກທີ່ຕິດຈາກໜ້າດິນ ແບບໃໝ່ນີ້ ສາມາດຄວບຄຸມການຕິດເຊື້ອພະຍາດແມ່ກາຝາກ ແລະ ປັບປຸງຄວາມຮູ້, ທັດສະນະຄະຕິ ແລະ ການປະຕິບັດຕົວຈິງ ຂອງຊຸມຊົນກ່ຽວກັບພະຍາດແມ່ກາຝາກ ແລະ ການຢາຍຢາປິ່ນປົວພະຍາດແມ່ກາຝາກທົ່ວປວງຊົນດີຂຶ້ນກວ່າເກົ່າ. ຜູ້ນຳຊຸມຊົນມີຄວາມເປັນເຈົ້າການ ແລະ ສາມາດດຳເນີນໂຄງການປະຕິບັດການຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ ແລະ ແມ່ກາຝາກທີ່ຕິດມາຈາກໜ້າດິນແບບໃໝ່. ສະນັ້ນ ມັນມີຄວາມເປັນໄປໄດ້ທີ່ຈະຂະຫຍາຍໄປເຂດອື່ນໆທີ່ມີການລະບາດຂອງພະຍາດໃບໄມ້ໃນຕັບທີ່ຢູ່ໃນແຂວງສາລະວັນ ແລະ ໃນຕໍ່ໜ້າ ສາມາດຂະຫຍາຍໄປເຂດອື່ນໆ ຂອງ ສປປ ລາວ ເພື່ອຄວບຄຸມພະຍາດໃບໄມ້ໃນຕັບ ແລະ ແມ່ກາຝາກອື່ນໆທີ່ຕິດເຊື້ອຮ່ວມ.

Chapter 1: Introduction

1.1 Description of Opisthorchiasis

1.1.1 *Opisthorchis viverrini* and opisthorchiasis

In the family of Opisthorchiidea, there are three species food-borne trematodes (FBT) such as *Opisthorchis viverrini*, *Opisthorchis felineus*, and *Clonorchis sinensis.* These parasites reside in the bile duct and gall bladder. *O. viverrini* infection is confirmed as a major risk factor for cholangiocarcinoma(CCA) (Brusentsov et al., 2013; Chai et al., 2007). It is characterized by focal distribution. Human is a definitive host while cats and dogs are reservoir host for the infection (Brusentsov et al., 2013; Keiser and Utzinger, 2007b).

The life-cycle of the three species within the genus *Opisthorchis* is similar. It involves two intermediate hosts: a freshwater snail of the genus *Bithynia* and a cyprinoid fish species. The adult parasite lives in the billiary ducts in human and shed eggs. They are deposited in the bile duct and passed to the intestine. Eggs are excreted with faeces and may reach to water. Snail ingests the eggs and become thereby infected. A development of cercariae in snail takes within 4–5 weeks. Then cercariae are shed into the water. The free-swimming cercariae penetrate into the flesh of freshwater fish (cyprinoid fish) and encyst as metacercariae which is in the infective stage for the next host (Petney et al., 2012). Transmission of the parasite occurs when sanitation is inadequate, and outdoor defecation occurs. Human and mammals (cats and dogs) are infected by eating raw or insufficiently cooked infected fish (Forrer et al., 2012; Rangsin et al., 2009) (Figure 1.1).

Most persons infected with *O. viverrini* have no signs nor symptoms; only 5 to 10% of those with heavy infection have non-specific symptoms such as right hypochondria pain, flatulence, and fatigue, and enlarge gall bladder but all are reversible after elimination of flukes by treatment with praziquantel (PZQ). Infected individuals with heavy and long-standing infection may develop hepatobilliar diseases which may lead to severe complication as the fatal cholangiocarcinoma; today in Khon Kaen Province Thailand

where *O. viverrini* infection is highly prevalent, about 1000 cases ofCCA are diagnosed each year at Khon Kaen University Hospital (Sripa et al., 2012).

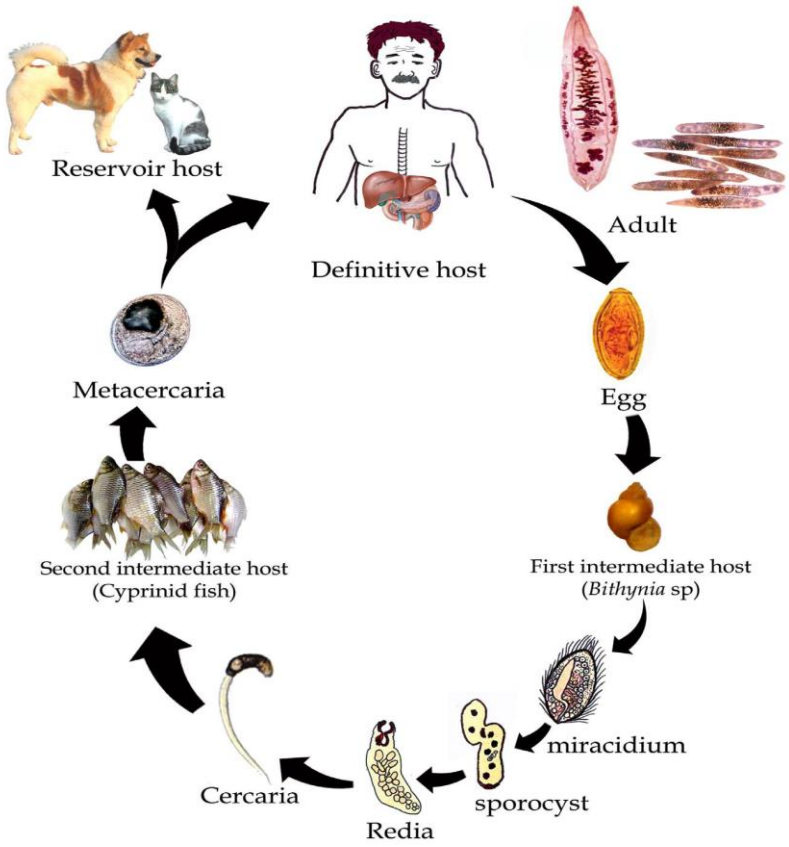

Figure 1.1: Life cycle of *O. viverrini* and *C. sinensis* (Ziegler et al., 2013)

1.1.2 Global distribution of opisthorchiasis

Food-borne trematodes (FBT) occur in many parts of the world (Figure 1.2). An estimate 750 million people worldwide are at risk of FBT. Fürst *et al.* estimated that about 56.2 million people are infected with FBTs in 2005, of 7.9 million had severe sequelae, 7,158 die mostly due to cholangiocarcinoma resulting in a DALYs of 665,352(Fürst et al., 2012a). The three species in the genus*Opisthorchis* about 12.5 million, 67.3 million, and 601 million people are at risk for *O. felineus, O. viverrini, and C. sinensis*, respectively (Keiser and Utzinger, 2009). *O. felineus* is endemic in Ob-Irtysh River basin (West Siberia) and Don and the Dnieper watersheds (Eastern Europe) (Brusentsov et al., 2013). *C. sinensis* is highly prevalent in China, Korea, and Vietnam; approximately 35

million people in Asia are infected with this parasite and 15 million are in China (Huang et al., 2013).

The first case of *O. viverrini* was reported in Thailand by Leiper in 1915 (Sripa et al., 2010). The infection is distributed in Southeast Asia: Lao PDR, Cambodia, Central Vietnam and Northeast Thailand. Today, about 67.3 million people are at risk of this infection. Ten million people from Lao PDR and Thailand are infected with this parasite. The exact figure for Cambodia and Central Vietnam is not yet unknown (Sithithaworn et al., 2012). In Lao PDR among the FBTs are *O. viverrini* and *Paragonimus* spp and many species of minute intestinal flukes (MIF) (Figure 1.3).

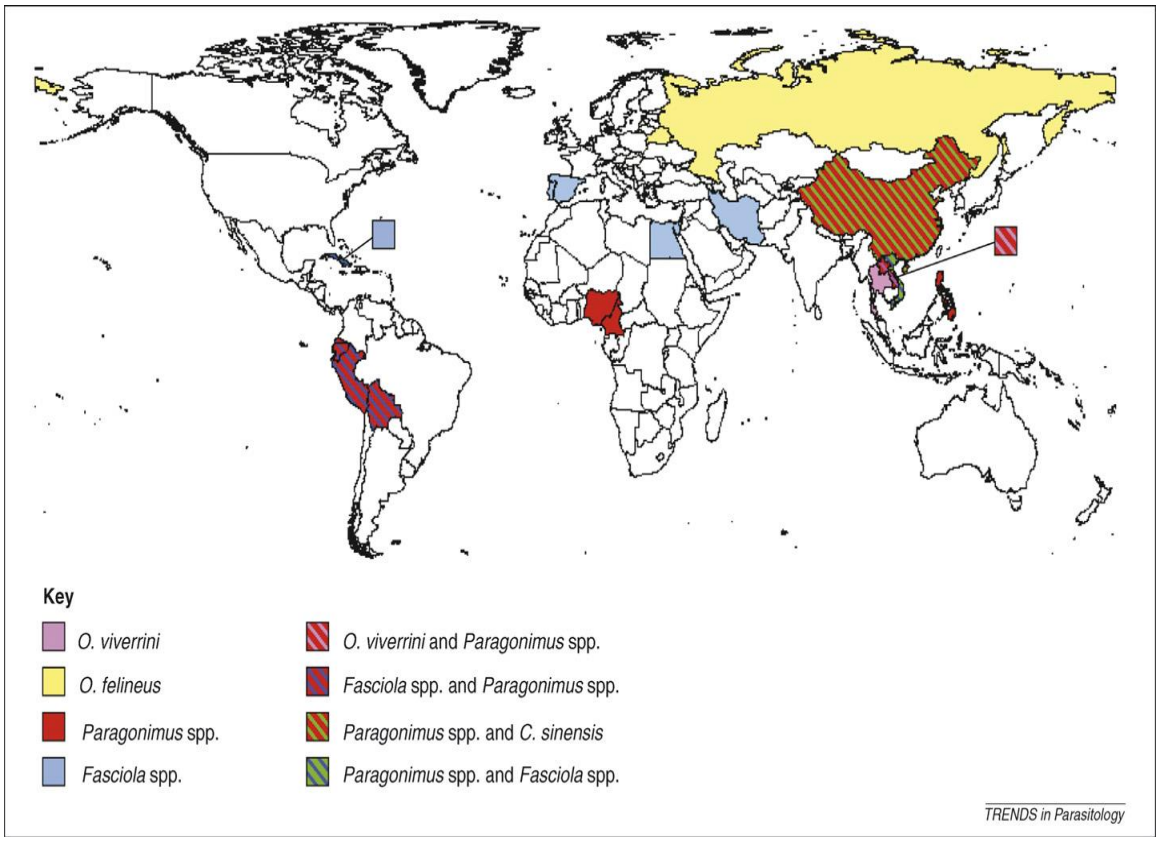

Figure 1.2: The world map on the distribution of food-borne trematodes (Keiser and Utzinger, 2007a)

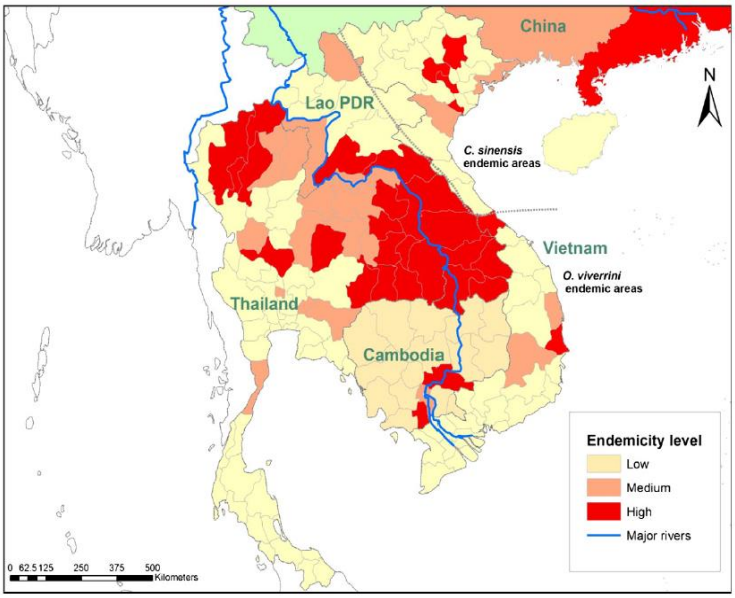

Figure 1.3: The prevalence of *O. viverrini* and *C. sinensis* in Asian countries (Sithithaworn et al., 2012)

1.1.3 *Opisthorchis viverrini* in Lao PDR

Several parasitological surveys documented FBTs in Lao PDR. There are liver flukes (*O. viverrini*), minute intestinal flukes such as *Haplorchis taichui, Haplorchis pulmolio, Haplorchis yokogawai, Prosthodendrium mlenkampi, Phanropsolus bonnie, and Echinostome*spp.*,* and lung flukes (*Paragonimus* spp.)(Chai et al., 2005; Chai et al., 2007; Giboda et al., 1991a; Giboda et al., 1991b; Lovis et al., 2009; Sato et al., 2010). *Paragonimus* spp was firstly report reported in Lao PDR in 1946 (Odermatt et al., 2007). Between .1978 and 1979 *Paragonimus* spp. infection was found in many provinces (Bunnag et al., 1981). Today it is highly prevalence in mountainous areas such as Hinhub District along Namxet river and Nambak District (Odermatt et al., 2007; Strobel et al., 2005).

Among the FBT, *O. viverrini* is the most important public health problem in Laos. Over two million people are infected with *O. viverrini,* mostly in central and southern Lao PDR (Sithithaworn et al., 2012). *O. viverrini* infection is characterized by its focal distribution. Its prevalence depends on the habit of eating raw or insufficiently cooked fish dishes and low access to sanitation facility. Recent studies indicate that the infection prevalence ranges from 50.0% to over 90% in high risk area. The infection occurs in villages where the habit of eating raw and insufficiently cooked freshwater fish are frequent. The

infection increases with age and is often co-infected with intestinal flukes (Lovis et al., 2009; Sayasone et al., 2009b; Soukhathammavong et al., 2011).

1.1.4 Risk factors for *Opisthorchis viverrini* infection

Many studies document that eating raw and sufficiently cooked fish cause infection with *O. viverrini.* Absence of proper sanitation the infection favours the spread in environment (Grundy-Warr et al., 2012; Wang, 2012). Most of cyprinoids fish in Lao PDR and Thailand are confirmed to have infected with *O. viverrini*-metacercariae (Sayasone et al., 2007; Sithithaworn et al., 1997). The fish dishes such as "*Koi Pa*" and "*Som Pa*" are high risk for infection with *O. viverrini* due to containinghundreds of viable *O. viverrini* metacercariae except for the long-term fermented fish (Prasongwatana et al., 2013)

In Lao PDR the consumption of raw or insufficiently cooked fish dishes is deeply rooted in the local culture. People start to eat raw fish dishes very early in life with adoption of food habits of the adults. Therefore, the infection rate of *O. viverrini* rises quickly with age. E.g., in a cross-sectional study in Saravanedistrict, Saravaneprovince, 45.0% and 20% of children under 6 years of age were eating regularly raw fish dishes and were infected with *O. viverrini*, respectively (Sayasone et al., 2007). Infection rate rose to 55% and 70% in school-aged children (6-15 years of age) and adolescents and young adults (16-25 years of age), respectively. In older age group the infection rate was 80% and higher. Male had a higher risk to be infected with *O. viverrini* than female (Strandgaard et al., 2008; Xayaseng et al., 2013). Based on these information the target population for the control of infection with *O. viverrini* in a highly endemic district is the practically the entire population, except young children (e.g. pre-school children) where the infection rates remain low (Sayasone et al., 2007).

1.2 Description of soil-transmitted helminth

1.2.1 Soil-transmitted helminth

Soil-transmitted helminth (STH) is a group of nematode parasites of the intestinal tract and transmitted by faecal contaminated soil (Jia et al., 2012). The most frequent species are *Ascaris lumbricoides* (*A. lumbricoides*, roundworm), *Trichuris trichiura* (*T. trichiura*, whipworm), and hookworm (*Ancylostoma duodenale* and *Necator americanus*);

A. lumbricoides and hookworm parasite the small intestine while *T. trichiura* inhabitsthe colon (Hotez et al., 2006).

The life cycles of *A. lumbricoides* and *T. triuchiura* are shown in Figure 1.4 and figure 5. Adult female of *A. lumbricoides* and *T. triuchiura* produce eggs that are excreted in human feces and contaminated in soil and plants if outdoor defecation or using human excreta for fertilizing crops. Eggs continue to develop to infective stage. Human is infected by ingesting of infective eggs. Eggs are hatched when reached to stomach and released larvae; larvae migrate through lung and trachea, and then are swallowed again to gastrointestinal tract where they develop into adult worm (Jia et al., 2012).

Life cycle of hookworm follows a similar same pattern as *A. lumbricoides* and *T. triuchiura* however eggs are not infective and its mode of transmission differs. Larvae hatch when eggs are in the soil; a next stage, larvae (filariform larvae) develop and may directly penetrate into the skin when exposed to the contaminated soil, e.g., often skin of feet when walking barefoot (Figure 1.6).

Children under 15 years of age and women in reproductive age are most susceptible to hookworm infection. The infection causes chronic and insidious effects on a host which can dramatically affect physical and cognitive development in children (Hotez et al., 2006). Hookworm infection can cause blood loss and may lead to iron deficiency anaemia and protein malnutrition while *A. lumbricoides* impair the nutritional status of children and rarely cause obstruction in small intestine. *T. trichiura* can cause blood loss, dysentery, and rectal prolapse.

1.2.2 Global distribution of soil-transmitted helminth

STH occur in tropical and sub-tropical countries of the Americas, Sub-Saharan Africa, China and Asia where communities have limited access to safe water and proper sanitation, and have poor personal hygiene practices, lived under poor conditions, and have occupation which engaged to agricultural practices (Hotez et al., 2006). Current estimation show that 4.5 billion people are at risk for STH, of which about 1.2 billion people are already infected with *A. lumbricoides*, almost 800 million with *T. trichiura*, and 700 million with hookworm (Keiser and Utzinger, 2008). Children aged less than 15 years were prioritized for helminth control.

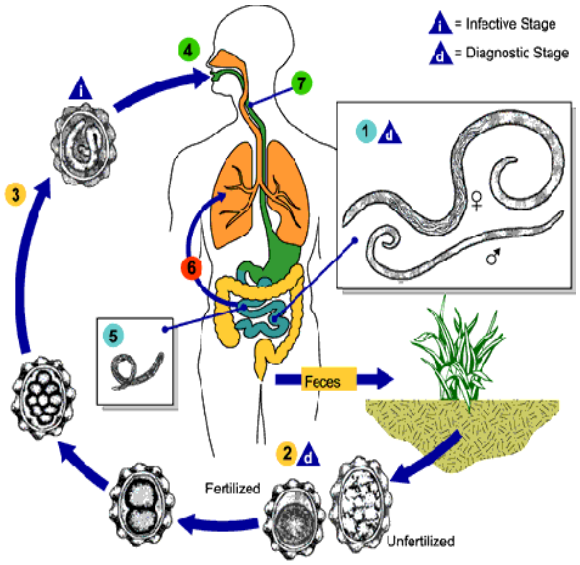

Figure 1.4: Life cycle of *A. Lumbricoides* (Source: www.dpd.cdc.gov)

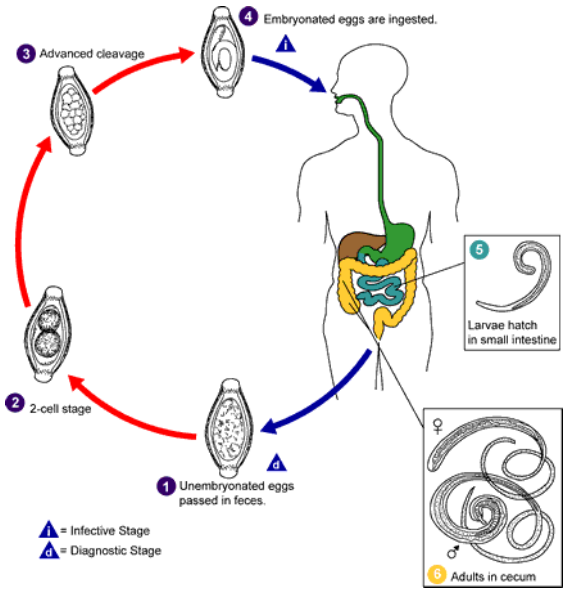

Figure 1.5: Life cycle of *T. trichiura* (Source: www.dpd.cdc.gov)

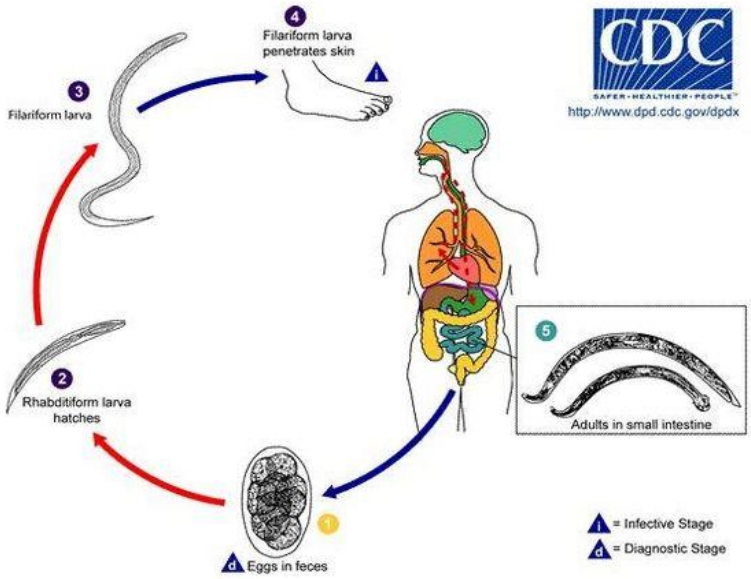

Figure 1.6: Life cycle of hookworm (Source: www.dpd.cdc.gov)

1.2.3 Soil-transmitted helminth in Lao PDR

In Laos, STH infections are highly prevalent. An estimated 1,646,000 people are at risk for STH, of which 625,000 are pre-schoolchildren, 1,000,000 are schoolchildren, and 21,000 are women at reproductive age (Montresor et al., 2008). Their presence has been extensively documented although considerable variations between locations prevail exist (Rim et al., 2003; Sayasone et al., 2007). STH infection is common in the northern Lao PDR particularly *A. lumbricoides* followed by *T. trichiura*. The public health significance importance of STH is known and the need for preventive chemotherapy recognise; the school-aged children are targeted in current control efforts (Bethony et al., 2006).

1.3 Global and national strategies for helminth control

1.3.1 Global strategy for helminth control

Regular preventive chemotherapy combined with health education that was recommended by World Health Assembly Resolution 54.19 in May 2001 remains the most practical approach to control morbidity and interrupting the transmission of schistosomiasis and STH. Compliance to treatment was recommended to be not less than 75%. Praziquantel (PZQ) remains a drug of choice for treatment of food-borne and

water-borne trematodiases (Hotez et al., 2006). A combination of two single-oral dose drugs praziquantel and albendazole 400mg or mebendazole 500mg is the most effective for the control of simultaneous infection with STH. An estimate annual cost (including delivery cost) for individual deworming for a person in a year was USD 0.50 (WHO, 2006).

Access to preventive chemotherapy of endemic countries was reported in 2008. An estimate 670 million people from 75 countries had access to regular preventive chemotherapy. Most of them were from lymphatic filariasis and onchocerciasis endemic countries. Less than 20% and 10% access to the deworming were those suffering from STH and schistosomiasis, respectively (World Health Organization, 2010).

World Health Organization and the Western Pacific Regional Office urged all member states affected by FBTs to provide regular large-scale preventive chemotherapy combined with health education intervention in endemic areas. In addition the country should promote eating cooked food and construct and use latrinesand improve knowledge on reservoir hosts which make the control more difficult (WHO/FAO, 2004). The control of FBTs is still limited to pilot activities areas in China, Lao PDR and Cambodia (Montresor et al., 2008). It is challenging for poor countries to conduct regular deworming due to resources are limited health resources (WHO, 2006).

1.3.2 Helminth control strategy in Lao PDR

Preventive chemotherapy along with health education is the main strategy of the Lao Ministry of Health for helminth control. Seven helminth species are prioritized to be addressed namely *A. lumbricoides, T. trichiura,* hookworm, *O. viverrini, Paragonimus* spp.*, S. mekongi,* and *lymphatic filariasis*. To assure implementing the Lao National Policy and Strategies for Prevention and Control of Helminthiasis was developed and issued in 2003 and revised in 2008 by the Ministry of Health.

Preventive chemotherapy is provided via vertical program. Nationwide health promotion for STH deworming is provided twice a year for children under 5 years of age and women in reproductive age through EPI day or EPI in villages and mother and child health services at health facilities. Primary schoolchildren and school-aged children nationwide have accessed to deworming twice a year since 2004 through the education

sector which under the school deworming program (Phommasack et al., 2008). Some endemic liver fluke areas had received an irregular mass treatment in the late of the 2000s (Strandgaard et al., 2008) as also Reported by the Head of Savannakhet Provincial Malaria Station in 2009. Two most southern districts endemic for *S*. *mekongi*had received the mass treatment against *S. mekongi* in the 1990s and then the intervention interrupted until 2008 when the mass treatment was provided again in these two districts (reported by Khong District Health Office in 2008).

In 2008, pre-schoolchildren (55%) and schoolchildren nationwide (99%) and those who were at risk for *S. mekongi*(93%) and *O. viverrini* (33.%)received mass treatment, respectively (Montresor et al., 2008). Although many children and schoolchildren recently had access to deworming STH remains a burden in Lao PDR (Jex et al., 2011).

However, the provision of mass treatment against different worms via vertical program (top-down manner) requires substantial financial and human resources. The control of opisthorchiasis needs long-term interventions, so that it is unlikely that the Lao government can support such intervention. Furthermore, distributing medicine in this manner leaves the community in passive role.

1.4 Review of intervention for the control of parasitic infection

1.4.1 Community-directed treatment with ivermectin (CDTi) in Africa

Community-directed treatment with ivermectin against onchocerciasis in Africais recognized as a successful approach for the control of onchocerciasis. It was accepted by African Program for Onchocerciasis Control (APOC) in 1995 andhas been implementing in many onchocerciasis-affected African countries. Today it can be used as a model in developing other community-based health programs and a potential entry point in the fight against other diseases (TDR/WHO, 2008). Brieger *et al.* reported that by 2005 about 16 countries with 95,000 communities and 33 million people were covered by this intervention (Brieger et al., 2011). The main concept of this intervention is to make the affected communities themselves to be in charge to the intervention and infuse with a sense of their own value and their empowerment to tackle problem within communities (TDR/WHO, 2008). Communities themselves plan and manage the intervention. They select village worker for the training, design when and how to

distribute drug (house to house or central village), keep drug in safe manner and save for re-treatment to those absentees and temporary non-eligible (sick and pregnant), manage the adverse effect or referral to close facility, and adapt technique to fit with the setting. The role of district health office was to provide the drug to distributing point, conducting health education, supervising the intervention and CDTi, and provide financial support when needed (Katabarwa et al., 2002).

The CDTi gives a significant achievement compared to a vertical control program (Akogun et al., 2001; Lakwo and Gasarasi, 2006; Okeibunor et al., 2004; Seketeli et al., 2002). It increases and maintains a high coverage, reduces the costs, and increases ownership of the intervention by the community which contributing to sustain the intervention (Brieger et al., 2002). In addition, communities perceived a real benefit from the intervention and that they were willing to invest in these activities e.g. to pay for treatment, pay high attention to good sanitation, and route of transmission (Onwujekwe et al., 1998). CDTi has become a tool to integrate and enhance other vertical control programs (Ndyomugyenyi and Kabatereine, 2003; Okeibunor et al., 2004; Sama et al., 2007).

1.4.2 Intervention for the control of *O. viverrini*

There were several interventions against infection with *O. viverrini* implemented in Thailand but today the infection with *O. viverrini* remains highly prevalent in areas of north-eastern of Thailand. A national control program against opisthorchiasis was implemented between 1987 and 2001 by the Department of Communicable Disease Control, Thai Ministry of Health. This activity was put in the five-year national public health plan (1987-1991). They focused on stool examination, treatment of positive case, and health education such as demonstration of save fish dish preparation and improve sanitation facilities. Since then the prevalence of opisthorchiasis had decreased from 63.6% in 1984 –1987 to 9.4% in 2001 (Jongsuksuntigul and Imsomboon, 2003).

Before the national control program against opisthorchiasis, there were several interventions available in different provinces across Thailand. Between 1950 and 1958 the control program had been implemented in five provinces (central, northeast, and south parts) which focused on intestinal helminth and opisthorchiasis. Between 1967 and 1974 the control of opisthorchiasis was made in northeast Thailand with mass

treatment and health education by demonstration of safe fish dish preparation and provided low cost of cooking pot. Since 1974 only extensive health education was implemented as a measure for the liver fluke control. Between 1984 – 1987 the control of opisthorchiasis was made in four province of Northeast Thailand focused on treatment positive cases (Jongsuksuntigul and Imsomboon, 2003).

Community participation against the *O. viverrini* was piloted in two villages and two schools in Thailand. The intervention started with mass treatment to all entire population and followed by re-treatment positive cases. Health education was lead by community leaders; village leaders played a folk song about anti-liver fluke over a loudspeaker and interchanged with reading monthly bulletin for anti-liver fluke; at school, trained teachers taught about the liver fluke and provided display room for liver fluke infection including demonstrating *O. viverrini* parasite via microscope by collecting stool specimen from local people and intermediate host for *O. viverrini* infection. The two schools were announced *O. viverrini*–free and in the two villages the prevalence of *O. viverrini* infection was decreased from 58.3% to 36.8%, 10.1%, and 7.4% in year 1,2 and 3, respectively (Sornmani, 1987).

Today a comprehensive community-based intervention for the control of opisthorchiasis is ongoing in Lawang areas of Khon Kaen Province Northeast Thailand where the liver fluke was highly prevalent and can still be found in certain areas. It mainly focuses on the increase of community's awareness about opisthorchiasis, demonstration on how to properly cook fish, and improve sanitation. In addition the treatment of infected cases is also available. Health education is conducted by trained village volunteers.

Based on the reviews of interventions against different worm infections mentioned above, we conclude that the intervention against *O. viverrini* that include some activities like treatment positive cases after stool examination, construction of latrines, demonstration of proper preparation of cooked fish dishes, and demonstration the show room for helminth species is not possible for the large-scale and long-term intervention due to it requires substantial fund and staff for running the intervention, and in addition, it is challenging for poor countries to run such intervention due to resource constraints. In contrast, community-directed treatment ivermectin against Onchocerciasis is suitable for developing countries to apply to their own setting for the control of different worm infections by applying larger-scale and long-term intervention.

1.5 Effectiveness of and possible adverse effects induced by praziquantel

Praziquantel (PZQ) remains an effective drug for food- and water-borne trematodiases treatment at a single dose of 40 mg / kg of body weight (Haswell-Elkins and Levri E, 2003). At this dosage, the cure rate of *O. viverrini* infection (no helminth's egg was found in stool sample after treatment) has shown to be as high as 91% (Bunnag et al., 1984; Bunnag and Harinasuta, 1981; Okeibunor et al., 2004). A recent study conducted in Lao PDR, the cure rate for *O. viverrini* was 71.4% at the dose of 40mg / kg while at a dose of 75 mg / kg it was 96.6%(Lovis et al., 2009); another study conducted among Lao schoolchildren in southern province the cure rate was 64.0% at the dose of 40 mg/kg.

Adverse effects are generally quite frequent but they are mild and transient (Keiser and Utzinger, 2004). Most frequent adverse effects are abdominal pain, cramp, dizziness, nausea, vomiting, vertigo, headache, rash and hypertensions (Soukhathammavong et al., 2011; Sousa-Figueiredo et al., 2012; Yangco et al., 1987). Due to the sudden expulsion of antigens (dead worms) in patients with early stages of cholangiocarcinoma, more severe complications might occur after treatment (Haswell-Elkins and Levri E, 2003). Detailed information on this issue, however, is lacking.

However there were three case reports of experiencing with serious health problem after ingestion of PZQ; such as a 54 years-old clonorchiasis had hypersensitivity reaction and got treatment with anti-histamines (Lee et al., 2011) while another case was 35 years-old clonorchiasis experienced with anaphylactic reaction and got subsided after stomach wash and treated with anti-anaphylactic medicine at emergency department (Shen et al., 2007); also a 46 years-old case of paragonimiasis had anaphylactic reaction (Kyung et al., 2011).

1.6 Definition of knowledge, attitudes, perceptions and practices

Knowledge refers to a familiarity of someone or something which can include facts, information, description, and skills acquired through experience or education. It can refer to theoretical or practical understanding of a subject. It can be implicit (as with practical skill or expertise) and explicit (as with theoretical understanding of a subject).

Attitude is defined as a positive or negative evaluation of people, objects, event, activities, ideas, or just about anything in environment, but there is still debate about precise definitions. It could be explicit (i.e., deliberated formed) and implicit (i.e., subconscious attitude) attitudes. Attitudes can be changed through persuasion and an important domain of research on attitude change focuses on responses to communication.

With regards to perception, Hana Strandgaard mentioned in her paper that based on the recommendations of the medical anthropologist Good she used the term “perception” in her study to describe “what people know”, she said that “perception” is described as a neutron cover term for both “knowledge” and “belief”, knowledge means the way of lay’s people looking at things to a true gold standard (related to “etic” perspective) whereas “belief” has implication of more genuinely reflecting what do the study population think (related to “emic” perspective) (Strandgaard et al., 2008).

Belief is usually defined as a conviction of the truth of a proposition without its verification; therefore a belief is a subjective mental interpretation derived from perceptions, contemplation (reasoning), or communication.

The “health belief model” involves three components i.) individual perception (perceived susceptibility/severity of diseases), ii.) modifying factors (socio-demographic data, perceived threat of diseases, and cues of action), and iii.) likelihood of action (perceived benefits minus perceived barriers to behaviour change, and likelihood of behaviour change). Once an individual perceives a susceptibility/severity of diseases, he/she will perceive threat of disease and then he/she is likely to have behaviour change; the socio-demographic data (age, sex, ethnicity, personality, knowledge, and socio-economic) links to the perceived susceptibility /severity of diseases, perceived threat of diseases, and perceived benefits minus barriers to behaviour change; once one perceived threat of disease and perceive benefit or barrier and then he/she it is likely to move to the likelihood of behaviour change; the cues of action, a strategies to activate one’s “readiness”, make one perceive threat of diseases which leads to likely to change of behaviour (Strecher and Rosenstock, 1997).

Perceived the susceptibility refers to individual’s subjective perception on his/her risk of contracting a health condition; Perceived severity refers to a feeling concerning the

seriousness of contracting an illness or of leaving it untreated; it includes both medical and clinical consequences (such as death, disability, and pain) and social consequences (such as effects of the condition on work, family life, and social relationship); Perceived benefits – one's opinion of the efficacy of the advised action to reduce risk or seriousness of impact; Perceived barrier – one's opinion of the tangible and psychological costs of the advised action such as expensive, dangerous like negative side effects, unpleasant like painful, difficult, upsetting, inconvenient, time consuming and so fort; Cues to action means strategies to activate one's "readiness" (application: provide how-to information, promote, awareness, employ reminder system); self-efficacy refers to one's confidence in one's ability to take action (Strecher and Rosenstock, 1997).

1.7 Access to health care services

Access to health care services is described by different authors that it depends on different determinants such as population characteristics, health system, external environment, and the fit between patient and health care system (Andersen, 1995; Obrist et al., 2007; Penchansky and Thomas, 1981).

Andersen stated that population characteristics, health system, and external environment are primary determinants which might influence the personal health practice and use of health services. Population characteristics include demographic, social structure, health beliefs, enabling resources (income, insurance coverage, rural or urban, region), and need. Health beliefs are attitudes, values, and knowledge about health and health services and might influence the subsequent perception of need and use of health services. The term of need, describes how people view their own health and functional state, how they experience symptoms of illness, pain, and worries about their health, and whether or not they think that the health problem is enough important to seek care (Andersen, 1995).

Roy Penchansky defined that "Access" described the "fit" between the patient and the health care system, the specific dimensions are availability, accessibility, accommodation, affordability, and acceptability (Obrist et al., 2007; Penchansky and Thomas, 1981).

John L. Fiedler mentioned that access to health care can best be understood as interaction by two sets characteristics such as individual and health care delivery system. There are two approaches to measure the access such as process indicator (encourage/facilitate or hinder the utilization) and outcome indicator that is the characteristic that individual's passage through the delivery system such as utilization rate, and or patient satisfaction. Outcome indicator is the most appropriate to use if the study mainly look at the impact of the program or to identify the differences in access among different population, in contrast if we need to assess on how and why a particular program affects access then the process indictors is the best (Fiedler, 1981).

Attitudes towards and knowledge about health care and social cultural definitions of illness that he/she has learned, and the perception towards the medical care actually received are important factors for the encouragement of compliance to the health services (Aday and Andersen, 1974).

1.8 Factors influencing the compliance to mass treatment

Several research studies have been conducted on knowledge, attitudes, perceptions, and practices related to parasitic infections and compliance to mass treatment (Table 1.1).

Table 1.1: Summary of the studies on knowledge, attitudes perceptions, and practices in relation to the parasitic infections and compliance to mass treatment against different worms

Author/title	Results
E. Mathieu et al : Factor associated with participation in a campaign of MDA against lymphatic filariasis in Leogane, Haitii (Mathieu et al., 2004)	Most interviewee knew about filariasis and knowing at least one sign of symptoms, well aware of MDA, knowing from other people, radio, most of interviewee encourage others to attend MDA, 63% took treatment Factors associated with compliance : being male, knowing about the MDA through posters and banners, knowing that mosquito transmit the disease Not compliance to MDA: absenteeism during the day of distributing drug, use contraceptive drug, pregnancy
Cinthia A. Acka et al: Parasitic worms: KAP in Western Cote d'Ivoire with implications for integrated control (Acka et al., 2010)	Open defecation was perceived as more comfortable, in this study site only one out of four sites had latrine water from unprotected well were perceived to be more tasty then from pump Population at community-based intervention is better than the school-based intervention because study. Three quarter of study population knew about STH and indicated that the research and

	control project were the main source of information however only less than 15% mentioned about only project.
Pauline NM Mwinzi et al: Integrated community-directed intervention for schistosomiasis and STH in Western Kenya – a pilot study (Mwinzi et al., 2012)	Pre-treatment average prevalence of *S. mansoni* was 17.4% (5-43%); treatment coverage ranged from 54.2%-96.6% (CDD records), assessment from household survey the compliance was 91.9%. Six months after one round of MDA: the prevalence of helminth decreased by 33.2%, 69.4%, 42.6% for *S. mansoni*, hookworm, and trichuriasis respectively
Daniel Yirga et al: Factors associated with compliance with community-directed treatment with ivermectin for Onchocerciasis control in Southwest Ethiopia (Yirga et al., 2010)	Factors were associated with compliance: I.) perceived high risk, ii.) one's family support, iii.) perceived the well performance of CDDs, iv.) perceiving the technique for measuring height is the best way to determine the person's treatment, v.) employment
Sharmini Gunawardena et al: factors influencing drug compliance in the mass drug administration programme against filariasis in the Western province of Sri Lanka (Gunawardena et al., 2007)	Perceived benefit of MDA program in urban areas Perceived the severity (danger) in rural areas
Brooker et al: Community perception of school-based delivery of anthelminthics in Ghana and Tanzania (Brooker et al., 2001)	Study population perceived of the important of helminth infection that it caused seriousness and chronic health problem so that they were willing to pay for the continuation of the deworming
Fred Nuwaba et al : Predictor of compliance with community-directed ivermectin treatment in Uganda: quantitative results (Nuwaha et al., 2005)	Major factors support compliance were: perceived CDDs worked well, perceived that measuring was the best way to determine one's dose of ivermectin, having social support from one family , saying that Ivermectin cause nothing, perceived personal risk of Onchocerciasis, believed that ivermectin prevent Onchocerciasis, Perceived radios as supporting treatment with ivermectin The strongest factor: perception on CDD performed work well
William R. Brieger et al: Compliance with eight years of annual ivermectin treatment of Onchocerciasis in Cameroon and Nigeria (Brieger et al., 2011)	42.9% took treatment 6 – 8 times annually Factors associated with compliance: being male, age over 24 years, having been married, not being Christian, having little or no formal education, being ethnic minority The strongest association: ethnic status, education Discussion: higher educated people had high mobile and hard to reach
Paul T. Cantey et al: Increasing compliance with MDA programs for lymphatic filariasis in India through education and lymphedema management programs (Cantey et al., 2010)	90.2% complied to Com-MDA+LM, 75.0% Com-MDA Barriers to compliance: i.) fear of side effect, ii.) lack of recognition of one's personal benefit from adherence Compliance to MDA: knowing MDA in advance of its occurrence, knowing every one is at risk, knowing MDA was for LF, knowing at least one component of lymphedema management technique taught from the program

Nnamdi Callistus D UKWANDU: The perception, belief, and practices towards genitourinary schistosomiasis by inhabitants of selected endemic areas in South-eastern Nigeria (Ukwandu and Nmorsi, 2004)	42.0% knew about the disease, 0.4% knew the cause of the infection, 5.0% had treatment, and 5.0% denied to seek treatment of any sort Those who knew about the disease and did not know the causes had sought any kind of treatment and believed that the disease is a natural phenomenon in ones development stage and therefore no morbidity and mortality.
Andre M.N. Renzaho: Community-based study on knowledge, attitudes, and practices on the mode of transmission, prevention, and treatment of the Buruli ulcer in Ga West District, Ghana (Renzaho et al., 2007)	67% heard about BUD but 53% did not know its cause. They linked the cause with different things: drinking non-potable water (17%), poor personal hygiene or dirty surrounding (8.1%), swimming or wading ponds (5.5%), witchcraft or curse (5.2%). 71.8% of patient firstly sought treatment with herbalist, then hospital. They did not go to hospital due to prolong stay in hospital, cost for treatment, loss of earning and opportunity associated with parent, attending their children hospitalization over extended period, delay in being attended by medical staff, and not knowing the cause of disease or require treatment. The level of acceptance of BUD sufferers is high in adult but not do so in children.
Hana Strandgaard et al: Local perceptions and practices in regard to Opisthorchiasis in two villages in Lao PDR (Strandgaard et al., 2008)	Introducing health education alongside treatment had an effect on knowledge and change in behaviour Eating raw fish was common, and mainly practiced by men, however women were not aware they were exposed to opisthorchiasis while preparing food. Although there is no locally derived term, a medically appointed term for Opisthorchiasis was acknowledged. Due to the vague disease symptoms, no treatment seeking behaviour was found in relation to the disease People did use pit latrine at home but not did so when they were in rice field.

Based on the previous research findings summarised in Table 11 above we conclude that local existing community's knowledge, attitudes and practices regarding helminth infection and associated risk factors, and knowledge about the intervention and its purpose and perceived benefit of the intervention are crucial factors for increasing the compliance to mass treatment. Fear of adverse effect induced by deworming drug is likely to discourage community to take mass treatment. It indicates that community-based intervention is more effective approach than school-based intervention.

1.9 Challenges for successful helminth control

Re-infection rates are high and therefore a long-term approach: Studies have shown that even in communities where regular preventive chemotherapy is conducted the average monthly incidence of re-infection is around 2.0%, ranging from 1.1% to 5.0% (Sornmani et al., 1984). Due to the high frequency of raw and insufficiently cooked fish

consumption and the absence and/or utilisation of adequate sanitation facilities the transmission is insufficiently reduced. Sithithaworn's review indicated that the re-infection of *O. viverrini* after treatment with PZQ was very high in irrigated area and rural area if northeast of Thailand. For instant, prevalence at pre-treatment was 55.1% and 97.4%. However after one year the re-infection was 54.8% and 94.0%, respectively (Sithithaworn and Haswell-Elkins, 2003). Long-term interventions are necessary to change also the underlying risk factors for infection. Hence, in the meantime repeated preventive chemotherapy is required (WHO/FAO, 2004).

In contexts of limited available (financial) resources costs (increase cost-effectiveness) must be reduced: Substantial amount of resources are required to intervene (medicine, IEC materials, distribution etc). External funding is indispensable, though exceedingly difficult to acquire for long time periods. Therefore, costs for delivering interventions must be reduced; cost-effectiveness increased.

The Impact of preventive chemotherapy depends on high coverage in community and therefore a positive perception of result in high compliance of community is warranted: A positive perception on and attitude towards preventive chemotherapy and health education of the population is a prerequisite for high community participation and, thus, a high coverage. Knowledge on the targeted disease might also play an important role. In the case of preventive chemotherapy for opisthorchiasis and to some extend also for STH these aspects are unknown for Lao PDR.

Communities with higher involvements may take more ownership of the intervention: Ownership of the program by the community may improve sustainability of the intervention, thus, the chances that it will be executed over a long period of time.

Chapter 2: Goals and objectives

2.1 Goal

The overall goalof this PhD thesis is to develop an innovative approach for the control of liver fluke and intestinal co-infection in liver fluke endemic areas of southern Laos, to implement it and assess its effectiveness.

2.2 Specific objectives

- To assess the current status of helminth infection in Laos
- To determine the prevalence of infections with liver fluke and STH in relation to the existing local community's knowledge, attitudes and practicesregarding worm infection and associated risk factors in liver fluke endemic areas Saravane district, Saravane province southern Laos
- To deepen our understanding on consumption of raw or insufficiently cooked fish dishes in liver fluke endemic areas Saravane district, Saravane province southern Laos
- To assess the existing local community's knowledge and perceptions pertaining deworming intervention in endemic areas of schistosomiasis and other intestinal helminths in Khong district, Champasak province southern Laos
- To design, implement and evaluate an innovative approach using community-directed intervention modelto deliver treatment of and health education for liver fluke and intestinal helminth infection in endemic areasin Laos
- To develop recommendationsfor policy makers of concern institutions for further scaling up of the new approach for the control of liver fluke and intestinal helminth infection in liver fluke endemic areas southern Laos

Chapter 3: Methodology

3.1 Overview of research methodology

This PhD thesis is composed of six studies: one review and five community-based studies. It is divided into two sections: First section relates to baseline information on helminth infection in Laos and related to liver fluke endemic areasof southern Laos. The second section relates to the implementation and evaluation of community intervention (Figure 3.1).

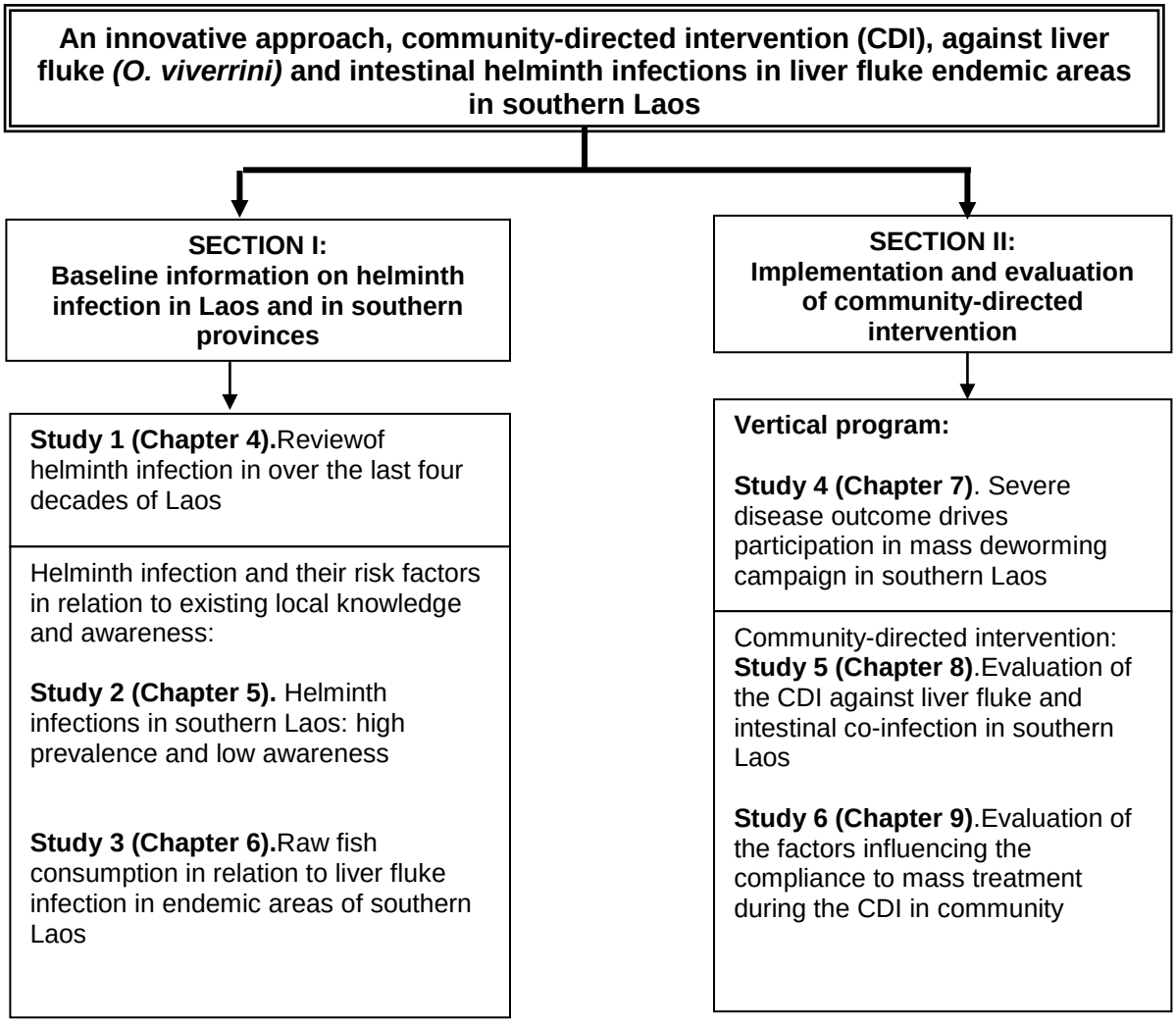

Figure 3.1: Overview of research methodology in this PhD thesis

3.1.1 Study site

Four community-based surveys (studies 2 [chapter 5], 3 [chapter 6], 5 [chapter 8] and 6 [chapter 9]) were conducted in liver fluke endemic areas of Saravane district (Saravane province, southern Laos) between 2010 and 2012. Saravane district is located on the Bolaven Plateau. It covers 2,441 km^2 and has a population density of three people per square kilometre (km^2). The 89,068 inhabitants (female: 45,520) live in 178 villages and in 13,239 households. Ethnic groups include the Laotheung and the Laoloum. The annual income per capita is USD 627. There are nine health centres, which cover 71% of the villages. The district has 19 pharmacies, 91 villages with drug kits, two private clinics and 13 outreach teams. In 2002, a national parasitology survey indicated that 21.5%, 11.9%, 10.9% and 5.4% of primary school children in Saravane province were infected with *O. viverrini*, *A. lumbricoides*, hookworm and *T. trichiura,* respectively (Rim et al., 2003). In 2004, the prevalence of *O. viverrini* infection was estimated at 58.5% (village range from 20.0% to 85.5%) in Saravane district. The infection rate increased with age. Eating raw or insufficiently cooked fish dishes was very common (79.7%). Only one in 13 villages had latrines. Sixty per cent of the cyprinoid fish species consumed in this district are infected with *O. viverrini* metacercariae (Sayasone et al., 2007) Mass treatment against helminth infection does not yet exist in Saravane district (Director of Saravane Provincial Health Department [PHD])(Figure 3.2 and Figure 3.3).

One community-based survey (Study 4, Chapter 7) was carried out in endemic area of *S. mekongi* and multiparasitism Donelong island, Khong district, Champasak province, southern Laos in 2008(Figure 3.3).This island is one of the Mekong islands. This area is a most important source of freshwater fish (including Cyprinoid fish species) in southern Laos. Fishery is a main livelihoods together with rice cultivation and livestock(Singhanouvong and Phouthavong, 2002). Widespread rocky banks are suitable habitats for *Neotricula aperta* snail, the intermediate host for *S. mekongi* transmission (Ohmae et al., 2004). Donelong island is highly endemic for the Mekong schistosomiasis (Sayasone et al., 2011). Four villages are on Donelong namely Houalong, Longsong, Longkang and Hanglong. The total population is 2,054 inhabitants (316 households). Most villagers are subsistence farmers and fishermen. MekongRiver is a main water source for household and cultivation activities. A pharmacy and health facilities do not exist on the island. The nearest pharmacy is located in Meaungsen

village on the mainland, approximately 30 minutes by motorboat. The closest health facility is the Khong district hospital which is accessible by motorboat and then by road, roughly within a one hour travel time. In Khong District (including Donelong island) *S. mekongi* control started in the 1980 ties (Muth et al., 2010; Urbani et al., 2002). Several MDA rounds combined with health education were conducted between 1984 and 1999 using praziquantel and mebendazole/albendazole (Urbani et al., 2002). In 2006, multiple helminth infections at high prevalence rates were documented on Donelong. Infection with *S. mekongi* and *O. viverrini* reached 68.0%and 92.0%, respectively. STH were very common (hookworm 76.8%, *A. lumbricoides* 31.7%, *Trichuris trichiura* 25.0%) and *Taenia* spp. (1.8%) (Sayasone et al., 2011) and minute intestinal flukes (e.g., *Haplorchis taichui* 30.6%) were also reported (Lovis et al., 2009). In 54% of the examined Donelong population 3-6 simultaneous helminth species infections were diagnosed, and in addition intestinal protozoa such as *Giardia intestinalis* (3.0%) were detected (Sayasone et al., 2011).

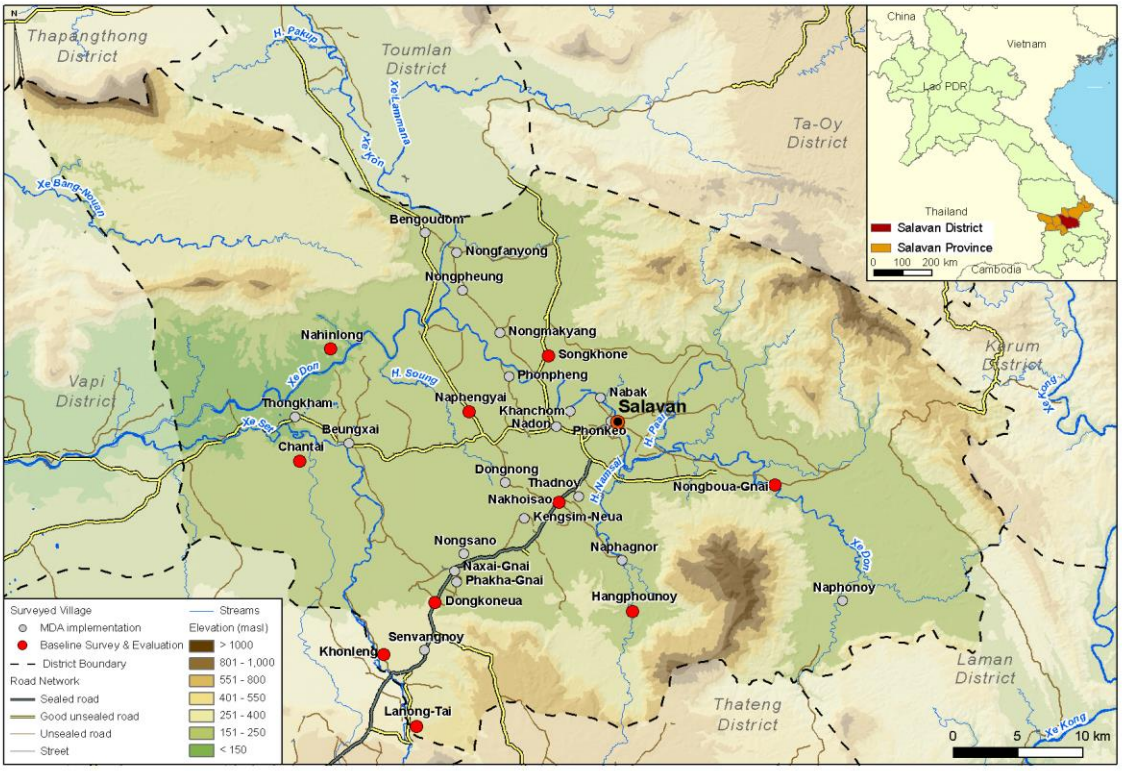

Figure 3.2: Map of study site in Saravane district, Saravane province southern Laos (red spots), and a community–directed intervention areas (white spots)

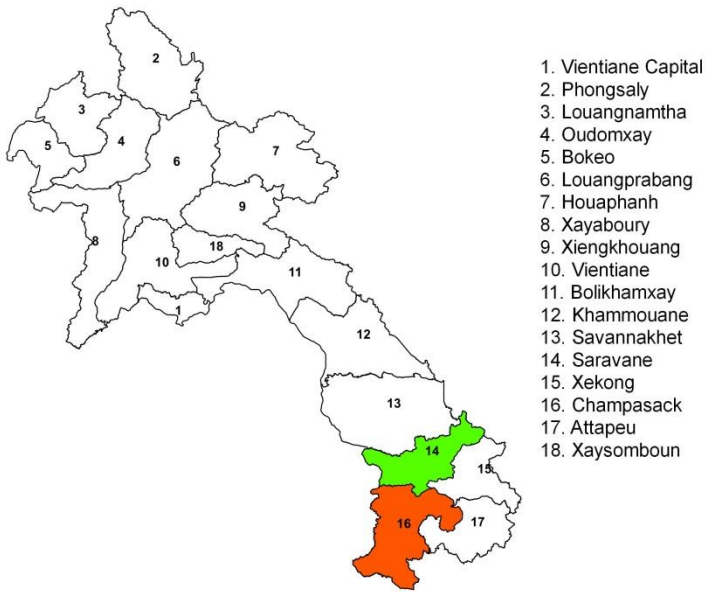

Figure 3.3: Map of study site in two southern provinces (Saravane and Champasack provinces)

3.1.2 Study design

A cross-sectional study was applied for all five community-based surveys (Figure 3.1).Four community-based surveys applied a combination of both quantitative and qualitative research methods whereas one survey used only qualitative research methods.Quantitative research method consisted of i.) stool examination (Figure 3.4) using Kato Katz method standard 41.7g template to diagnosis helminth infection in two stool samples obtained from each subject aged ≥2 years of age under the light microscope; presence and absence of parasite egg for each helminth species were recoded on the notes, and infection intensity for each helminth species was calculated, and ii.) structured interview with heads of households and household members to understand the knowledge regarding worm infection and associated risk factors. Qualitative research method composed of i.) indepth interview with community leaders; ii.) in depth interview with community drug distributors (CDDs, Figure 3.7), iii.) semi-structured interview with villagers (Explanatory Model Interview Catalogue [EMIC]), iv.) focus group discussion (FGD) among men (Figure 3.5) and among women (Figure 3.6)

separately in each village and v.) direct observation in all study villages was performed(Figure 3.4).

Figure 3.4: Field work for community-based survey in Saravane district: diagnosis of helminth infection

Figure 3.5: Field work for community-based survey in Saravane district: focus group discussion among men

Figure 3.6: Field work for community-based survey in Saravane district: focus group discussion among women

Figure 3.7: Field work for community-based survey in Saravane district: interview with head of household

3.1.3 Stool examination

From each enrolled person two stool samples were collected on two consecutive days and examined. For each stool sample, one Kato Katz thick smear slide was established, using standard 41.7 mg templates (Katz et al., 1972). After a clearance time of 30 minutes, the slide was examined under a light microscope (100 x magnification). All samples were examined on the day of collection. The number of eggs per parasite was counted and recorded for each parasite species separately. The intensity of helminth infections was expressed in terms of egg count per gram faeces (EPG) and the following light, moderate, and high intensity groups were established based on the EPG counts: Hookworm, 1-1999 EPG, 2000-3999 EPG, and ≥4000 EPG; *A. lumbricoides*, 1-4999 EPG, 5000-49,999 EPG, and ≥50,000 EPG; and *T. trichiura* and *O. viverrini*, 1-999 EPG, 1000-9999 EPG, and ≥10,000 EPG (Maleewong et al., 1992; Sayasone et al., 2007).

3.2 Description of research methodology for each study

SECTION I: Baseline information on helminth infection in Laosand southern Saravane province

3.2.1 Review on the helminth infection in over the last four decades of Lao PDR (Study 1, Chapter 4)

We searched data on helminthiasis in peer-reviewed published literature between the 1970 and 2013 through PubMed database using key words : “Laos” or “Lao PDR”, “helminths”, “*opisthorchis*”, “liver fluke”, “*Schistosoma mekongi*”, “blood fluke” “soil-transmitted helminth”, and “parasitic worms”, and combined with the terms of “epidemiology”, “prevalence”, “control”, “intervention”, and “research”. Some articles obtained from the library of SwissTPH or had to be ordered from the library of the University of Basel. We found 102 articles, of which 85 were obtained as full text, 67 articles were relevant to our review. The first author (Phongluxa K) read all articles and extracted the data.

We estimated the true prevalence of helminth infections using data from this review such as number of screening, number of positive cases, and sensitivity for the tools used to diagnose the STHs and *O. viverrini* and the location of the study site. All were typed in

Microsoft Excel sheet and transferred to the Stata version 10.1 for analysis. WinBUGS program version 14 was applied using Bayersian model for analysis. The WinBUGS's result was transferred to the "text" format and saved into "dbf" format. Quantum GIS version 1.7.0 Wroclaw was used for synthesizing the maps.

3.2.2 Helminth infection in southern Laos: high prevalence and low awareness (Study 2, Chapter 5)

We carried out a baseline survey using a cross-sectional survey in 10 randomly selected villages in Saravane district in 2010(Figure 3.2 and 3.3). Two stool samples obtained from individuals aged ≥2 years of selected household were examined using a single Kato Katz method, standard 41.7g templates. The Kato Katz slide was read under a light microscope (100 x magnifications) after 30 minutes; and presence or absence of helminth egg of each parasite species was recorded. We interviewed household heads concerning the knowledgeregarding worm infection. A total of eight FGDs were conducted in four villages, one FGD was among men and another FGD was among womenin each village; and a direct observation was conducted. Descriptive statistic and univariate and multivariate logistic regression analyses for quantitative data and content analysis for qualitative data that transcribed from notes and records were performed.

3.2.3 Raw fish consumption in liver fluke endemic areas in rural southern Laos (Study 3, Chapter 6)

To deepen our understanding pertaining behaviour of consumption of raw fish dishes in liver fluke endemic areas southern Laos, we conducted a qualitative research in four villages of Saravane district, Saravane province southern Laos in February 2010 (Figure 3.3). A total of 8 FGDs were conducted, one was among men and another was among women in each village. A direct observation was carried out. FGDs distilled the knowledge, attitudes perceptions and practices of adult community members on raw fish preparation, consumption and its consequences for health. Conversations transcribed from notes and tape-recorders were analyzed, using MAXQDA software.

SECTION II: Assessment of deworming interventions

3.2.4 Severe disease outcome drives participation in mass deworming campaign in Laos (Study 4, Chapter 7)

In 2007, we conducted a cross-sectional survey in 4 villages during the mass drug administration (MDA) against *S. mekongi* in four villages (Houalong, Longsong, Longkang and Hanglong) of DonelongIsland, Khong District of Champasack province(Figure 3.3)**.**This island is in the *S. mekongi* endemic areas. We interviewed all heads of household who participated in MDA and inquired about demographic data, household assets, and risk factor for helminth infection, and previous participation in MDA campaign. We also in-depth interviewed opinion leaders (heads of village, head of Youth Union, head of Lao Women Union, monk, teacher) who presence at the day of survey concerning their knowledge on MDA, helminth infection and its risk factors, and perception and practices towards the deworming in community. We observed the MDA attendants at the point of distributing drug. Quantitative date was entered in Epidata freeware (www.epidata.dk). Descriptive analysis was performed with SPSS program (version 11.5). Qualitative data was transcribed from notes directly after each interview. Field notes of the observational studies were treated as the qualitative interview data. Qualitative content analysis was performed.

3.2.5 Community-directed intervention against liver fluke and intestinal helminth infections

3.2.5.1 Description of community-directed intervention

Community-directed intervention was initiated during a consensus meeting with the Saravane Provincial Health Department (PHD) and the Saravane District Health Office. Saravane PHD and DHO sent information to concern authorities regarding the intervention. National Institute of Public Health (NIOPH) Ministry of Health in collaboration with Swiss Tropical and Public Health Institute (SwissTPH) provided a technical support to the province. A one-day training workshop was organized at Saravan District Health Office (DHO). Representatives from community level: community leaders (a head of village and village health volunteer of each village), head/deputy head of village group office, health center staff, and concern Saravane DHO staff were invited

to a workshop. In a workshop,a knowledge regarding mass treatment procedures, performance of mass treatment records and management side effects induced by PZQ and a knowledge regarding worm infection: liver fluke and STH were provided.Deworming drug was distributed at the Saravane DHO during the monthly meeting of health center staff. Trained community leaders distributed deworming medicine in villages in collaboration with the trained head of village group and health center staff or DHO if it is needed (Figure 3.8).

3.2.5.2 Implementation of community-directed intervention

The community-directed intervention was implemented in 30 randomly selected from 179 villages of Saravane district, Saravane province (white dots in Figure 3.2). The total population was 21,422 and belonged to two main ethnic groups Laoloum and Laotheung. Most villages are remote and difficult to access due to poor road condition. They are located in a distance between 15 and 75km from the Saravane City. Each village has two village health volunteers (VHV) and a village health committee.

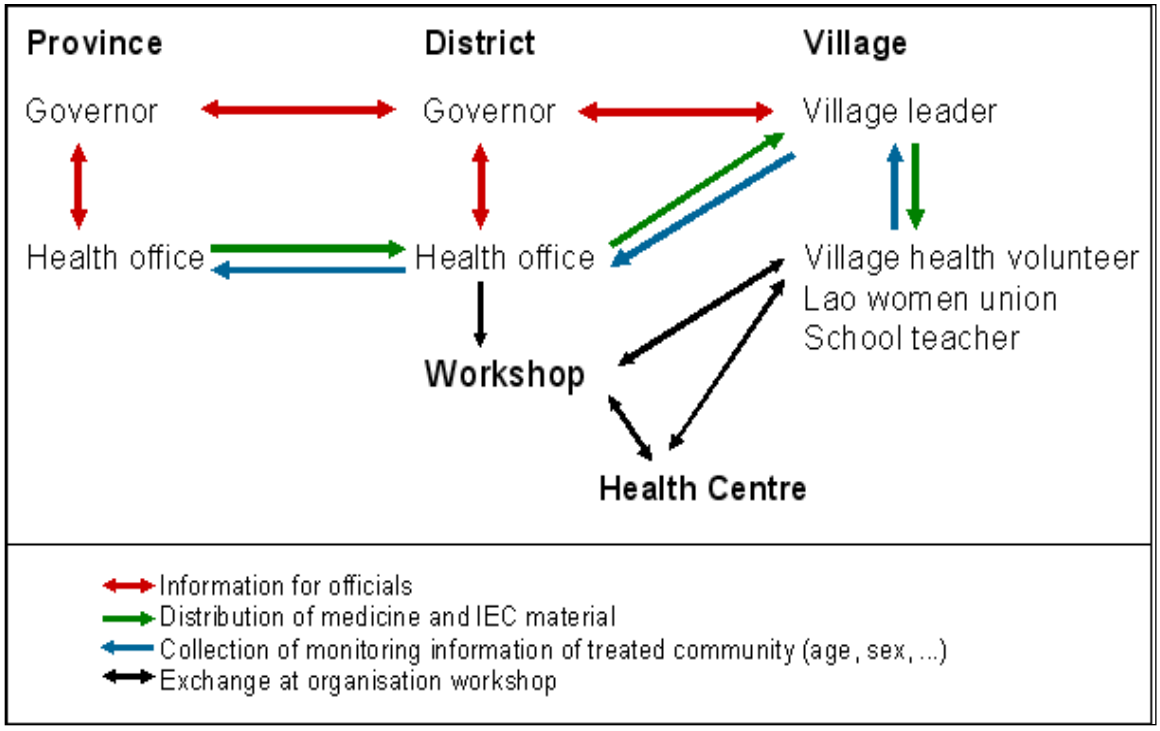

Figure 3.8: Scheme of community-directed intervention against liver fluke and STHs

A one-day training workshop was organized two times and chaired by vice-district governor: one was in March 2010 before intervention and one was in April 2012 just before the last round of mass treatment (Figure 3.9). Health center staff brought deworming drug from DHO to its own catchments villages; the trained community leader took it from its health center. Those villages that were closed to DHO, trained community leaders pick it up directly from DHO. Trained community leaders distributed deworming drug in a village one in a year. Two single-oral dose drugs, PZQ (40mg per kilo of body weight) and a tablet of albendazole (400mg), were administered to the entire population in the village aged 2 years and above except and pregnan and lactating women. Once community leaders completed a mass treatment they returned the treatment records together with remaining deworming drug to Saravane DHO. Beside the treatment, trained community leader also conducted a health education regarding worm infection in a village. All village activities were performed without any financial support.

3.2.6 Evaluation of the community-directed intervention after mass treatment in 2011 and 2012 (Study 5, Chapter 8)

In 2010 we randomly selected 10 villages among the 30 CDI villages and conducted the base-line surveys. In 2011 and 2012 we carried out a follow-up cross-sectional surveys in same villages (Figure 3.2 marked with red spots). The same method was applied for baseline survey and the two evaluation surveys.

Two stool samples obtained from individuals aged ≥2 years of selected household were examined using Kato Katz thick smear method standard 41.7g templates. The Kato Katz slide was read under a light microscope (100 x magnifications) after 30 minutes; and presence or absence of helminth egg of each parasite species was noted. We interviewed household heads concerning the knowledge regarding worm infection. A total of eight FGDs were conducted in four villages, one was among men and another was among women in each village (Figure 3.5 and Figure 3.6); and a direct observation was conducted in all study villages. Descriptive statistic and univariate and multivariate logistic regression analyses for quantitative data and content analysis for qualitative data that transcribed from notes and records were performed.

Figure 3.9: One-day training for CDDs held at Saravane District Health Office in 2010

3.2.7 Evaluation of the factors influencing the compliance to community-directed intervention (Study 6, Chapter 9)

We carried out a cross-sectional survey in 30 intervention villages in Saravane district in 2011 (white dots in Figure 3.2) using a semi-structured interview, Explanatory Model Interview Catalogue (EMIC), to study community's view on helminth infection and current CDI in respondents who took and did not take treatment. We interested to gather information on socio-demographic characteristic, opinion on vignette depicted about severe and none-severe liver fluke infection, perceived cause, illness, and preventive measures for liver fluke and STH, and perception towards the CDI. We also in-depth interviewed CDDs regarding the implementation of intervention in community.

3.3 Ethical considerations

The ethnical clearance from the Lao National Ethics Committee for Health Research (NECHR), Ministry of Health was obtained for all community-based surveys. The intervention study was approved by WHO ERC (Geneva). In addition, permission for field work was obtained from the Lao Ministry of Health.

SECTION I: Baseline information on helminth infection in Laos and liver fluke endemic areas southern Laos

Chapter 4: Helminthiases in Lao People's Democratic Republic: the last four decades reviewed

Khampheng Phongluxa[a,b,c], Somphou Sayasone[a,b,c], Federica Giardina[b,c] , Phonepasong Ayé Soukhathammavong[a,b,c], Kongsap Akkhavong[a], Penelope Vounatsou[b,c], Peter van Eeuwijk[b,c,d], Peter Odermatt[b,c*]

[a] *National Institute of Public Health, Ministry of Health, Ban Kaognot, Sisattanak district, Vientiane Capital, Lao PDR*

[b] *Swiss Tropical and Public Health Institute, Basel, Switzerland*

[c] *University of Basel, Basel, Switzerland*

[d] *Institute of Social Anthropology, University of Basel, Münsterplatz 19, CH-4051 Basel, Switzerland*

* Corresponding author: Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, Socinstrasse 57, P.O. Box, 4002 Basel, Switzerland, Tel. +41 61 284 82 14, E-mail: peter.odermatt@unibas.ch

This manuscript is prepared for Acta Tropica

4.1 Abstract

Helminthiasis is a public health concern in Lao PDR. However a comprehensive review does not exist. This review aimed to understand the trend of helminth parasitic infections, e.g., hookworm, *Ascaris lumbricoides (A. lumbricoides), Trichuris trichiura (T. trichiura), Opisthorchis viverrini (O. viverrini),* and *Schistosoma mekongi (S. mekongi)* over the last 40 years (1970 – 2010). Data were obtained from international publications searching in PubMed database. Currently the prevalence of ascariasis, trichuriasis, and hookworm are relatively low compared to the 1990s but this not true for the highland areas; hookworm is the predominant species among the soil-transmitted helminth (STH). *O. viverrini* infection rate remains high and even currently higher than before with the diagnosis using multiple Kato Katz slides per a stool sample. Multiparasitism was reported. Eating raw or partially cook fish and open defecation are the main cause to keeping infection and re-infection of *O. viverrini* in community. However interventions to address this problem are scare. Nowadays, in endemic area of *S. mekongi* the infection is emerged and re-emerged, and children at 5 years had already been infected. The effective control program for trematodiases and social science researches in parasitology were limited. In conclusion, parasitic infections remain public health concern in Lao PDR. Regular health education on *opisthorchiasis* and annual mass treatment should be integrated into routine work of community leaders and health staff. Regular parasitological survey in endemic site of *S. mekongi* should be held by national or local health authorities.

Keyword: Helminthiasis, soil-transmitted helminth, *O. viverrini, S. mekongi*, Lao PDR

4.2 Introduction

Many species of parasitic infections are grouped to the neglected tropical diseases, which are mostly affecting people living in the poor communities of developing countries (Fürst et al., 2012a). Today, estimated 4.5 billion, 750 million, and 600 million people are at risk of infection with soil-transmitted helminthes (STHs), food-borne trematodes (FBTs), and *Schistosoma* sp., worldwide, respectively (WHO/HTM/NTD, 2011).

Four main groups of helminth parasitic infections cause significant health problem in Lao People Democratic Republic (Lao PDR) such as STHs, FBTs: *Opisthorchiasis viverrini* (*O. viverrini*) and paragonimiasis; *Schistosomiasis mekongi* (*S. mekongi*) and lymphatic filariasis (Lf) (Unpublished Policy on Helminth Control in Lao PDR, 2008). In the last 40 years a substantial amount of parasitological surveys were conducted in the country. However reviews on helminthiases whichgives an overview and the need for further steps are not available. Previous reviews focused on the distribution of *S. mekongi* (Harinasuta, 1984; Ohmae et al., 2004), and teaniasis and cysticercosis (Conlan et al., 2008).

Lao PDR is a low-income country, situated in Southeast Asia. Mekong River runs from the North to the South with abundant of its tributaries. Mountainous and highland areas are to the northern part while plateau and alluvial plains are to the Central and Southern regions. Administratively, Lao PDR was divided into 16 provinces and one Capital City. Population is of about 6 million, 72.9% of them live in rural areas, and 76.0% are subsistence farmers. According to the Lao national survey in 2003, the access to latrine and safe water was limited (37% and 52% respectively). Raw and insufficiently cooked fish dishes are deeply culturally rooted food (Xayaseng et al., 2013). Freshwater fish is one of staple food and it was an estimated that about 50kg of fish was consumed by a person per year (Singhanouvong and Phouthavong, 2002). It is known that poor access to latrine and clean water, poor hygienic practices, behaviour of eating raw or partially cooked fish, and contact with infested water contribute to high prevalence of helminthiases.

Summarizing of the previous researches for a particular issue and bringing the result together to shape the scenario of what has been done is essential to improve intervention and design and implementation, and design relevant further research and intervention (Rowley and Slack, 2004).

This review of peer-reviewed published literature for Lao PDR between 1970 and 2013 aimed at producing an update on the distribution of three main groups of parasites: STHs, FBTs: *O. viverrini*, *Paragonimus spp*, and *S. mekongi*.

4.3 Methods

4.3.1 Searching strategy

We searched data on helminthiasis in peer-reviewed published literature between the 1970 and 2013 through the PubMed database using key words : “Laos” or “Lao PDR”, “helminths”, “O*pisthorchis*”, “liver fluke”, “*Schistosoma mekongi*”, “blood fluke” “soil-transmitted helminth”, and “parasitic worm”, and combined with the terms of “epidemiology”, “prevalence”, “control”, “intervention”, and “research”. Some articles obtained from the library of SwissTPH or had to be ordered from the library of the University of Basel. We gathered 102 articles, of which 85 were obtained as full text.Sixty-seven articles were relevant for our review. Hereafter the first author (Khampheng Phongluxa) had read all related articles, and extracted the information.

4.3.2 Estimation of the true prevalence of helminth infections

The true prevalence of helminthiasis was estimated using prevalence data in this review such as number of screening, number of positive cases, and sensitivity for the tools used to diagnose the STHs and *O. viverrini* (Table 4.4) and the location of the study site. All data were entered in Microsoft Excel and transferred to the Stata version 10.1. WinBUGS program version 14 was used to perform Bayersian model. The result were transferred to “text” format and saved in “dbf” format. Quantum GIS version 1.7.0 Wroclaw was used for establish the maps.

4.4 Results

4.4.1 Distribution of soil-transmitted helminthes (STHs)

The reported prevalence of STH between 1970 and 2013 is summarized in Table 4.1. It indicates that currently although the ascariasis, trichuriasis, and hookworm species are common infections in Lao PDR but they are relatively rare if compared to the previous decades. An exemption is the hookworm infection. It is the predominant infection among

the STHs (Giboda et al., 1991a; Giboda et al., 1991b; Sayasone et al., 2009b; Sayasone et al., 2011; Soukhathammavong et al., 2012). Primary school-aged children are mainlt infected with STHs (Kobayashi et al., 1996; Soukhathammavong et al., 2012). The prevalence rate of ascariasis was higher in highland than in lowland areas such as 83.6%, 57.6%, 62.1%, 67.7%, and a range from 50.6% to 81.9% were reported in mountainous Khamkeuth and Vienthong districts, Phatang village, Nam Theun Hinboune (Nakai Plateau), and seven northern provinces respectively (Erlanger et al., 2008; Rim et al., 2003; Siharath et al., 2000).

According to the estimation of the true prevalence of soil-transmitted helminthiasis, the Figure 4.1, Figure 4.2 and Figure 4.3 show that all three ascariasis, trichuriasis, and hookworm species were common in northern provinces particularly Houaphan, Louangprabang, and Phongsaly provinces have the estimated prevalence rate of more than 81.0%.

4.4.2 Distribution of *Opisthorchis viverrini*

O. viverrini is a zoonotic food-borne trematode. The first case of *O. viverrini* was reported in Thailand by Leiper in 1915 (Sripa et al., 2010).

The reported *O. viverrini* infection rate over the last 40 years is abbreviated in Table 4.2. It shows that the infection is a public health problem since the 1970s markedly in central and southern provinces. Today with the application of multiple Kato Katz slides per a stool sample, the *O. viverrini* infection rate was reported very high in some areas such as 92.1% of school children in Attapeu province (Soukhathammavong et al., 2011), 79.1% of inhabitant in Donelong Island (Lovis et al., 2009), and 92.0%, and 90.9% in Khong and Mounlapamoak districts respectively were *O. viverrini* –infected (Sayasone et al., 2011). However this technique was not applied for the highland areas, the infection rate was reported very low as shown 5.7% in Pasong district (Sayasone et al., 2011), and a range of up to 7.8% in six northern provinces (Rim et al., 2003). Children aged 2 years had already been infected with *O. viverrini*. The infection rate increased with age and reached its peak between 20 and 54 years. There was no significant difference between gender though males consumed raw or partially fish dishes more than females (Giboda et al., 1991a; Kobayashi et al., 2000; Sayasone et al., 2007; Sithithaworn et al., 2006).

With regards to the estimation of the true prevalence of *O. viverrini* infection based on the prevalence data and sensitivity of the tools used for diagnosis, it points that *O. viverrini* was highly endemic in central and southern provinces with the range from 33.0% to 81.8% except for Xekong province the true prevalence of *O. viverrini* was under 14.0%. The highest prevalence of *O. viverrini* was identified in Saravane and Champasack provinces; the infection rate ranged from 65.0% to 81.8% (Figure 4.4).

4.4.3 Epidemiology in animals and transmission route for *Opisthorchis viverrini*

Lao traditional fish dishes are associated with the *O. viverrini* infection such as *Koi Pa* – lemon marinated raw fish salad, *Koi Pa Siew* – lemon marinated raw small fish salad, *Lap Pa Nuew* – minced raw fish salad, *Pa Dek* – fermented fish sauce, and *Som Pa* – raw sour fermented fish. Cats, dogs, cyprinoids fishes and snails in paddy-rice fields and irrigation are infected with *O. viverrini* and others flukes (Giboda et al., 1991b; Rim et al., 2008; Sayasone et al., 2007; Scholz et al., 1991).

4.4.4 Distribution of paragonimiasis

Paragonimiasis is a food-borne trematodiasis and zoonosis and prevalent in foci of Asia. Humans get infected due to eating raw or uncooked or pickled crabs (Strobel et al., 2005). In Lao PDR *paragonimiasis* was firstly reported in 1946 (Odermatt et al., 2007). Between 1978 and 1979 Savannakhet, Vientiane, Xiengkhouang, Louangprabang, Houaphanh, and Phongsaly provinces, and in Xedone River were known as endemic areas of paragonimiasis (Bunnag et al., 1981). However no any surveys related to paragonimiasis were published in the 1980s and 1990s except the case reports for *paragonimiasis* among Laotian living in abroad (Mayer, 1979; Meehan et al., 2002; Mukerjee et al., 1992; Yee et al., 1992). In the 2000s, Odermatt reported that 12.7% of 118 villagers living in three villages of Hinherb District contracted with *Paragonimus*. Crabs were identified as the main intermediate hosts for the transmission (Odermatt et al., 2007). Afterwards the survey was explored in another northern Nambak district that 14.5% of schoolchildren and 50.6% of adult were infected with the parasite (Song et al., 2008). In addition to that a case report of cutaneous paragonimiasis in Lao male living in the same district was confirmed in 2006 (Clyti et al., 2006). In 2008, *P. heterotremus* was exempled as causative agent in Lao PDR (Yahiro et al., 2008). A recent report indicated that dominant *P. harinasutai* followed by *P. bangkokensis* and *P. heterotremus*(Ngoc et al., 2009).

4.4.5 Distribution of *Schistosoma mekongi*

The endemic area of *S. mekongi* is limited to two districts, Munlapamoak and Khong, of the most southern Champasak province. The first case of *S. mekongi*was reported in 1957 from a Laotian migrated and lived in France (Ohmae et al., 2004).

Table 4.3 shows that today the infection with *S. mekongi* re-emerged in the endemic area Khong District Champasack Province. Between 1960 and 1969 the *S. mekongi* infection rate was very high in some areas ranging from 11.1% to 100% whereas in 1989 it was declined to 42.2% (Harinasuta, 1984; Urbani et al., 2002). Later the reports identified *S. mekongi* in 13.5% of people in Pakse and 16.5% in Vientiane (Courson, 1972; Ohmae et al., 2004; Urbani et al., 2002). Some case reports on this infection documented among Laotian living in abroad and living in Lao PDR (Wittes et al., 1984). Dogs and pigs in endemic area were found infected with *S. mekongi* (Harinasuta, 1984; Strandgaard et al., 2001). However in 2002, the national average prevalence of *S. mekongi* among primary school children in Champasak Province was reported 1.7% (Rim et al., 2003), current study conducted in Khong Island indicated of 68.0% of inhabitants infected with *S. mekongi* and children under 5 years had already been infected and the infection rate had increased when the age reached to 6 years old and then remained stable (Sayasone et al., 2011).

4.4.6 Epidemiology in animals and transmission route for *S. mekongi*

Exposure with infested water is risky for contracted with *S. mekongi* particularly during April to June when the volume of water in the Mekong River is low (Ohmae et al., 2004). Snail in the species of *Neotricula aperta* of alpha and gamma strains intermediate host. They adhere to rocks where the water in the Mekong River flow slowly (Ohmae et al., 2004). Pigs and dogs in endemic area may be infected (Strandgaard et al., 2001) but no cattle and rodents (Kitikoon et al., 1975; Schneider et al., 1975).

4.4.7 Distribution of other parasitic infections

Other helminthiases have been reported in the country. The infection with *Capillariasis philippinensis* was firstly reported in 2008. Patients were admitted to hospital for treatment of other disorders (Soukhathammavong et al., 2008). Teaniasis was widely spread however it was low prevalence rate ranged between 0.6% and 22.8%. It is relatively low

prevalence if comparing to the habit of eating raw pork and undercooked vegetables. (Table 4.1) An outbreak of trichinellosis was first occurred in Bolikhamxay province in 2004 as 21 cases were confirmed by Western Blot Test (Sayasone et al., 2006) and one year later, an outbreak occurred in northern Oudomxay Province. 67.6% of 133 population confirmed by ELISA test (Barennes et al., 2008). Fortunately in this outbreak no vertical transmission from mother to child (Taybouavone et al., 2009). Moreover, case reports of trichinellosis among Laotian living in the United State and in Lao PDR were published (Stehr-Green and Schantz, 1986; Suwansrinon et al., 2007). Helminthiasis caused by *Strongyloides stercoralis*was diagnosed with the prevalence ranged between 1.4% and 27.5%. All age groups suffered from *S. stercoralis* but the peak prevalence was observed at age of between 20 and 29 years (Erlanger et al., 2008; Sayasone et al., 2009a; Vannachone et al., 1998). A case report of infection with *S. stercoralis* was reported in 1998 among Lao refugees living in Australia (Vannachone et al., 1998).

4.4.8 Control and prevention of parasitic infections

Lao National Policy and Strategies for Prevention and Control of Helminthiasis was issued in 2003 and revised in 2008 by the Ministry of Health and concern institutions. Seven species: ascariasis, trichuriasis, hookworm, *O. viverrini, Paragonimus* spp*, S. mekongi,* and *lymphatic filariasis* were prioritized. This policy serves as the best reference for implementing the control activities in the country. Health promotion for deworming STH twice a year was implemented nationwide for children under 5 years of age and women in reproductive age through EPI day or EPI in villages and mother and child health services at health facilities. Primary school-aged children nationwide have accessed to deworming against STH twice a year since 2004 through of schools (education sector) and under the school health deworming program (Phommasack et al., 2008). Treatment of *O. viverrini* was available in some provincial malaria stations with proper tools for diagnosis including in Vientiane Capital which were distributed for free of charge. Between 2002 and 2004, MDA was provided in two districts of Vientiane province (Strandgaard et al., 2008) and in primary and secondary schools across Savannakheth southern province (Reported by Head of Provincial Malaria Station in 2009). Since the Khong district was recognized as the endemic area of S. *mekongi*, six rounds of MDA against *S. mekongi* were implemented between 1989 and 1998. The infection rate had been satisfactorily decreased in 1991 so that the MDA was extended to the remaining inhabitants residing along the Mekong River in the district (Ohmae et al., 2004).Till 2007 MDA was held in four

villages of Donelong Island, the study site for NIOPH and SwissTPH project. One year later, all entire villages of Khong and Mounlapamoak districts were covered by MDA leads by Khong district health staff under the support of World Health Organization (WHO) (Report by Director of Khong District Health Office in 2008).

4.5 Discussion

STH infections are very common in Lao PDR. However, their infection rates vary from village to village level are generally high in mountainous areas. Nationwide, primary schoolchildren aged 6-15 years are the most affected persons of STH, whereas children aged less than 5 years show a higher infection rate of *A. lumbricoides*. STH infection prevalences of recent years (2000-2006) are relatively low compared to the 1990s; this does not apply for the mountainous areas like Namtheun Hinboun (Nakai Plateau) and seven northern provinces where the infection rate of *A. lumbricoides* persists at high level at 67.7% and the range from 50.6% - 81.9% respectively. The hookworm infection rate decreases but is still higher than other STH infections. These reported changes might be the result from promoted health education by the Ministry of Health through their routine outreach activities and health care services; the school health deworming program started in 2004 and it covers now all provinces in Lao PDR; deworming activities for children under 5 years are provided through health education to mothers during the EPI day; and deworming treatment for women in the reproductive age is implemented through routine health care services (MCH) units.

T. solium,is widespread in many Asian countries like China, Nepal, South Korea, Indonesia, Vietnam, Thailand, and Cambodia. It is associated with the consumption of raw pork and uncooked vegetables, but also with poor sanitation, poor food inspection, and use of the human faeces for fertilizer (Conlan et al., 2008). This review has found that the infection rate of taeniasis is very low compared to other helminthiases. Grounded on culturally embedded nutritional practices, many Lao people are in the habit of consuming raw, sour pork sausages and uncooked vegetables; in addition to it there is a high percentage of Laotians who live in poor or even bad conditions of sanitation, and thus the infection rate of taeniasis is supposed to be high. However, the actual low infection rate could result from particular self-deworming practices in the community due to the visible presence of worm in one's faeces which causes people to seek for cure either by buying deworming drugs (Mebendazole or Albendazole) directly from a pharmacy or by taking

traditional medicine such as *"makeua"* or *"ya look korn"*, which is reasonably effective against taeniasis.

O. viverrini infection rate varies areas. It is a public health problem in Lao PDR in the past 40 years and now remains a public health challenge particularly in central and southern provinces. Most studies noted of habit of eating raw or partially cooked fish and practice open defecation as a main cause for infection and re-infection in community. This finding coincides with the results of other studies that have detected and identified

A) a high percentage of community members who consume raw or insufficiently cooked fish (Giboda et al., 1991a; Giboda et al., 1991b; Hinz et al., 1994; Jongsuksuntigul and Imsomboon, 1998; Jongsuksuntigul and Imsomboon, 2003; Keiser and Utzinger, 2007a; Keiser and Utzinger, 2004; Kobayashi et al., 2000; Sayasone et al., 2007; Sayasone et al., 2009b),
B) communities which have fish as their main source for food security (Grundy-Warr et al., 2012; Singhanouvong and Phouthavong, 2002),
C) the presence of *O. viverrini* infection in some animals like fish (21 species), cats, dogs, and snail species of *Bithynia* spp in Vientiane and Saravan Province (Giboda et al., 1991a; Giboda et al., 1991b; Sayasone et al., 2007), and
D) many communities living yet without any appropriate toilet facilities (Phongluxa et al., 2013; Sayasone et al., 2007).

All these practices (see A-D) contribute to a high infection and re-infection rate after treatment in both intermediate and definite hosts in Lao PDR.

Schistosomiasis is a re-emerging public health problem in in the schistosomiasis endemic districts in southern Lao PDR. Humans and animals have been found infected with this parasite: for instance, 42.2% of the inhabitants in Lao PDR (in 1989), 12.2% of the pigs (in 2001), in 2002 1.7% of the primary schoolchildren, and in 2006 68.0% of inhabitants in endemic area (in 2006) in the district were infected with *S. mekongi*. The prevention of this disease and its control across endemic districts has just been initiated again at the beginning of 2008. MDA was supported by WHO, and administered by local health authorities.

Social science research and intervention studies on helminth infections have only recently begun. Furthermore, many studies are conducted in regions outside of Lao PDR. A first socio-scientific study in Lao PDR on opisthorchiasis in two villages in Vientiane Lao PDR (Strandgaard et al., 2008) has put emphasis on local perceptions and knowledge of villagers in regard to mode of transmission of *O. viverrini*, degree of its exposure, and notion of its disease symptoms; the study has found not only distinct gender differences in knowledge, but also an incompatibility of local understanding (of helminthes) with biomedical terminology. Moreover, local eating behaviour was identified as the major risk of helminth infection, and the promotion of latrines was considered to be very difficult. Nevertheless, the researchers found a high degree of willingness of the villagers to participate in control programmes. A research study in the Bolivian Amazonian region (Tanner et al., 2011) revealed the importance of local ethnomedical knowledge and its direct involvement in public health campaigns and educational programmes on STH. Moreover, the researchers point out that the assessment of sanitation and hygiene as well as the perception of risk follow local systems of understanding and are not synonymous with developmental discourses on poverty, scruffiness and backwardness. In Nigeria, the outcome of a study on willingness to pay for the drug praziquantel in a schistosomiasis hyperendemic area (Adeneye et al., 2006) resulted in a high degree of willingness of villagers to buy this drug for treatment. Nevertheless, the expressed high willingness contrasted the actual condition of a very low affordability for villagers purchasing this drug. The ability to buy PZQ depends strongly on household income, occupation, and education; as its consequence the many poor households could simply not afford such a medication. Critical research on MDA in Uganda (Parker and Allen, 2011) emphasizes strongly the consideration of local circumstances, and the correspondent adaptation of MDA interventions (such as local mobility, local understandings, historical experiences, food supply, or rumours about side effects). Control tools in evaluation and monitoring of schistosomiasis and STH are to be adjusted to local contexts and not primarily to national and international intervention and eradication programmes. Finally, an interdisciplinary research project in Tanzania on schistosomiasis and intestinal helminths (Freudenthal et al., 2006) focused its interventions on schools and their teachers; schistosomiasis education curriculum based on local experiences and biomedical findings served as the vehicle for teachers to enhance the pupils' knowledge and practice in regard to these parasitic diseases. By this, schools and the communities were better linked, and the

community members started to develop and implement actively and successfully their own preventive measures.

4.6 Conclusion

Parasitic infections are emerging and re-emerging public health concerns in Lao PDR. Only recently the Lao PDR's Ministry of Health promoted and supported the helminth control activities which are implemented by different actors in the communities. However, at present a majority of people affected with helminthiases are not reached by these interventions. The most affected persons with STH are primary schoolchildren aged 6-15, and children aged under 5 years are highly infected with *A. lumbricoides*.

Opisthorchiasis is the most common parasitic infection among adults between 20 and 54 years old and co-infected with other liver flukes. However, regular health education, which is best adapted to local understandings and practices in regard to this parasitic disease, in combination with annual MDA in endemic sites of Opisthorchiasis has reasonably brought down the high infection rate. Therefore, we suggest that for further control and prevention of Opisthorchiasis in Lao PDR regular health education on Opisthorchiasis and annual MDA are to be integrated into the routine works of trained community leaders (including village health volunteer) under the supervision of the district health authorities. Consequently, in order to reduce the general helminth infection rate to a scientifically appropriate and culturally acceptable level that does no longer pose a major health threat, the access of community members to low-cost deworming programmes that are conducted in their communities has to be strongly improved. Community leaders have to be urgently involved by acting as, for instance, drug distributors and health educators in their own community and thus strengthening the 'ownership' or sense of belonging of such an intervention. Schools and their teachers and pupils are certainly another appropriate 'target group' for health education in helminth prevention and treatment, and they may thus become 'partners in action' of households and community. Regular parasitological surveys with a particular focus on endemic sites of schistosomiasis are to be organized by national and provincial health authorities. Furthermore, this review reports a slight reduction of hookworm infection in Lao PDR. However, we recommend that the efficacy of the existing deworming drug (Mebendazole 500mg) should be tested and its administration revisited if necessary in comparison with the quality were effective Albendazole (400mg).

4.7 Acknowledgements

We thank to Heidy Immler and Rebekka Hirsbranner and other librarian from University of Basel for assisting to collect or order some full articles. I acknowledge to Rudolf Geigy Foundation for the financial support my PhD work at SwissTPH, and the University of Basel, Basel, Switzerland.

Table 4.1: Prevalence of soil-transmitted helminthiases and others in Lao PDR, 1970 - 2013

Study area	Ref.	Year of study	Study Pop.	Method	Prevalence (%)					
					A.l.	T.t.	Hw.	Str	Ent.	Tn.
Southern province										
Champasack province (Bachieng sub-urban)	(Soukhathammavong et al., 2012)	2009	465 (<16 yrs)	2KK	34.0	45.0	43.0	NA	NA	NA
ChampasackProvince (Rural areas)	(Sayasone et al., 2011)	2006	669	2KK	31.7	25.0	76.8	4.6	3.6	3.7
SaravanProvince	(Chai et al., 2005)	2002-2003	1270	KK	2.5	1.5	10.6	-	-	5.7
Pakse area (sub-urban)	(Chai and Hongvanthong, 1998)	9-10/1995	137	KK	26.3	19.0	19.0	-	-	-
Central provinces										
Plain areas										
Hospitals and two communities (Urban)	(Sayasone et al., 2009b)	9-10/2005	232	KK and FECT	0.4	8.6	65.9	10.3	0.9	22.8
SavannakhetProvince (Urban)	(Chai et al., 2007)	7/2002	981	KK	0.1	9.5	26.7	-	-	-
Vientiane Capital (Urban)	(Chai et al., 2005)	2002-2003	599	KK	0.5	5.0	4.0	-	-	1.8
Vientiane Capital (Urban)	(Phathammavong et al., 2007)	2005-2006	299	DFS	14.7	4.0	0.3	-	-	-
VientianeProvince:										
Nam Ngum Reservoir (Sub-urban)	(Sithithaworn et al., 2006)	5/1999	173	FECT	20.8	22.5	16.8	4.0	-	1.7
Nam Ngum Reservoir (Sub-urban)		12/1999	261	FECT	8.0	17.6	13.4	15.3	-	1.1
Parkkading District (Sub-urban)	(Hohmann et al., 2001)	7/1998	153	KK	39.2	25.4	37.9	-	-	-
Sisomseun village (Rural area)	(Vannachone et al., 1998)	12/1996	258	KK/APC	25.8	34.2	21.0	27.5	2.0	3.5
Phavang village (Rural area)		12/1996	190	KK/APC	55.8	18.2	48.0	18.4	2.6	4.2
Thakhek Neua village (Urban area)		12/1996	224	KK/APC	5.0	21.0	13.1	9.4	0.0	1.3
Nathandong village (Rural area)	(Kobayashi et al., 1996)	9/1996	70 (< 16yrs)	KK	61.4	47.1	37.1	-	-	-
Nathantong village (Rural area)		9/1996	58 (<16 yrs)	KK	32.7	39.7	37.9	-	-	-
Vangheur village (Rural area)		1995	105	KK	38.1	5.7	4.7	-	-	-
Vientiane Capital in villages along the MekongRiver (Urban areas)	(Sornmani et al., 1974)	1971	2,493	DFS	49.3	49.9	30.6	-	-	-
Mountainous areas										
Namteun Hinboun (Nakai Plateau)	(Erlanger et al., 2008)	2001-2002	5107	KK	67.7	3.9	9.7	1.4	4.4	4.8
Viengthong District (Sub-urban)	(Hohmann et al., 2001)	7/1998	189		57.6	-	13.7	-	-	-
Khamkeuth District (Sub-urban)		7/1998	307		83.6	23.1	1.9	-	-	-
Phatang village (Rural area)	(Siharath et al., 2000)	1995	227		62.1	51.1	11.4	-	-	-
National scale										
Primary school children nationwide	(Rim et al., 2003)	2000-2002	29,846(<16 yrs)	1KK	34.9	25.8	19.1	-	-	0.6

Note: "-" - Not applicable; A.l - *ascaris lumbricoides*;; T.t - *trichuris trichiura*; Hw - hookworm.; Strg – strongyloides stercoralis; Ent - enterobius vermicularis; Tn - Taenia; KK - Kato-Katz; 2KK - two Kato-Katz slides; APC – agar plate culture method; DFS - direct faecal smear.

Table 4.2: Prevalence of opisthorchiasis in Lao PDR over the last 40 years, 1970 – 2013

Study area	Ref.	Year	Study pop	Method	O.v	Others
Southern provinces						
Attapeu province (Urban primary school)	(Soukhathammavong et al., 2011)	2010	214 (<16yrs)	3KK	92.1	
Bachieng (Sub-urban schools)	(Soukhathammavong et al., 2012)	2009	465 (<16yrs)	2KK	16.6	
ChampasackProvince	(Forrer et al., 2012)	2007	3371	2KK	61.1	
DonelongIsland (Rural areas)	(Lovis et al., 2009)	2007	108	1KK	50.0	
(Champasak province)			91	3KK	79.1	
			108	FECT	34.3	
			108	PCR	63.9	Ht
Three districts of Champasack province	(Sayasone et al., 2011)	2006	669	2KK	64.3	
SaravanProvince	(Sayasone et al., 2007)	2-3/ 2004	814	1KK	58.5	
SaravanProvince	(Chai et al., 2005)	2002-2003	1270	1KK	70.8	Ht/Hp/Hy
Pakse area (Sub-urban)	(Chai and Hongvanthong, 1998)	9-10/1995	137	1KK	43.8	
Central provinces						
Plain areas						
Urban hospitals and two communities	(Sayasone et al., 2009b)	9-10/2005	232	3KK ;FECT	86.2	
SavannakhetProvince	(Chai et al., 2007)	7/2002	981	1KK	67.1	Ht/Hp/Hy/Pm/ Pb
Vientiane Capital	(Chai et al., 2005)	2002-2003	599	1KK	53.3	Ht/Hp/Hy
Vientiane Capital	(Phathammavong et al., 2007)	2005-2006	299	DFS	18.1	
VientianeProvince	(Strandgaard et al., 2008)	April 2002	NA	NA	62.0	
Villagers at Nam Ngum Reservoir	(Sithithaworn et al., 2006)	5/ 1999	173	FECT	53.8	MIF
		12/1999	261	FECT	42.1	
Khammouane province :	(Vannachone et al., 1998)	12/1996	669	1KK	56.7	
Sisomseun village (Rural area)			258	1KK	53.1	
Phavang village (Rural area)		12/1996	190	1KK	55.0	
Thakhek Neua village (Urban area)		12/1996	224	1KK	56.7	
Khammouane province:	(Kobayashi et al., 2000)					
Sisomseun village (Rural area)		12/1996	189	1KK	52.9	
Phavang village (Rural area)		12/1996	258	1KK	55.0	
Thakhek Neua village (Urban area)		12/1996	224	1KK	60.7	
Khammouane province:	(Kobayashi et al., 1996)					
Nathandong village		9/ 1996	70	FECT	38.6	
Nathantong village		9/ 1996	58	FECT	36.2	
Vientiane province :	(Giboda et al., 1991b)	1991				
Nam Ngum Reservoir (Su-urban)			776	MIFC	35.9	*Haplorchis spp*
Power station camps (Su-urban)	(Giboda et al., 1991b)	1991	232	KK	83.6	*Haplorchis spp*
Nam Ngum Dam camps	(Giboda et al., 1991a)	1989	535	MIFC	52.1	
Village on the bank of Nam Ngum Reservoir	(Giboda et al., 1991a)	1989	232	1KK	83.6	
Vientiane Capital in villages along the MekongRiver	(Sornmani et al., 1974)	1971	2,493	DFS	46.5	

Mountainous areas					
Vientiane province: Phatang village	(Siharath et al., 2000)	1995	227	DFS/1KK	7.5
Vientiane province: Vangheur village	(Siharath et al., 2000)	1995	105	DFS/1KK	2.9
Namteun Hinboun (Nakai Plateau)	(Erlanger et al., 2008)	2001-2002	5107	KK	0.9
National scale survey					
Nationwide primary school children	(Rim et al., 2003)	2000-2002	29,846 (<16yrs)	1KK	10.9

Note: O.v – *Opisthorchis viverrini ;* KK - Kato-Katz technique ; 1KK - single Kato-Katz slide; 2KK - duplicate Kato-Katz slides; 3KK - triplicate Kato-Katz slides ; DFS - direct faecal smear technique ; FECT - formalin ethyl acetate concentration technique ; Ht - *haplorchis taichui* ; Hp – *haplorchis pumilio*, Hy – *haplorchis yokogawai* ; Pm – *prostodendriummolenkampi* ; Pb – *prostodendrium bonne*i ; MIF – minute intestinal flukes

Table 4.3: Distribution of *Schistosoma mekongi* in Lao PDR, 1966 - 2013

Study area	Ref	Year	Study population	Method	Sample size	Prevalence
Human as a definite host						
Southern Champasack	(Sayasone et al., 2011)	2006	Pop age ≥ 6m	2KK	669	24.2
Province						
Khong district			Pop age ≥ 6m		225	68.0
Mounlapamoak district			Pop age ≥ 6m		232	3.9
Paksong district			Pop age ≥ 6m		212	0
National scale parasitological survey		2000-2002	Primary school children nationwide	1KK	29,846	1.7
Survey in KhongIsland before mass drug administration launched	(Urbani et al., 2002)	1989	Villagers	1KK	2249	42.2
Case report for three cases of *Schistosomiasis mekongi*	(Wittes et al., 1984)	1984	3 cases	Rectal biopsy		NA
The egg from a human case of schistosoma in Laos	(Taylor and Moose, 1971)	1971	Collect the worm egg of infected human	Confirm the size of egg Measurement of egg	NA	NA
Baseline survey in 15 villages along the MekongRiver:	(Courson, 1972)	1968-1969	Inhabitants	Skin test and SE	2,988	
A village directly across river from KhongIsland					-	38.0
A village 12 kilometres downstream from Khong Island					-	20.0
KhongIsland	(Urbani et al., 2002)	1966-1969	Inhabitants	Skin test	184	18.8
				Stool exam.	78	25.6
KhongIsland			Inhabitants	Skin test	223	79.8
				Stool exam.	149	32.9
Pakse District		1969	Inhabitants	Skin test	-	13.5
Vientiane Capital				Skin test	-	16.5
KhongIsland			School children		-	30.0
KhongIsland			Adult and children		-	100
				Stool exam.		

Khong Insland	(Harinasuta, 1984)	1969		Skin test & SE	-	14.4
KhongIsland	(Harinasuta, 1984)	1967		Skin test & SE	-	11.9
Animal as a definite host						
Hadxaikhoun villages Khong district	(Strandgaard et al., 2001)	2001	Pigs	Filtration, sedimentation, and centrifugation of 5g of feces	98	12.2
KhongIsland	(Kitikoon et al., 1975)	1975	Pigs	MIFC	15	0
			Cattle		43	0
KhongIsland	(Schneider et al., 1975)	1975	Buffalo	MIFC MIFC	103	0
KhongIsland	(Harinasuta, 1984)	1969	Dogs		-	11.0

Note: DK - do not know; MIFC - merthiolate-iodine-formaldehyde concentration technique; KK - Kato-Katz; 1KK - single Kato-Katz slide; SE – stool examination

Table 4.4: Sensitivity for the tools used for diagnosis of soil-transmitted helminthes in this review

Item	Sensitivity (%)				Range of sensitivity	Reference.
	A.l	T.t	Hw	*O. viverrini*		
1KK	70.8	68.2	1.4			(Santos et al., 2005)
1KK for one sample	68.8	20.0	22.6			(Glinz et al., 2010)
1KK	67.8	76.6	19.6			(Habtamu et al., 2011)
1KK for one sample	96.9	91.4	65.2			(Tarafder et al., 2010)
1KK for one sample	68.0	88.0	81.0			(Knopp et al., 2011)
1KK	88.1	82.6	78.3			(Levecke et al., 2011)
1KK for 3 samples	68.8	31.1	38.7			(Glinz et al., 2010)
1KK for 3 stool samples	99.6	95.1	83.3			(Knopp et al., 2008)
Thick smear method	46.5	66.6	28.3			(Santos et al., 2005)
Ether concentration	43.8	51.1	35.5			(Glinz et al., 2010)
MIFC		72.3				(Shaker et al., 1994)
1KK				85.0		(Stensvold et al., 2006)
1KK				62.3	49.8–73.7	(Lovis et al., 2009)
3KK				91.4	81.0–97.1	(Lovis et al., 2009)
1KK (EPG>1000)				53.0		(Stensvold et al., 2006)
FECT (EPG>1000)				46.0		(Stensvold et al., 2006)
FECT				49.3	37.0–61.6	(Lovis et al., 2009)
PCR (FECTs>1000)				50.0		(Stensvold et al., 2006)

EPG - egg per gram of stool ; A.l - *ascaris lumbricoides*;; T.t - *trichuris trichiura*; Hw - hookworm.; O.v – *O. viverrini;* MIFC - merthiolate-iodine-formaldehyde concentration technique; 1KK - single Kato-Katz slide ; 2KK - duplicate Kato-Katz slides; 3KK - triplicate Kato-Katz slides ; DFS - direct faecal smear technique ; FECT - formalin ethyl acetate concentration technique ;

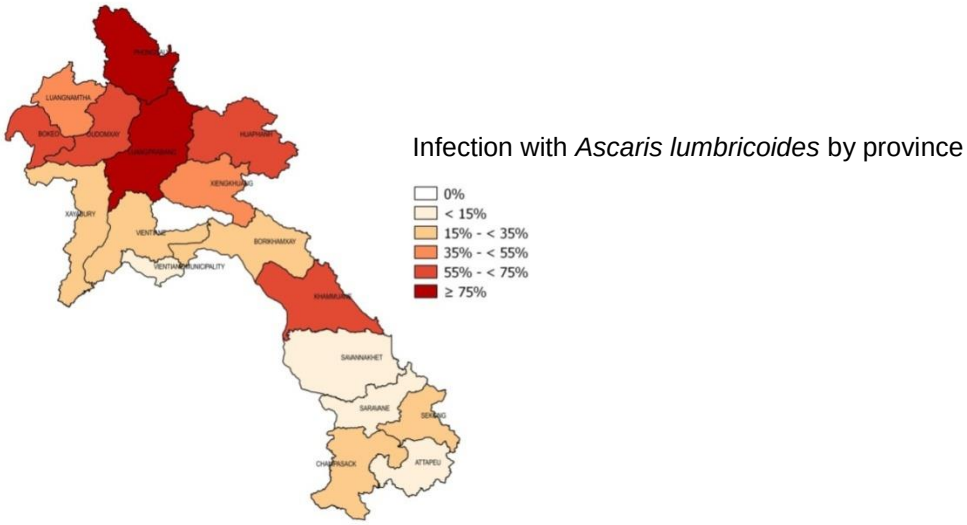

Figure 4.1: Estimation of infection prevalence of ascariasis by province between the 1970 and 2013

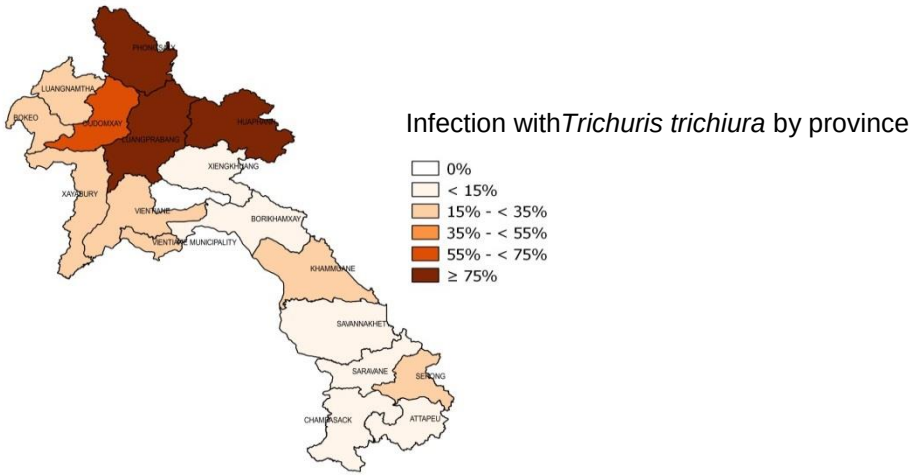

Figure 4.2: Estimation of infection prevalence of trichuriasis by province between the 1970 and 2013

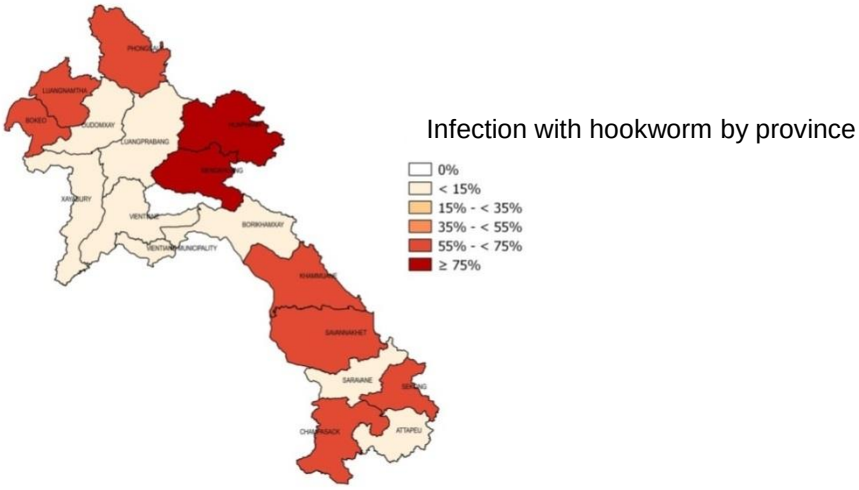

Figure 4.3:
Estimation of infection prevalenceof hookworm by province between the 1970 and 2013

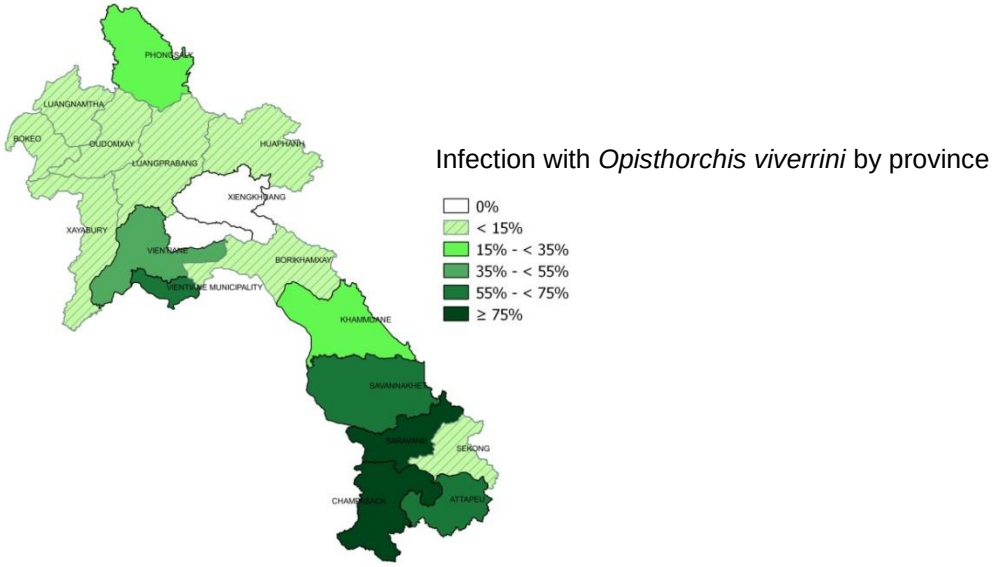

Figure 4.4: Estimation of infection prevalence of *O. viverrini* by province between the 1970 and 2013

Chapter 5: Helminth infection in southern Laos: High prevalence and low awareness

Khampheng Phongluxa[1, 2 3], Vilavanh Xayaseng[1, 2, 3], Youthanavanh Vonghachack[2, 3, 5], Kongsap Akkhavong[1], Peter van Eeuwijk[2,3,4], Peter Odermatt[2, 3, *]

1 National Institute of Public Health, Ministry of Health, Vientiane, Lao PDR
2 Swiss Tropical and Public Health Institute, Basel, Switzerland
3 University of Basel, Basel, Switzerland
4 Institute of Social Anthropology, Basel, Switzerland
5 University of Health Science, Ministry of Health, Vientiane, Lao PDR

* Corresponding author: Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, P.O. Box, CH-4002 Basel, Switzerland. Tel.: +41 61 284-8214; fax: +41 61 284-8105;

This manuscript has been published in *Parasites & Vectors 2013, 6:328*

5.1 Abstract

Helminthiasis is a public health concern in Lao People's Democratic Republic (Lao PDR, Laos). This study aimed to understand helminth infection and associated risk factors in relation to existing local knowledge, attitudes and practices regarding worm infections in endemic communities.A cross-sectional survey was conducted in 10 randomly selected villages in Saravane district, Southern Laos. Two stool samples obtained from 574 members (aged ≥2 years) of selected households were examined using the Kato Katz method. Household heads (n=130) were interviewed. Eight focus group discussions (FGDs) and direct observations were performed. Uni- and multivariate logistic regression analyses were conducted to predict infection. Content analysis was conducted for qualitative data. The prevalence of *Opisthorchis viverrini*, hookworm, *Trichuris trichiura, Ascaris lumbricoides* and *Taenia* sp. was 88.7%, 86.6%, 32.9%, 9.8% and 11.5%, respectively. Most individuals were co-infected with *O. viverrini* and hookworm. More men had multiple helminth infections than did women. Only one-third of household heads had heard about liver fluke before, of which 59.2% associated it with eating raw fish dish. Among the soil-transmitted helminths, roundworm was the most well known (70.8%) but was attributed to raw food consumption (91.3%). Eating raw fish was a common practice (75.4%); few households possessed a latrine (16.1%); less than half of the study participants mentioned health benefits from latrine use and personal hygiene. Focus group discussion participants had a low level of awareness of worm infections; more men liked eating raw fish dishes than did women; some disliked using latrines because they were not used to it and because of their bad smell. Poor personal and village hygiene practices were observed. This study highlights a high helminth infection rate and poor community awareness of worm infections and associated risk factors. Only a sound awareness of worm infection and the underlying risk factors may prevent infection and re-infection after treatment.

Keywords: helminth infection, soil-transmitted helminth, liver fluke, raw fish consumption, latrine use, health education

5.2 Introduction

Food-borne trematodiases (FBT) are among the neglected tropical diseases (Utzinger et al., 2010) and a public health problem in many parts of the world, with a global burden of 665,000 disability adjusted life years (Fürst et al., 2012a). FBT often co-exists with soil-transmitted helminthiasis (STH) (Sayasone et al., 2009b; Sayasone et al., 2011). About 750 million people are at risk for FBT, of which 40 million are infected (Keiser and Utzinger, 2007a). An estimated 1.2 billion, 800 million and 740 million people worldwide are infected with *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm, respectively (Keiser and Utzinger, 2008). In Southeast Asia, about 67.3 million people are at risk for *Opisthorchis viverrini,* the most frequently observed FBT. Ten million people are infected in Thailand and Laos (Sithithaworn et al., 2012). *O. viverrini* infection is common where consumption of raw or insufficiently cooked fish dishes is deeply rooted in local culture and where proper sanitation is minimal or absent (Utzinger et al., 2010). *O. viverrini* infection results in hepatobiliary morbidity (Fürst et al., 2012a) and chronic infection may lead to cholangiocarcinoma, a fatal bile duct cancer (Bouvard et al., 2009). Preventive chemotherapy together with health education is the most current helminth control strategy (Hotez et al., 2006; WHO, 2002; WHO/FAO, 2004). However, re-infection rates after treatment with anti-helminthic drugs are rapidly reaching pre-treatment prevalence rates (Lovis et al., 2012) as food and hygiene behaviour patterns remain unchanged, indicating that health education is not effectively addressing the critical issues.

Deepening our understanding of helminth infections in relation to local notions of these infections, its risk factors and deworming measures is important for developing sustainable and effective helminth control. For example, in northern Vietnam, local communities were aware of the risks of eating raw fish, however, people were less cautious about consuming raw fish dishes because, they argued, with the effective drug, they could be easily cured after an infection (Phan et al., 2011). Having a good knowledge of worm infection and of people's perception of the risk factors and of the benefits of deworming facilitates the development of valid interventions and convinces people to comply with the intervention (Cantey et al., 2010; Gunawardena et al., 2007; Nuwaha et al., 2005; Yirga et al., 2010). Hence, an in-depth knowledge of infection prevalence and of the risks of endemic helminths and an understanding of

corresponding local knowledge and perception patterns is essential for improving helminth control activities in the local setting.

In Laos, over two million people are infected with liver fluke (Sithithaworn et al., 2012). Recent surveys reveal a rampant *O. viverrini* infection rate of more than 90% of the general population in southern areas (Forrer et al., 2012; Sayasone et al., 2009a; Soukhathammavong et al., 2011). About 1.6 million children under 15 years of age are at risk of STHs. However, our understanding of the local knowledge, attitudes and practices in relation to worm infection and its risk factors is limited. Today, preventive chemotherapy combined with health education via vertical programmes remains the main strategy for helminth control in Laos. It is implemented without detailed knowledge of the attitudes and practices of the local communities. Therefore, underlying risk factors such as food preparation and hygiene behaviour remain inadequately addressed and, hence, re-infection rates are high.

This study aimed to advance our understanding of helminth infection in relation to the community's existing knowledge, attitudes and practices in endemic areas in southern Laos. A cross-sectional survey was conducted in randomly selected villages and households in Saravane district to assess helminth infections and their risk factors. Focus group discussions (FGDs) and direct observations were carried out to triangulate knowledge, attitudes and practices with regard to helminth infections.

5.3 Methods

5.3.1 Ethics statement

Ethical clearance was obtained from the National Ethics Committee on Health Research, Ministry of Health, Lao PDR (Ethical Clearance No 169/NECHR, 1 April 2008). Written informed consent was obtained from heads of selected households. For illiterate persons, informed consent was read out and, after approval, the person signed with a fingerprint. The interviewees were informed about the study aim, the study procedures, the need for voluntarily participation, and their right to stop participation at any time. All infections diagnosed in this study were treated according to the national treatment guidelines (Lao MOH, 2004).

5.3.2 Study areas and population

The study was conducted in ten randomly selected villages of Saravane district, Saravane province (red dots in Figure 3.3). The total population in these villages comprised 6,207 inhabitants (including 3,056 females and 847 children under five years of age). Some villages were located near rivers, namely Xedonh and Xeseth, and their tributaries (Houay Lanong, Houay Namxai, and Houay Nongboua). In some villages, the Laotheung ethnic group formed the majority of the population. The main occupation of residents was subsistence rice farming. Daily food intake consisted of rice with vegetables and bamboo, as well as fish from rivers and ponds and game. In four villages (Nakhoisao, Nahinlong, Naphengyai, and Hangphounoy), demonstration latrines were constructed by the Saravane Provincial Health Office and international projects.

Saravane district is located on the Bolaven Plateau. It covers 2,441 km^2 and has a population density of three people per km^2. The 89,068 inhabitants (female: 45,520) live in 178 villages and in 13,239 households. Ethnic groups include the Laotheung and the Laoloum. The annual income per capita is USD 627. There are nine health centres, which cover 71% of the villages. The district has 19 pharmacies, 91 villages with drug kits, two private clinics and 13 outreach teams (Report Saravane District Health Office [DHO], 2008). In 2002, a national parasitology survey indicated that 21.5%, 11.9%, 10.9% and 5.4% of primary school children in Saravane province were infected with *O. viverrini*, *A. lumbricoides*, hookworm and *T. trichiura,* respectively (Rim et al., 2003). In 2004, the prevalence of *O. viverrini* infection was estimated at 58.5% (village range from 20.0% to 85.5%) in Saravane district. The infection rate increased with age. Eating raw or insufficiently cooked fish dishes was very common (79.7%). Only one in 13 villages had latrines. Sixty per cent of the cyprinoid fish species consumed in this district are infected with *O. viverrini* metacercariae (Sayasone et al., 2007). Mass treatment against helminth infection does not yet exist in Saravane district (Director of Saravane Provincial Health Department [PHD]).

5.3.3 Study design

A cross-sectional survey was carried out in January and February 2010, using two-stage cluster sampling. First, 10 villages were randomly selected from the list of villages in the district obtained from the Saravane DHO. Second, 20 households were randomly

selected from the household list. All household members aged 2 years and older were enrolled and intestinal helminth infections were diagnosed from two stools samples. Heads of households were interviewed. Eight FGDs were carried out in four randomly selected villages; in each village two FGDs were conducted: one among men and another among women. Direct observations were performed in all villages.

5.3.4 Field and laboratory procedures

Village leaders and household heads were informed about the study's objectives and procedures. A structured interview was conducted with heads of selected households, where information on socio-demographic household characteristics, household assets, and knowledge, attitudes and practices relating to *O. viverrini* and helminth infections (e.g. raw fish consumption, hygiene and sanitation behaviour) were collected. FGD participants were randomly selected from households that were not part of the cross-sectional survey. In FGDs, open-ended and open questions were used, i.e. (i) Have you heard about liver fluke/roundworm/hookworm/whipworm? (ii) If yes, could you please tell us how people get this infection? (iii) What is the relationship between infection and disease? (iv) How can you prevent it? (v) Do you eat raw fish dishes? How often? (vi) What do you think about eating raw fish dishes? (vii) Do you have a latrine? What do you think about using latrines? (viii) What are the benefits of using a latrine and of hand washing before eating/after defecation? (ix) What do you think about hand washing before eating and after defecation? (x) Do you wash your hands before eating and/or after defecation? Team leaders made direct observations during visits in the communities regarding the cleanliness of the village, the consumption of raw fish, personal hygiene practices, wearing shoes and the presence of sanitation facilities.

In the cross-sectional study, for each enrolled household member, two stool samples were collected on two consecutive days and examined. Stool containers labelled with date, ID, name, age and sex of participant were handed-out. Heads of households were instructed on how to fill the container with stool samples. On the collection day, people who gave a first stool sample received a second pre-labelled container to use for the following day. All collected samples were kept in a cool box and were transported by car to the provincial hospital's laboratory in Saravane within an hour after collection. For each stool sample, one Kato Katz thick smear slide was created, using standard 41.7 mg templates (Katz et al., 1972). After a clearance time of 30 minutes, the slide was

examined under a light microscope (100 x magnification). All samples were examined on the day of collection. The number of eggs per parasite was counted and recorded for each parasite species separately.

5.3.5 Data management and statistical analysis

Data were entered twice (double entry) into EpiData, version 3.1 (Epidata Association; Odense, Denmark) and validated. Analysis was performed using Stata software, version 10.1 (Stata Corp., College Station, TX, USA). Only participants with two stool samples were retained in the analysis. Individuals were divided into seven age groups (in year) (<6, 6–15, 16–29, 30–39, 40–49, 50–59 and 60+); most participants were aged between 6–15 (26.8%), 16–29 (21.8%) and 30–39 (16.0%). Descriptive statistics were calculated (counts, percentages, means and standard deviations [SD]). The intensity of helminth infections was expressed in terms of egg count per gram faeces (EPG). According to Maleewong *et al*. and Sayasone *et al.*(Maleewong et al., 1992; Sayasone et al., 2007), for the infection with *O. viverrini,*and STHsthe following light, moderate, and high intensity groups were established based on the EPG counts: Hookworm, 1-1999 EPG, 2000-3999 EPG, and ≥4000 EPG; *A. lumbricoides*, 1-4999 EPG, 5000-49,999 EPG, and ≥50,000 EPG; and *T. trichiura* and *O. viverrini*, 1-999 EPG, 1000-9999 EPG, and ≥10,000 EPG. Pearson's $\chi^2$and Fisher's exact tests were used to compare proportions. The association between *O. viverrini* infection and sex, age group, ethnicity, raw fish consumption, having a latrine, and socio-economic status (SES) was assessed in a univariate logistic regression analysis. Predictors with $p<0.25$ were retained in a multivariate logistic regression model. Odds ratio (OR) and 95% confidence intervals (95% CI) were reported. P-values less than 5% were considered significant.

SES of households was assessed using multiple correspondence analysis (MCA). The technique has been used before for categorical data (Forrer et al., 2012). Household assets, materials used for house construction, water source and possession of a latrine were used to construct a socio-economic index. Households were classified into one of five quintiles: most poor, very poor, poor, less poor and least poor, using the socio-economic index.

Qualitative data from FGDs were transcribed from notes and tape recordings, then translated from Lao into English, typed into MSWord and imported to MAXQDA (version

10) software for textual analysis. Statements were coded and categorised according to the following themes: knowledge of liver fluke, hookworm, whipworm, roundworm and tapeworm; raw fish consumption; hand washing before eating; hand washing after latrine use and deworming. Coded data were retrieved and exported to MSExcel for frequency and content analysis.

5.4 Results

5.4.1 Characteristics of the study population

One hundred and thirty heads of households were retained in the analysis (Figure 5.1); 53.1% were male; the mean age was 41.2 years (SD 13.6 years, range: 20–81 years); mean age by gender was 43.4 years (SD 14.6 years; range 20–81 years) for men and 38.5 years (SD 11.8 years; range 21–74 years) for women. Almost all household heads were farmers (93.1%); 56.9% had completed primary school while 29.2% had not attended school; 56.9% belonged to the Laoloum ethnic group.

From the enrolled households, 574 people submitted two stool samples (Figure 5.1); 50.3% of these were from females; the mean age was 25.5 years (SD 18.2 years, range: 2–81 years). There was no significant age difference between genders: the mean age for males was 24.4 years (SD 18.2 years, range 2–81 years, 95%CI 22.3–26.5) and 26.6 years (SD 18.3 years, range 2–74 years, 95%CI 24.5–28.7) for females; 53.3% belonged to the Laoloum ethnic group.

Among 67 FGD participants, 52.2% were females. The mean age was 40.6 years (range 15–73 years). Most of them were in the age groups of 35–44 years (32.8%) and 25–34 years (22.4%); more than two-third of the FGD participants belonged to the Laotheung ethnic group (71.6%) and were Buddhists (71.7%); 55.2% had attended primary school while 40.3% had not attended school at all. All were farmers.

5.4.2 Helminth infection prevalence, intensity and risk factors

Intestinal helminth infections were highly prevalent. *O. viverrini,* hookworm, *T. trichiura* and *A. lumbricoides* were diagnosed in 88.7%, 86.6%, 32.9% and 9.8% of the individuals, respectively. In addition, *Taenia* sp. was detected in 11.5% of the study participants. *O. viverrini* infection intensity increased with age and reached a mean

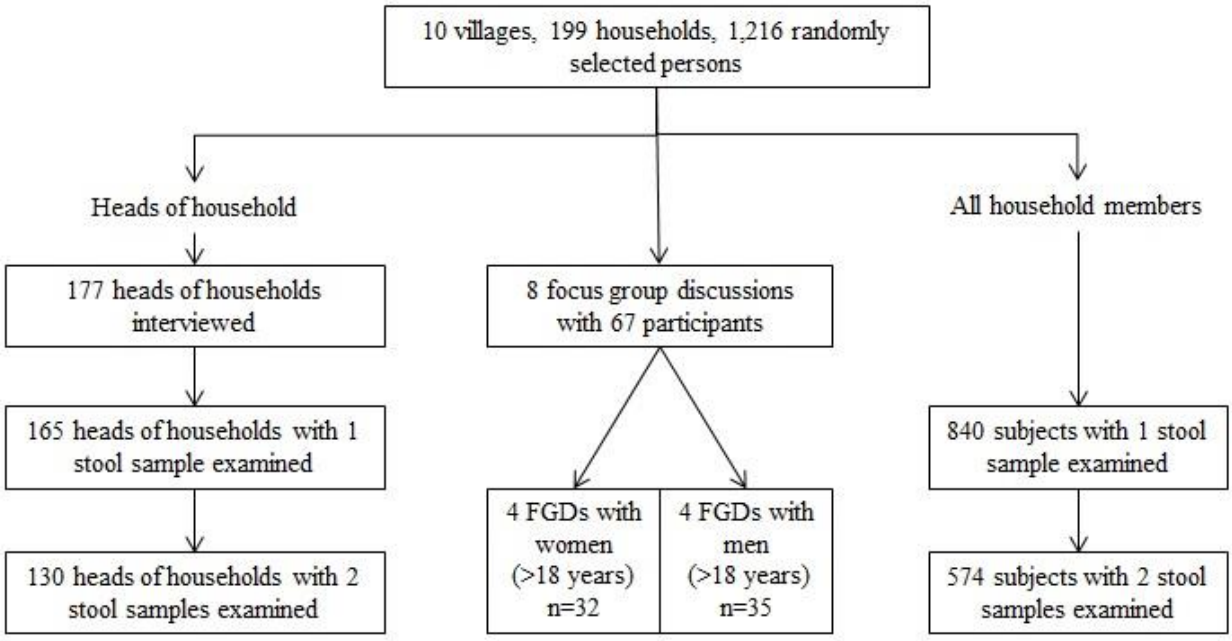

Figure 5.1: Study diagram, Saravane District, 2010

infection intensity of 2163 EPG in the oldest age group. *O. viverrini*, hookworm and *A. lumbricoides* infection rates were not significantly different between genders but *T. trichiura* infection was significantly more frequent in male participants than in female participants (p=0.031, Table 5.1).

Prevalence of *O. viverrini* and hookworm increased significantly with age, from 72.6% to 100% (p<0.001) and from 71.2% to 96.7% (p=0.001) from the youngest to the oldest age group, respectively, whereas *Taenia* sp. increased from 6.8% at ages <6 years to 21.4% among people aged 50–59 and then declined to 13.3% at ages >59 (p=0.034, Figure 5.3).

Multiparasitism was very common. More than half of the participants (52.4%) harboured two helminth species or more. Three different species were diagnosed in 27.2% of the participants. Infection with three helminth species was detected in males significantly more (33.3%) than in females (21.1%, p=0.005, Figure 5.2). Among *O. viverrini*-infected people, more than three quarters (77.3%) were co-infected with hookworm, of which 74.7% were children in the age group 6–15 years.

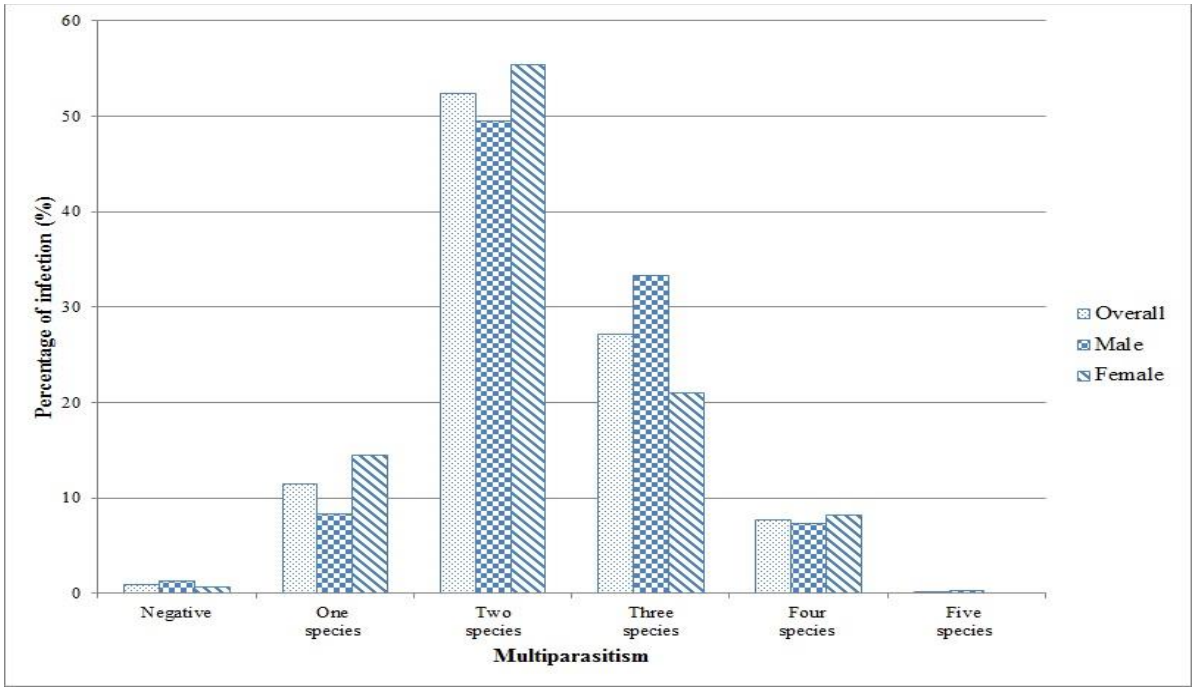

Figure 5.2: Multiple helminth infections in study population by gender in Saravane District, 2010 (n=574)

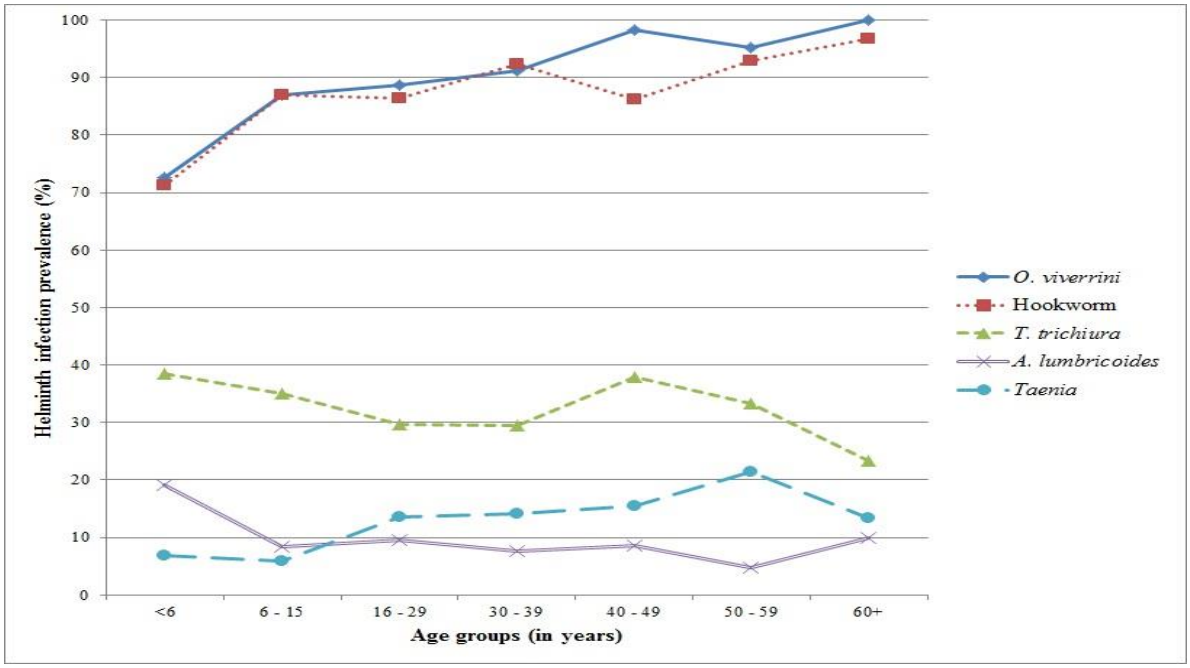

Figure 5.3: Helminth infection rate by age groups, Saravane District, 2010 (n=574)

5.4.3 Risk factors of *O. viverrini* infection

After an initial univariate prediction of *O. viverrini,* hookworm, *T. trichiura* and *A. lumbricoides* infection in all study participants, the following variables were included in the multivariable logistic regression analysis model for predicting hookworm: gender, age group, ethnicity and having a latrine; only the first three variables were included for predicting *O. viverrini* and *A. lumbricoides* and only gender and ethnicity were included for predicting *T. trichiura*. Results indicated that males had a strongly increased risk for *O. viverrini* infection compared to females (OR=1.9, p=0.023). Laoloum had a significantly higher risk for *O. viverrini* infection than did Laotheung (OR=2.3, p=0.003) but a lower risk for hookworm infection (OR=0.59, p=0.049), *T. trichiura* (OR=0.25, p<0.001)and *A. lumbricoides* (OR=0.27, p<0.001) compared to Laotheung. Children aged <6 years were at significantly lower risk for *O. viverrini* (OR=0.12, p=0.006) and hookworm infection (OR=0.08, p=0.015) compared to older age groups. In contrast, they had a significantly higher risk of being infected with *A. lumbricoides* than did other age groups (OR=5.31, p=0.035; Table 5.2).

With regards to knowledge of helminth infection and its risk factors, the following variables were retained as predictors for an *O. viverrini* infection in the multivariable logistic regression model: having heard about *O. viverrini*, eating raw fish salad, eating raw fermented fish and eating sour rice-fermented fish. Results showed that only eating raw fish salad was associated with the *O. viverrini* infection: those who reported eating raw fish salad *(Koi Pa, Lap Pa Nuew)* had a highly increased risk for infection compared to those who did not eat raw fish salad (OR=16.1, p=0.026).

5.4.4 Knowledge, attitudes and practices of heads of households

Heads of households were interviewed about their knowledge of worm infection and prevention. Questions about liver fluke, hookworm, whipworm and roundworm were asked. Of the interviewees, 37.7% had heard about liver fluke before, named "*pha yat bai mai nai tap*" or "*san tap*" in Lao. A little more than half (59.2%) linked the infection to eating raw or insufficiently cooked fish, but only about a quarter of them linked it to the consumption of raw fermented fish sauce (24.5%) and raw sour rice-fermented fish (24.5%). Few household heads knew how to prevent liver fluke infections (14.3%). Among the STHs, roundworm was most well-known (70.8%). However, almost all of

those people who knew of it (91.3%) attributed it to consumption of any type of raw food. Only a few people (14.3%) mentioned correct preventive measures (Table 5.3).

Among household heads, 43.1% thought that hand washing before eating could prevent diseases such as abdominal pains and diarrhoea. Others (21.5%) did not see any link to health. A few household heads (2.3%) reported that in order to prevent worm infections, people should wash their hands before eating.

Only a few household heads (16.1%) reported having a latrine. Among them, females (92.3%) used them significantly more frequently than did male household heads (50.0%, p=0.047; Table 5.4). About a quarter (26.1%) of household heads thought that the possession of a latrine would be convenient, as one would not get wet from rain and would not need to go to the forest. About a quarter (24.6%) of them believed that latrine possession could prevent disease transmission. Some heads of households (15.4%) understood that latrine use could prevent diarrhoea or even malaria.

Raw food consumption was very common (Table 5.4). Among household heads, 75.4% reported regularly consuming raw fish dishes *(Koi Pa, Lap Pa Nuew),* 68.1% at sour rice-fermented fish *(Som Pa, Som Pa Noy/Som Pa Chom)* and 45.4% ate fermented fish sauce *(Pa Deak, Pa Deak Nam)*. Many more men reported eating raw fish dish and other raw food dishes than did females (91.3% versus 57.4%*;* $p<0.001$).

5.4.5 Focus group discussion results

Among the 67 FGD participants, 50.7% reported having heard about liver fluke infection before; 43.3% associated the infection with eating any type of raw food and 4.5% linked the infection to eating raw vegetables; 11.9% related the consumption of raw or insufficiently cooked fish to a worm infection. Roundworm was the most well-known STH (77.6%; Table 5.5).

Half of the participants (49.3%) who reported repeatedly eating raw fish dishes explained this issue. A man (aged 31 years) in Naphengyai village said that he loved to eat raw small cyprinoid fish salad, while two other men stated that eating raw fish dishes was their habit. One woman (aged 56 years) in Nongbouayai village said: "*We have the habit of eating raw fish dishes such as Koi Pa, Lap Pa Nuew, Koi Phan, Koi Cham because, on the one hand, we would like to change the style of cooking our usual dishes but, on*

the other hand, this type of dish like Lap Pa Nuew can be easily prepared and served for many people and is sufficient for all members in the family, even if we only could catch a small amount of fish". Eight women confirmed that women mostly prepared raw fish dishes. Some respondents (16.4%) reported consuming *Som Pa* (raw sour rice-fermented fish). Eight participants stated that this dish is rarely consumed.

The frequency of eating raw fish dishes depends on the availability of fish in the village. Three-quarters of participants (75.8%) reported that during the rainy season and thereafter, people more frequently eat raw fish dishes due to an abundance of fish in the ponds, rivers and rain-fed paddy fields. During the dry season, most people do not eat it more than once per month. A man from Chantai village (aged 45 years) stated that, "…*if fish were always available throughout the year, we would eat Koi Pa, Lap Pa Nuew, Koi Phan and Koi Cham every day*".

When asked about personal hygiene, 46.3% mentioned that hand washing before eating was common. However, one woman (aged 41 years) mentioned that she sometimes forgot to wash her hands, particularly when very hungry after an intense period of working in rice fields. Ten participants said that no one in the village washes his/her hands after defecation.

When discussing the benefits of hand washing before eating, 29.9% of participants thought that it would not prevent any worm infections or any other diseases; 14.9% did it just to keep the hands clean; only a few participants (4.5%) linked it to health benefits.

Open defecation is very common and was mentioned by 16 of the 67 FGD participants (23.9%). When asked about latrine use, one man (aged 55 years) in Chantai village said that he had asked the government to support latrine construction because the surrounding forest is going to be *"finished"* soon, and they will not have a place to defecate anymore. Three men and one woman disliked the use of pit latrines due to their bad smell. Two men said: "*I feel uncomfortable if I use the toilet because I cannot get used to it. I am afraid all the time that others will open the toilet's door".* Another one said that, "…*what do we do if the toilet is full? I would say that to defecate in the forest is therefore a more convenient way*".

During the discussion about the general benefits of latrines, only 14.9% participants thought that the use of latrines could prevent diseases from being transmitted in their village; four FGD participants thought that animals in the village would not eat human faeces any more if they had latrines. For instance, one woman aged 58 years from Naphengyai village said that, "…*animals would not eat human faeces and chickens would not die anymore…*"; the remaining seven participants mentioned that the villages would be cleaner and latrine use more convenient.

5.4.6 Direct observation results

In two of the ten study villages, we could directly observe fish dish preparation during our field work. In Dongkoneua village, the village committee obtained the fish from the nearby village market and prepared a welcome meal for our team while we were working in their village. The food served during that meal was well cooked. In Chantai village, household members caught fish from a nearby river and prepared raw sticky fish salad *(LapPa Nuew)*. The team was told that *Lap Pa Nuew* must be served with raw fish.

Of ten study villages, five had at least a few latrines. However, in these five villages, fewer than 20% of households owned a latrine. Only one of four FGD villages (Naphengyai) had latrines. We looked at eleven latrines. Three had never been used before, while three others could only be used at night (i.e., they had no walls or roof and one was far from the source of water). Five latrines were used regularly (three were owned by village heads and two were owned by village health volunteers). We observed pigs, cows and buffalos straying freely in the study villages. Walking barefoot outside of the houses was very common, particularly for children.

5.5 Discussion

This study deepened our understanding of helminth infections and multiparasitism in relation to knowledge, attitudes and practices in Southern Laos, where helminth infections are highly endemic. We conducted a cross-sectional survey in ten randomly selected villages in Saravane district. Stool examination were performed on all members (aged ≥2 years) of selected households. At the same time, interviews with the heads of households, FGDs and direct observations were performed to better understand knowledge, attitudes and practices related to these infections.

Our findings show that trematode infections, i.e.,*O. viverrini* infections, were highly prevalent (88.7%). In fact, prevalence rates were one and a half time higher than indicated in a previous assessment in 2004 (58.5%) (Sayasone et al., 2007), which might be explained by the fact that no community control activities were conducted between the two assessments. The current study employed a rigorous diagnostic procedure using two stool samples per person, which certainly contributes to explaining the higher prevalence rate of the current assessment. In addition, most individuals had multiple infections with two helminth species and a quarter was infected with more than three species. Co-infections were most frequent with hookworm, which was the second most frequent helminth infection found in our study (77.3%).

Our interview results reveal that household heads have very limited knowledge of *O. viverrini* infection, its route of transmission and potential means of prevention. The habit of eating raw and insufficiently cooked fish was a very common practice and open defecation was widespread. Nevertheless, some household heads recognised the benefits of latrine use and gave reasons for not using them. During the discussions, participants mentioned that they disliked using latrines because they were either not used to it or did not know what to do when latrines were filled up. Even among people who had a latrine, not all of them used latrines regularly. Interestingly, women used latrines significantly more than men, indicating that they see a much greater benefit from having latrines in a household. Direct observations fully supported this finding. Hence, future sanitation promotion community interventions should particularly focus on women in target communities.

Our triangulated methodological approach (i.e., stool examination, interview with heads of households, FGDs with community members and direct observation) allowed us to confirm findings from different sources of data and, hence, show the strong relationship between the high prevalence rate of helminth infections and the corresponding low level of awareness and knowledge of selected community members. However, our helminth infection assessment was performed with a Kato-Katz technique, which does not allow one to distinguish between *O. viverrini* and minute intestinal flukes (MIF) (Lovis et al., 2009). The most recent research based on purging infected individuals and molecular diagnostic tools showed that in Southern Laos, a considerable amount of MIF is present (Chai et al., 2013; Rim et al., 2013). Thus, it is likely that the *O. viverrini* infection rate is over-reported in the current study. However, the route of transmission and preventive

measures for these parasites are the same. Therefore, our findings of low community knowledge and awareness of worm infections is still valid.

Our research shows a distinct link between the prevalence of hookworm infection and the household heads' knowledge of hookworm infections. A very high hookworm infection rate (86.6%) was observed and increased with age, from 71.2% in the youngest age group to 96.7% in the oldest age group. Conversely, household heads showed an extremely low level of knowledge of hookworm, e.g., awareness of infection risk through direct contact with soil. The majority of household heads reported wearing shoes outside but investigators directly observed that walking barefoot outside was very common in all villages. In addition, animal excreta originating from free straying animals such as pigs, cows and buffalos were observed in all surveyed villages. A recent study conducted in rural areas of central Thailand confirmed that walking barefoot outside and keeping livestock such as buffalos around the house were risk factors for hookworm infection (Jiraanankul et al., 2011). Hookworm infection is known to be an important cause of iron deficiency, affecting the physical and cognitive development of children (Hotez et al, 2006). Therefore, building awareness of the modes of transmission, the relationship between infection and disease, and preventative measures needs to be addressed in these affected communities.

The Lao government has made considerable efforts to control STHs in women at reproductive age, in children under five years of age and in primary school children by providing regular mass treatment with mebendazole twice a year (single oral dose 500 mg) (Phommasack et al., 2008). Against this backdrop, it is most astonishing that hookworm infection prevalence remains high. A high re-infection rate is a plausible explanation. Adequate health education messages and alternative communication channels, for instance peer education of mothers and primary school children, could address these issues. Another likely reason for the persistently high hookworm infection rate is the use of mebendazole instead of albendazole. Mebendazole has shown very low curative effects in recent studies in Southeast Asia (Soukhathammavong et al., 2012; Steinmann et al., 2011) and therefore, albendazole (single oral dose of 400 mg) should be used in deworming campaigns.

O. viverrini infection is acquired through consuming raw fish (Grundy-Warr et al., 2012; Sayasone et al., 2007; Tomokawa et al., 2012). In our study, we found that household

heads have poor knowledge of liver fluke infection, including its transmission mode and means of prevention. This low level of awareness is certainly one reason why raw fish eating practices in these communities are still prevalent and have not changed substantially since the last assessment made by Sayasone and colleagues in 2004 (Sayasone et al., 2007). A study conducted in northeast Thailand, where *O. viverrini* infection rate is very high, identified viable metacercariae in raw fish dishes such as *Koi Pa* and *Som Pa* (Prasongwatana et al., 2013). Therefore, a prerequisite of preventing *O. viverrini* infection in an efficient way is to decrease raw fish consumption. Awareness building is the first step in this process, using adequate health education messages and approaches.

The populous, rural communities of the Laoloum people show a very rich cultural life, with high and regular intensity of religious ceremonies and social occasions (e.g., life stage and agricultural events), where raw fish dishes are a prominent marker of commensality and underline the importance of ethnic and religious belonging (Xayaseng et al., 2013). In contrast, Laotheung communities — and many of them adhere to local religious beliefs — do not, in general, engage in the multitude of elaborate ceremonial practices, which include the mandatory consumption of raw or insufficiently cooked fish. Furthermore, the Laoloum people and their villages have a much better, and thus more frequent, access to raw fish and raw fish dishes, particularly at markets, food stalls, in shops and through street vendors, than do the Laotheung who tend to live in somewhat remote areas without well-developed road networks and easy access to urban centres. Direct observation revealed that environmental conditions also contribute to the increased *O. viverrini* infection rate among the riparian Laoloum people: they live mainly along big rivers and streams with a large fish stock; the abundance of freshwater fish leads to regular consumption of raw fish (Xayaseng et al., 2013). In contrast, Laotheung communities live in a mostly hilly and rugged physical environment and do not have this rich quantity and quality of fish in the creeks; consequently, they consume raw fish less frequently.

This study indicates that men have a higher risk of being infected with *O. viverrini* than women do. This quantitative result is consistent with the findings from FGDs where men discussed their preference for eating raw fish dishes such as *Koi Pa*, *Koi Pa Siew*, and *Lap Pa Nuew*. Eating raw fish dishes is their habit and they would eat this food every day if fish were always available. Furthermore, men, as social, economic, political and

religious representatives of their households and kin, participate in many more public and official events in the community than do women, where raw or insufficiently cooked fish dishes are usually served and consumed in commensality. The consumption of raw fish dishes is part of one's social obligations and integration in Laos (Xayaseng et al., 2013). A study by Strandgaard and colleagues in Vientiane province obtained similar findings where more men ate raw fish dishes than women did (Strandgaard et al., 2008). It is also known that in endemic liver fluke areas a slightly higher prevalence rate of *O. viverrini* infection was observed in men (Sithithaworn and Haswell-Elkins, 2003). Moreover, we found that more men harboured different worm species than women did. However, previous assessment in this district by Sayasone and colleagues in 2004 did not show a difference of infection rates between genders (Sayasone et al., 2007). Appropriate health messages regarding flukes and STHs need to address these gender differences and tackle men's riskier consumption pattern.

Our research confirms previous results that *O. viverrini* infection prevalence increases with age (Kobayashi et al., 2000; Maleewong et al., 1992; Sayasone et al., 2007). Although our study found that children <6 years had a low risk of *O. viverrini* infection compared to other age groups, these children showed a much higher *O. viverrini* infection rate than found in a previous study in 2000 (72.6% versus 27.9%) (Kobayashi et al., 2000). In addition, the majority of *O. viverrini*-infected children aged 16 and under was co-infected with hookworm (74.7%). Regarding helminth infection, our study found that 49.2% of heads of households allowed their children to share any raw fish dish with adults once they could eat by themselves, particularly at age three (mentioned by 67.7%) and at age two (6.1%). This long-term exposure (from childhood) to *O. viverrini* infection poses serious health problems: *O. viverrini* is carcinogenic for cholangiocarcinoma (Bouvard et al., 2009), particularly when the infected person turns 35 years or older (Sriamporn et al., 2004; Steinmann et al., 2011). The interrelation of *O. viverrini* infection and age becomes a serious public health issue and requires an intergenerational (i.e. acting between children and their parents) and transgenerational approach (i.e., acting across multiple generations such as children and elderly people) to health education, for instance, targeting health messages and measures to each different age group.

Although Saravane province, like other provinces in Laos, benefits from rapid economic and infrastructural development, helminth infections in general and flukeinfections in

particular remain an important public health concern. To address it appropriately, a community-wide intervention must be initiated to ensure access to treatment and health education to increase knowledge of worm infections. Based on our findings, a combination of informal and formalised health education activities might be best suited to broaden local people's awareness and to promote adoption of healthy practices related to helminth infections.

5.6 Conclusion

This study discerned the relationship between helminth infection rates and quantity and the level of awareness of parasitic infections and its risk factors in endemic liver fluke areas in Saravane district. It highlights that helminth infection, particularly fluke and hookworm infections, imply a high burden, followed by *T. trichiura, Taenia* sp. and *A. lumbricoides*, notably in communities where multiple helminth infections exist. However, specific knowledge and awareness of helminth infections was very limited, particularly regarding the mode of transmission and means of prevention. Consumption of raw and insufficiently cooked fish was widely practiced because these fish dishes are deeply rooted in the local culture of food and nutrition, particularly among the Laoloum. We observed poor personal hygiene practices and unreliable village sanitation; only a few households have access to a latrine but not everybody who has a latrine uses it regularly. This study calls for local authorities and communities in Saravane district to integrate actions to address helminth infections by building awareness and strengthening knowledge about worm infections and practices related to these infections. Furthermore, this research adds to the much-needed arsenal of mixed quantitative and qualitative methodological approaches in helminth studies. Qualitative methods in combination with quantitative baseline studies of infection rates shed light on social determinants of helminth infection as well as on cultural processes and community and individual health practices in regard to helminth vulnerability and reveal significant relations between prevalence rates, reasons for infection and appropriate problem solving measures.

Competing interests

The authors declare that they have no competing interests and that the sponsors had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' contributions

KP and PO conceived the study idea, and designed and analysed the data, and interpreted results together with PvE. KP coordinated and conducted field work and drafted the manuscript; VX carried out data collection and sample collection; YV carried out laboratory work; KA had overall responsibility for data collection; PvE and PO revised the manuscript. All authors read and approved the final submission.

5.7 Acknowledgements

We would like to express our sincere thanks to the authorities, in particular the Ministry of Health, the National Centre of Malariology, Parasitology and Entomology, the Saravane Provincial Health Department, the Saravane District Health Office, the local authorities in the study villages, the participants involved in this study and our research team. Special thanks go to Phonepasong Ayé Soukhathammavong, Armelle Forrer, Audrey Bochaton, and Amena Briet for their help. We are grateful for generous financial support from the World Health Organisation (Geneva), and Rudolf Geigy Foundation and *Stiftung für freiheitliche Medizin* (Basel, Switzerland).

Table 5.1: Helminth infection prevalence and intensity by gender and age group (in year), Saravane District, 2010 (n=574)

Item	n (%)	Male	Female	<6	6-15	16-29	30-39	40-49	50-59	60+
Opisthorchiasis viverrini	509 (88.7)	91.2	86.1	72.6	87.0	88.8	91.3	98.3	95.2	100
GM faecal egg count (range), EPG:	925* (24 – 69,648)	1100.3	771.5	221.6	406.0	1337.9	1388.7	2508.7	1890.7	2162.9
Intensity infection:										
Light (1-999 EPG)	261 (51.3)	47.7	55.0	88.7	70.9	45.0	36.9	28.1	30.0	33.3
Moderate (1000-9999 EPG)	184 (36.1)	38.1	34.1	9.43	23.9	40.5	48.8	49.1	50.0	43.3
Heavy (≥10000 EPG)	64 (12.6)	14.2	10.8	1.9	5.2	14.4	14.3	22.8	20.0	23.3
Hookworm	497 (86.6)	88.8	84.4	71.2	87.0	86.4	92.4	86.2	92.9	96.7
GM faecal egg count (range), EPG:	446.5* (24 – 38,880)	492.2	403.6	342.1	393.5	443.9	538.7	381.4	543.1	768.5
Intensity of infection:										
Light (1-1999 EPG)	426 (85.7)	84.6	86.9	90.4	86.6	88.9	77.6	96	79.5	75.9
Moderate (2000-3999 EPG)	33 (6.6)	8.3	4.9	3.8	7.5	3.7	10.6	0.0	15.4	6.9
Heavy (≥4000 EPG)	38 (7.7)	7.1	8.2	5.8	5.9	7.4	11.8	4.0	5.1	17.2
Trichuris trichiura	189 (32.9)	37.5	28.4	38.4	35.1	29.6	29.4	37.9	33.3	23.3
GM faecal egg count (range), EPG:	189.6* (24 – 10,800)	179.9	202.9	187.9	179.1	221.4	156.3	253.5	128.8	246.2
Intensity of infection:										
Light (1-999 EPG)	164 (86.8)	85.9	87.8	92.9	81.5	86.5	88.9	90.9	92.9	71.4
Moderate (1000-9999 EPG)	24 (12.7)	14.0	10.9	7.1	16.7	13.5	11.1	9.1	7.1	28.6
Heavy (≥10000 EPG)	1 (0.5)	0	1.2	0	1.8	0	0	0	0	0
Ascaris lumbricoides	56 (9.8)	8.1	11.4	19.2	8.4	9.6	7.6	8.6	4.8	10.0
GM faecal egg count (range), EPG:	2984.5* (96 – 178,080)	3031.2	2952.4	6566.2	6691.1	757.1	4416.9	656.1	1515.4	4321.5
Intensity of infection:										
Light (1-4999 EPG)	35 (62.7)	65.2	60.6	42.9	53.8	83.3	57.1	100	50.0	66.7
Moderate (5000-49999 EPG)	15 (26.8)	21.7	30.3	42.9	23.1	16.7	28.6	0	50.0	33.3
Heavy (≥50000 EPG)	6 (10.7)	13.0	9.1	14.3	23.1	0	14.3	0	0	0
Taenia sp.	66 (11.5)	11.6	11.4	6.8	5.8	13.6	14.1	15.5	21.4	13.3

GM = geometric mean; EPG = egg per gram of stool; * = mean of parasite egg

Table 5.2: Summary results for logistic regression analysis for the association between risk factors and helminth infections (n=574)

	O. viverrini		**Hookworm**		***T. trichiura***		***A. lumbricoides***	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Univariate logistic regression								
Gender								
Male	1.67 (0.98-2.83)	0.057	1.45 (0.89-2.37)	0.128	1.52 (1.07-2.15)	0.020	0.68 (0.39-1.19)	0.178
Female	referent		1.00		1.00		1.00	
Age group (in year)								
<6	0.05 (0.01-0.36)	0.003	0.18 (0.05-0.67)	0.010	1.16 (0.53-2.54)	0.709	4.86 (1.05-22.56)	0.043
06 - 15	0.12 (0.01-0.89)	0.038	0.49 (0.14-1.76)	0.281	0.99 (0.49-2.01)	0.967	1.90 (0.41-8.78)	0.409
16 - 29	0.14 (0.02-1.08)	0.060	0.48 (0.13-1.71)	0.256	0.78 (0.38-1.63)	0.518	2.18 (0.47-10.14)	0.322
30 - 39	0.18 (0.02-1.51)	0.115	0.91 (0.22-3.71)	0.896	0.77 (0.36-1.68)	0.518	1.69 (0.33-8.49)	0.525
40 - 49	1.00		0.47 (0.12-1.88)	0.286	1.14 (0.50-2.59)	0.753	1.92 (0.36-10.47)	0.444
50 - 59	0.36 (0.03-4.10)	0.410	1.00		1.00		1.00	
60+	1.00		2.17 (0.21-21.9)	0.510	0.57 (0.19-1.63)	0.293	2.28 (0.36-14.54)	0.384
Ethnicity								
Laoloum	2.28 (1.33-3.91)	0.003	0.57 (0.35-0.94)	0.029	0.24 (0.17-0.35)	<0.001	0.28 (0.15-0.53)	<0.001
Laotheung	1.00		1.00		1.00		1.00	
Availability of latrine at home								
no	1.21 (0.63-2.32)	0.561	1.54 (0.86-2.75)	0.141	1.05 (0.66-1.67)	0.828	0.85 (0.42-1.70)	0.645
yes	1.00		1.00		1.00		1.00	
Multivariate logistic regression								
Gender								
Male	1.90 (1.09-3.31)	0.023	1.43 (0.87-2.37)	0.159	1.43 (0.99-2.07)	0.06	0.59 (0.33-1.05)	0.074
Female	1.00		1.00		1.00		1.00	
Age group (in year)								
<6	0.12 (0.02-0.54)	0.006	0.08 (0.01-0.61)	0.015	n.a		5.31 (1.12-25.18)	0.035
06 - 15	0.29 (0.06-1.31)	0.108	0.22 (0.03-1.69)	0.146			2.12 (0.45-9.97)	0.339
16 - 29	0.35 (0.08-1.64)	0.185	0.20 (0.03-1.62)	0.133			2.43 (0.51-11.54)	0.263
30 - 39	0.50 (0.10-2.49)	0.400	0.41 (0.05-3.51)	0.417			1.76 (0.34-9.02)	0.496
40 - 49	2.39 (0.21-27.58)	0.483	0.22 (0.03-1.87)	0.166			2.48 (0.45-13.77)	0.299
50 - 59	1.00		0.44 (0.04-4.46)	0.485			1.00	
60+	1.00						2.75 (0.42-18.04)	0.292
Ethnicity								
Laoloum	2.29 (1.31-4.01)	0.003	0.59 (0.35-0.99)	0.049	0.25 (0.17-0.36)	<0.001	0.27 (0.14-0.50)	<0.001
Laotheung	1.00		1.00		1.00		1.00	
Availability of latrine at home								
no	n.a		1.37 (0.74-2.54)	0.318	n.a		n.a	
yes			1.00					

Table 5.3: Knowledge of helminthiases among heads of households in 10 villages in Saravane district, 2010 (n=130)

Item	Total	Male (n=69)	Female (n=61)	p-value
Knowledge about liver fluke				
Heard about liver fluke	49 (37.7)	46.4	27.9	0.030
Transmission route for liver fluke infection:		**n=32**	**n=17**	
Eating raw fish dishes	29 (59.2)	65.6	47.1	0.208
Eating raw sour fermented fish	12 (24.5)	18.7	35.3	0.200
Eating raw fermented fish	12 (24.5)	28.1	17.6	0.503
Eating pickled fish	6 (12.2)	12.5	11.8	1.000
Prevention of liver fluke infection:				0.374
Not eating any raw food: meat, shrimp etc.	21 (42.9)	40.6	47.1	
Avoiding raw fish consumption	7 (14.3)	18.7	5.9	
Maintaining good personal hygiene and use latrine	2 (4.1)	6.3	0	
Taking deworming medicine	2 (4.1)	3.1	5.9	
Avoiding cigarettes and alcohol	1 (2.0)	3.1	0	
Seeking health care	1 (2.0)	0	5.9	
Knowledge about soil-transmitted helminths				
Heard about hookworm	11 (8.5)	5.8	11.5	0.346
Transmission route for hookworm infection:		**n=4**	**n=7**	0.448
Eating raw meat, fish, vegetables	2 (18.2)	25.0	14.3	
Infection through food	1 (9.1)	25.0	0	
No idea	8 (72.7)	50.0	85.7	
Prevention of hookworm infection:				0.288
Taking deworming drugs	1 (9.1)	0	14.3	
Avoiding raw foodstuff consumption	3 (27.3)	50	14.3	
Maintaining good personal hygiene	2 (18.2)	25	0	
Heard about whipworm	2 (1.5)	1.4	1.6	1.000
Transmission route for whipworm infection	0	0	0	
Prevention of whipworm infection	0	0	0	
Heard about roundworm	92 (70.8)	69.6	72.1	0.748
Knowledge about transmission route:		**n=48**	**n=44**	
Hand washing before eating	8 (8.7)	10.4	6.8	0.716
Eating raw food	84 (91.3)	89.6	93.2	0.716
Prevention of roundworm infection:				
Hand washing before eating	19 (20.6)	27.1	13.6	0.111
Hand washing after using latrine	8 (8.7)	10.4	6.8	0.716
Taking deworming drug	11 (11.9)	8.3	15.9	0.341
Eating cooked food	33 (45.2)	58.9	41.2	0.129

Table 5.4: Risk behaviour of heads of households in Saravane district, 2010 (n=130)

Risky behaviour	Total	Male (n=69)	Female (n=61)	p-value
Habit of eating raw food				
Eat raw fish dishes *(Koi Pa, Lap Pa Nuew)*	98 (75.4)	91.3	57.4	<0.001
Eat raw sour fermented fish *(Som Pa, Som Pa Noy/Som Pa Chom)*	59 (45.4)	56.5	32.8	0.007
Eat raw fermented fish *(Pa Daek, Pa Daek Nam)*	82 (68.1)	75.4	49.2	0.002
Eat raw sausages of pork *(Som Mou Dip)*	43 (33.1)	46.4	18.0	0.001
Eat raw beef salad *(Lap Xin Dip)*	93 (71.5)	88.4	52.5	<0.001
Eat raw vegetables	124 (95.4)	98.5	91.8	0.098
Cleaning vegetables before eating	123 (94.6)	98.5	90.2	0.051
Personal hygiene				
Hand washing before eating	127 (97.7)	97.1	98.4	0.663
Hand washing after defecation	108 (83.1)	81.2	85.2	0.535
Hand washing with soap	15 (11.5)	5.8	18.0	0.029
Wearing shoes when get outside/going to bush	119 (91.5)	89.9	93.4	0.540
Sanitation facility				
Having latrine at home	21 (16.1)	11.6	21.3	0.133
Using latrine every time	16 (76.2)	50.0	92.3	0.047
Using latrine sometime	4 (19.0)	37.5	7.7	
Not using latrine at all	1 (4.8)	12.5	0	

Table 5.5: Summary of focus group discussions, Saravane district, 2010 (n=67)

Items	n (%)	Male (n=32)	Female (n=35)
Knowledge about worm infection:			
Heard about liver fluke *"san tap"* or "*pha yat bai mai nai tap*"	34 (50.7)	34.4	65.7
How to get infection with *O. viverrini*:			
Eating raw vegetables	3 (4.5)	3.1	5.7
Not maintaining good personal hygiene: hand washing, nail clipping, unclean environment	8 (11.9)	15.6	11.4
Eating any raw food: meat, snail, shrimp	29 (43.3)	34.4	51.4
Eating raw fish dishes *(KoiPa, LapPa Nuew)*	8 (11.9)	12.5	11.4
Heard about roundworm	52 (77.6)	84.4	71.4
How to get infection with roundworm:			
It just occurs in our body	2 (2.9)	0	5.7
Eat any raw: meat, fish, shrimp, vegetables	7 (10.4)	15.6	5.7
Not maintaining good personal hygiene: not hand washing before eating, not clipping nails, flies touching our food, drinking dirty water	16 (23.9)	18.7	28.6
Heard about hookworm	3 (4.5)	6.2	2.8
Do not know	3 (4.5)	6.2	2.8
Heard about whipworm	2 (2.9)	6.2	0
Do not know	2 (2.9)	6.2	0
Heard about tapeworm	33 (49.3)	46.9	51.4
Eating raw food	8 (11.9)	21.9	2.8
Eating raw fish dishes	33 (49.3)	53.1	45.7
Perceptions of latrine use:			
Village will not be dirty	15 (22.4)	34.4	11.4
Flies do not touch our food anymore	4 (5.9)	12.5	0
Prevention of diseases/no transmission of diseases	10 (14.9)	18.8	11.4
Animals will not eat human faeces	6 (8.9)	0	17.1
Convenience (not getting wet from rain, convenience during the night and when sick)	13 (19.4)	6.2	31.4
Perceived liver fluke as health problem in community	6 (8.9)	12.5	5.7
Practices personal hygiene:			
Hand washing before eating	31 (46.3)	31.2	60.0
Saying that most of people in village do not wash hands with soap	10 (14.9)	0	28.6
Perceptions of personal hygiene:			
Hands will be clean if we wash hands before eating	10 (14.9)	0	28.6
We will be healthy if we wash hands before eating	3 (4.5)	9.4	0
We can not get any worm infections or diseases if we wash our hands before eating	20 (29.9)	28.1	31.4
Deworming in community:			
Getting dewormed	37 (55.2)	75.0	37.1
Treatment of tapeworm with traditional medicine	19 (28.3)	43.7	14.3
Treatment with modern medicine	18 (26.9)	31.2	22.8
Treatment of roundworm using modern medicine	2 (2.9)	2.9	0

Chapter 6: Raw fish consumption in liver fluke endemic areas in rural southern Laos

Vilavanh Xayaseng [a,b,c], Khampheng Phongluxa [a,b,c], Peter van Eeuwijk [c,d], Kongsap Akkhavong [a], Peter Odermatt [b,c,*]

[a] National Institute of Public Health, Ministry of Health, Vientiane, Lao People's Democratic Republic

[b] Swiss Tropical and Public Health Institute, Basel, Switzerland

[c] University of Basel, Basel, Switzerland

[d] Institute of Social Anthropology, Basel, Switzerland

* Corresponding author: Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, Socinstrasse 57, P.O. Box, 4002 Basel, Switzerland, Tel. +41 61 284 82 14, E-mail: peter.odermatt@unibas.ch

This manuscript has been published in *Acta Tropica 2013, 127:105-11*

6.1 Abstract

Consumption of raw or insufficiently cooked fish is a major public health concern in Southeast Asia, and in Lao People's Democratic Republic (Lao PDR), in particular. We aimed to assess the knowledge, attitudes, perceptions and practices of villagers in liver fluke endemic areas related to raw fish preparation, consumption and its health consequences. In February 2010, eight focus group discussions (FGDs, 35 men and 37 women total) and direct observations were conducted in four randomly selected villages in Saravane District, SaravaneProvince (Lao PDR). FGDs distilled the knowledge, attitudes, perceptions and practices of adult community members on raw fish preparation, consumption and its consequences for health. Conversations were transcribed from notes and tape-recorders. MAXQDA software was used for content analysis. Knowledge regarding the health effects of raw fish consumption was heterogeneous. Some participants did not associate liver fluke infection with any ill health, while others linked it to digestive problems. Participants also associated vegetables and tree leave consumption with liver fluke infection. The majority of FGD participants considered fish flesh that had been prepared with weaver ant extract to be safe for consumption. Visual appearance, taste, smell and personal preference were given as reasons for consuming raw fish dishes. Moreover, participants considered it a traditional way of food preparation, practiced for generations in Laos. Ten different fish dishes that use raw or fermented fish were identified. All FGD participants reported consuming dishes with raw fish. This study reveals a low degree of knowledge among local people on the health risks related to frequent consumption of raw or insufficiently cooked fish. Fish dishes were considered to be 'well-prepared' (that is, 'cooked') even though the fish had not been heated. In future, successful health education campaigns will have to address the specific knowledge, attitudes, perceptions and practices of the concerned population.

Key words: raw or insufficiently cooked fish dishes, food preparation, raw fish consumption, liver fluke, Laos, Opisthorchiasis, *Opisthorchis viverrini*

6.2 Introduction

Raw and insufficiently cooked food consumption is very common in Southeast Asia (Grundy-Warr et al., 2012). In Lao People's Democratic Republic (Laos, Lao PDR) raw food consumption has deep cultural roots. For instance, in the southern Saravane Province, up to 90% of village populations regularly consume raw or insufficiently cooked fish (Sayasone et al., 2007). Food transmitted parasitic infections are, as a matter of course, very common in Laos. Of major public health concern is infection with the liver fluke *Opisthorchis viverrini,* a food-borne trematodiasis transmitted through the consumption of raw or insufficiently cooked fish. *O. viverrini* infection may lead to severe hepatobiliary pathologies, depending on the duration and intensity of infection (Mairiang et al., 2012; Mairiang and Mairiang, 2003; Sayasone et al., 2012). A most severe complication is cholangiocarcinoma, a fatal bile duct cancer (Sripa et al., 2011; Sripa et al., 2012).

O. viverrini infection is endemic in several countries in Southeast Asia (Sithithaworn et al., 2012) and in all provinces of Laos(Rim et al., 2003). It is highly prevalent in central and southern Laos, reaching infection rates of more than 90% in adult populations (Forrer et al., 2012; Sayasone et al., 2007; Sayasone et al., 2011). It is estimated that over 2 million Laotians are currently infected with liver flukes (Sithithaworn et al., 2012). Mixed infection (multiparasitism) with food-borne trematodiasis, such as *O. viverrini*, and minute intestinal flukes, such as *Haplorchis taichui* and others, is also very common in Laos PDR(Sato et al., 2010; Sayasone et al., 2009b).

To combat the problem, the Ministry of Health employs an intervention strategy of preventive chemotherapy using praziquantel (single dose 40 mg/kg body weight) combined with health education and promotion of latrine use. However, in the presence of widespread and frequent consumption of raw or insufficiently cooked fish dishes, rates of re-infection with *O. viverrini* are rapid and high. Hence, food consumption behaviour change is a prerequisite for sustainable control of liver fluke infection and associated diseases (Ziegler et al., 2011).

To advance our understanding of how best to achieve food consumption behaviour change in this context, we studied villagers' knowledge, attitudes, perceptions and practices related to the consumption of raw and insufficiently cooked fish dishes in rural

communities in southern Laos that are highly endemic for liver fluke infections. We conducted a qualitative study using focus group discussions (FGD) and direct observation in four villages in SaravaneProvince.

6.3 Methods

6.3.1 Study design and area

This research was part of a larger project in Saravane District, SaravaneProvince, on "Rolling out preventive chemotherapy to achieve rapid and sustained impact on opisthorchiasis and soil-transmitted helminthiases in Lao PDR: an intervention study in Saravane District", which was launched in January 2010. We used direct observation and FGDs (Dawson et al., 1993; Silverman, 2007) to collect qualitative information on the knowledge, attitudes, perceptions and practices related to liver fluke infection and raw and insufficiently cooked fish consumption.

The study was carried out in February 2010 in four randomly selected villages in Saravane District, namely in Hangphounoy, Napheng-Gnai, Songkhon and Nongboua-Gnai. Saravane District is located in the low plain of Saravane Province (in the southern part of Lao PDR) and has a total population of 94,965 people (48,636 women) living in 179 villages and 13,239 households; the average income is 762 USD/person/year; 674 families are categorised as poor (4.8%); and the annual fertility rate is 2.4%. Saravane District is located around the provincial capital Saravane, where a provincial hospital with 70 beds is located. This district has 9 health centres, 19 pharmacies, 91 village drug kits and 67 health workers (unpublished report of Saravane District Health Office, 2009). In 2007, exceedingly high *O. viverrini* infection prevalence rates of 88.7% per village were observed in Saravane District, latrines were barely available and knowledge of liver fluke infection was scare. Most people harboured two worm species (Sayasone et al., 2007).

6.3.2 Characteristics of study population

FGD participants were adults aged 16-59 years from randomly selected households in four study villages. They had lived in the village for at least one year. Each FGD included 8-10 local participants. Two FGDs were conducted in each of the four villages: one with men and the other with women.

6.3.3 Data collection

Direct observation was carried out during visits to the four villages and results were noted. Observations focused on the cleanliness of houses, the type of water supply available, the distribution of information, education and communication campaigns (e.g., poster), and food preparation and consumption practices. FGDs were held at the Buddhist temple or at another appropriate protected public space. FDGs were led by a moderator and an assistant who took notes. All FGDs were conducted in Lao language and recorded by a digital tape recorder. Four FGDs with 35 men and four FGDs with 37 women were carried out.

A moderator led the discussion, using a discussion guide. An explanation of the parasite and its transmission was not provided to FGD participants beforehand. Using open-ended questions, participants were asked about their knowledge of liver fluke infection and associated health problems. The main questions posed in this discussion were: (i) describe *"san tap"* or *"pha yat bai mai nai tap"* (liver fluke – opisthorchiasis); (ii) how is it transmitted to humans and what diseases and symptoms does it cause? (iii) what other worms do you know, how are they transmitted to humans and what diseases and symptoms do they cause?; and (iv) explain how worms cause health problems in your community. Discussions about the participants' attitudes and perceptions focused on judgements and experiences regarding raw or insufficiently cooked fish preparation and consumption. Discussions about related practices centred on the mode of preparation of fish dishes and their consumption. For these two discussions, the main questions asked were: (i) tell us about the kind of food you eat most often; (ii) where do you find your food? (iii) describe how you prepare beef and pork? (iv) explain how you cook fish; (v) give details of your raw fish consumption; what type of dish do you eat most often? When and on which occasions do you eat raw fish? Why do you eat dishes made of raw fish? (vi) tell us about raw fish consumption in your family.

6.3.4 Data management and analysis

Notes and tape-recorded discussions were transcribed into Lao the day after the discussion. Subsequently, the transcripts were translated into English and imported into MAXQDA (version 10, VERBI Software). The statements were coded in different groups

and categories; all coded data were retrieved and exported to Excel for frequency analysis and content exploration.

6.3.5 Ethical considerations

Province, district and village authorities were informed about the study and their approval was obtained. The objectives and procedures of the study were explained in detail to FGD participants. It was made clear that discussions would be tape-recorded. All participants gave their written informed consent prior to enrolment. Ethical clearance was obtained from the Ethical Board of WHO and the National Ethics Committee for Health Research (NECHR), Ministry of Health, Vientiane, Lao PDR (Reference No. 169/NECHR, 1 April 2008).

6.4 Results

6.4.1 Observations

On several occasions, we observed villagers eating raw fish dishes. For instance, during our field visit to Napheng-Gnai, we observed people preparing and consuming a sticky raw fish dish, which was also served with Lao alcohol. The villagers, irrespective of their ethnic group or age, commonly consumed papaya salad with raw fermented fish sauce. The fish species used for these dishes were tracked and photographed in the Saravane market (Figure 6.2b).

We looked at health education posters on the walls of village authorities' houses and health centres. Posters were distributed by the Saravane District Health Office. They displayed information on bird flu prevention, hand washing with soap and latrine use, impregnated mosquito bed net use and rapid diagnostic tests, breastfeeding, vaccination, and family planning. We did not find posters on raw food consumption, liver flukes or related diseases.

Inhabitants engaged in a number of good hygiene practices. For example, we observed that people drank boiled water (water was mainly taken from rivers or unprotected wells due to preference for its taste, except for in Songkhon village where water was taken from public pumps), kept their livestock sheltered, and had a few sanitation facilities available (in Hangphounoy and Napheng-Gnai).

6.4.2 Characteristics of FGD participants

Seventy-two participants attended the eight FGDs: 51.4% were women; the mean age was 38.5 years (SD 11.1 years, age range 16-59 years). The majority (75.0%) were Buddhists whereas 25.0% were animists; 75.0% belonged to the Laoloum ethnic group; others belonged to *Xuoi* (23.6%) and *Katang* (1.4%) ethnic group. Thirty-four point seven had never attended school; more than half of them had finished primary school (55.6%), and some had graduated from secondary school (9.7%). Almost all participants (94.4%) were farmers; other occupations included labourer at the wood factory, gardener, and manager of a retail shop.

6.4.3 Focus group discussion results

In colloquial Lao language 'liver fluke' was referred to as *"pha yat bai mai nai tap",* which means the 'leave in liver' disease. In SaravaneProvince, liver fluke was well-known as *"san tap",* which means 'white oval spot in liver' or simply 'liver disease'. This term was commonly used by laypersons and health personnel at the provincial hospital and other health facilities, e.g. for explaining the diagnosis and for communication with patients.

6.4.4 Knowledge of liver flukes

Forty-one participants (57.8%) indicated that they were aware of liver flukes, in general. Liver fluke transmission was attributed to the consumption of raw or insufficiently cooked food such as beef, pork, shrimp and vegetables or foliage from vegetables and trees. Some of those who had heard about liver flukes described its symptoms, such as severe illness, big abdomen, pale or yellow eyes, and a very thin body. More than half of the statements collected (52.0%) mentioned the health consequences of consumption of raw or insufficiently cooked fish, such as digestive problems (e.g. cramps and abdominal pain, diarrhoea, nausea or vomiting [40.0%]).

Nevertheless, 48.0% of the participants said that they had not experienced any health problems related to raw fish consumption. None of the participants had ever visited health services to treat an illness related to raw and insufficiently cooked fish consumption.

6.4.5 Attitudes on raw fish consumption

When discussing food preparation, the majority of participants specified that the preparation of fish with weaver ant extract (i.e., a 'sour juice' made from squeezed adult weaver ants) (Figure 6.2a) was effective as a form of 'cooking'. Participants explained that weaver ant extract tastes sour and when fish is mixed thoroughly with this extract it is then safe and ready for consumption, particularly after the fish flesh turns white and/or the flesh becomes firmer. Participants thought that this mode of preparation was equivalent to boiling or heating fish. Most participants in Hangphounoy village (60.0%) stated that fish prepared with weaver ant extract was equivalent to well-cooked food and, thus, not harmful to health.

Fish salad *(koi pa)* is a dish that contains raw or insufficiently cooked fish flesh (Figure 6.1c). Some participants believed that by adding ingredients such as spices (e.g., chilli, pepper or ginger), salt, monosodium glutamate, alcohol, or warm water, the fish would become a well-prepared ('cooked') and healthy dish.

"To squeeze fish flesh with weaver ant extract only makes fish flesh hard, but it is not equivalent to well-prepared food and it [ant extract] cannot kill the disease, unlike ingredients such as chilli, salt, or glutamate; it is only through adding these that it [fish] becomes equivalent to a cooked dish – and this can kill the disease"
(Woman, 58 years).

6.4.6 Perception

When asked why they consumed raw fish dishes, the majority of participants argued and emphasised that it was due to personal preference for these dishes, which was shaped by sensory qualities such as visual appearance, flavour, and taste. Some stated that these dishes provide physical energy and strength necessary for hard work. All participants said that they ate raw fermented fish; when asked to discuss why they did so, all participants strongly emphasised that the addition of raw fermented fish *(pa daek)* (Figure 6.1d) in papaya salad has been a traditional formula in Lao cuisine for generations.

"I like to eat raw fish, I can work and go everywhere tirelessly after consuming raw fish"
(Man, 45 years).

The majority of participants (75.0%) felt safe consuming raw fish dishes because it is a long-standing tradition that has been practiced for many generations. Some (45.0%) mentioned that the use of raw fish in various dishes is a traditional Lao cooking style, which has been passed on from generation to generation and that it is important to serve these dishes at many social and cultural ceremonies.

"If everybody consumes raw fish dish during that event except for me, it is impossible to eat cooked food alone" (Man, 45 years).

6.4.7 Practice

When discussing liver fluke transmission in connection with raw fish consumption, 11.1% of the participants conceded that they definitely ate raw fish. Moreover, 12.5% of the participants consumed several types of raw fish dishes, even though they were well aware of the risks of parasitic infections such as taeniasis. The majority of participants (75.0%) consumed raw fish dishes once per month, particularly *"koi pa"* (fish salad) or *"lap pa nuew"* (sticky fish salad) (Figure 6.1b).

Participants mentioned ten different raw or insufficiently cooked fish dishes, such as *lap pa nuew* (sticky fish salad), *som pa juom/som pa jao* (fermented fish), *pa daek nuew* (sticky fermented fish or Lao fish sauce or)*, koi pa/koi kuan som* (fish salad), *loi pa siew/koi pa siew/koi kun som* (small fish salad)*, lap pa* (Lao fish salad), *soy soth* (Lao fish soup)*,soy cham* (wrap fish flesh with sauce), *chew pa dek nuew* (sticky fermented fish sauce)*,tam mak hoong* (papaya salad) (see Table 6.1). Few fish dishes were 'well-prepared' with raw fish flesh treated with weaver ant extract, while several dishes were prepared with raw fermented fish. All participants reported that they commonly consumed at least two types of the above-mentioned fish dishes; *pa deak nuew* (sticky fermented fish) was the most important flavouring substance for papaya salad.

When comparing the raw fish consumption between men and women, we found that men consumed more raw fish dishes than did women. Men showed a particular preference for *lap pa nuew* (sticky fish salad), while women preferred insufficiently cooked fish for its sour taste, for example *koi pa* (fish salad). Young children, in general, were not allowed to consume raw fish as they may not withstand the respective diseases. From 14 year onwards, children were allowed to consume raw fish dishes.

Figure6.1a: Welcome lunch of rural villagers served with sticky raw fish salad

Figure 6.1b.sticky raw fish salad, (c) raw fish salad, and (d) raw fermented fish sauce sold in Saravane market

Figure 6.1c.Raw fish salad *(Koi Pa)*

Figure 6.1d. Raw fermented fish sauce sold in Saravane market

"I do not allow my kids to eat raw fish, they are still young (3 and 5 years old), they would catch a disease; but if my kids were older than 14 years then I would allow them to eat it" (Woman, 25 years).

Participants who did not consume raw or insufficiently cooked fish had previously had an illness episode that they had perceived to be a consequence of raw fish consumption. Eight participants had stopped eating raw fish a few years before the FGDs, whereas three other participants continued to eat it from time to time. They particularly enjoyed consuming raw fish salad and raw sticky fish salad. However, all participants stated that they sometimes consumed green papaya salad with raw fermented fish. Some participants commented that they disliked the appearance of bright fish scales as they had often observed in *lap pa nuew* (sticky fish salad) and *koi pa siew* (small fish salad).

6.5 Discussion

Our qualitative research contributes to understanding raw fish consumption in liver fluke *O. viverrini* endemic settings in Lao PDR. In order to develop appropriate health interventions in endemic rural communities, we need to understand people's knowledge, attitudes, and perceptions of liver fluke infection in relation to practices of raw and insufficiently cooked fish consumption, preparation of fish dishes and potential health consequences.

Our results showed that (i) knowledge of health risks related to raw fish consumption was rather low and misconceptions were widespread; many villagers were unaware of the existence of liver flukes; those individuals who knew of it were uncertain about the origin of infection and/or its latent health consequences. (ii) fresh fish prepared with weaver ant extract or spices was considered to be 'well-cooked', comparable to boiled, fried or grilled fish dishes, and therefore safe for consumption. (iii) study participants reported a wide variety of raw fish dishes. Many villagers mentioned the long tradition of preparing and consuming these dishes and argued that this long-standing practice did not put people at any risk. In addition, these dishes are frequently prepared and served during feasts, celebrations or other social or religious gatherings where refusing to consume them is socially unacceptable.

In Southeast Asia, including Southern China, raw or insufficiently cooked fish consumption is a high-risk nutritional behaviour and, therefore, also a major public health concern. Liver fluke infections, i.e., *O. viverrini* and *Clonorchis sinensis*, are highly prevalent in rural communities where raw fish consumption is widely practiced (Sithithaworn et al., 2012). A high prevalence rate of *O. viverrini* infection (85.0%) was also reported in the present study area in 2010 (Phongluxa et al., 2013).

The majority of these infections are asymptomatic. Severe hepatobiliary disease is associated with long-lasting infections (Mairiang et al., 2012; Mairiang and Mairiang, 2003). Both liver fluke species were recognised as carcinogenic agents by WHO and may lead to cholangiocarcinoma (CCA), a bile duct cancer with a very poor prognosis (Sripa et al., 2012). Today, the highest CCA rates in the world are reported in Southeast Asia, where high liver fluke infection rate also exist. For instance, in Khon Kaen Province, Northern Thailand, more than 1,000 new CCA cases are diagnosed each year (Sripa et al., 2012). Participants in the present study were unaware of the signs and symptoms related to *O. viverrini* infection. Therefore, health education explaining the.*O. viverrini* infection and its related diseases in rural endemic communities endemic communities of Laos is of utmost importance; this is even more relevant since this disease is life threatening and not curable in its late stages.

Community-based interventions against liver fluke are currently based on preventive chemotherapy and information, education and communication (IEC) programmes. However, if raw fish consumption behaviour is not changed, liver fluke re-infection rates will remain high. For instance, after several decades of liver fluke control in Northeast Thailand, high liver fluke infection rate and high CCA incidence persist (Sripa et al., 2012). Hence, building awareness of the health risks of raw fish consumption and changing food consumption behaviour are prerequisites for sustainable control of liver fluke in rural endemic areas. Changing food consumption behaviour in this context requires formalised health education, as well as (i) information sharing networks within local peer-groups – for instance, from mother to mother on how to safely prepare fish dishes and on the life cycle of *O. viverrini* infection, its mode of transmission and associated health risks – where the implementation of information is socially controlled; (ii) the engagement of prominent ‘agents of change’ in a village, such as the head of village, village health volunteers, and the head of the Lao Women’s Union, who apply safe fish preparation and consumption practices and spread knowledge of *O. viverrini*

Table 6.1: Raw fish dishes commonly prepared in southern Laos

Name of dish	Description of preparation
Sticky fish salad *(LapPa Nuew)*	Mince fish, except head and tail, produce a soup with rest of fish and add fermented fish sauce, add it gradually to the minced fish while stirring until the minced fish becomes sticky; then add salt, glutamate, galangal, grilled chilli, coriander *(Eryngo)* and mint. Serve with green mustard green *(Pak Kad Kiew)*, *Pak Ka Donh(Careya arborea)*, young mango leaves, mango, sour leaf (wild) and/or Lao-style fried rice (roasted rice).
Fermented fish *(SomPa Juom, SomPa Jao)* cooked with*Pa Siew*	Add salt to raw fish (cut in small pieces), and leave ferment for 1 to 4 weeks. Then mix with spices and glutamate, natural leaves from paddy fields, green tamarind, and galangal. Serve with eggplants and tamarind.
Sticky fermented fish (Lao fish sauce) *(Pa Daek Nuew)*	Grill fish *(Pa Siew)* or leave it dry in sunlight, pound dried fish and add a little bit of water, then combine with spices (and salt and glutamate), keep it in bamboo stick for the fermentation a few months. Add alcohol or rice schnapps.
Fish salad *(Koi Pa/Koi Kuan Som)*, we cook *Pa Kor (Channa striata - Ophiocephalus striatus)* and *Pa Khao Mon (Puntius brevis)*	Slice fish meat delicately into edible pieces, then squeezing fish meat and weaver ants until meat is hardening and the colour of fish changes to white. Mixing white fish meat and ingredients such as salt, glutamate, galangal, Lao-style fried rice (roasted rice), grilled chilli, fermented fish, *Eryngo* (saw tooth coriander). Serve with *Pak Choi(Brassica rapa var. chinensis)*, dill, *Pak Ka Donh(Careya arborea)*, mint *(Mentha arvensis)*, lettuce *(Lactuca sativa)*, wild vegetable *(Song Pha)*, and young chayote leave.
Small fish salad*(LoiPa Siew/Koi Pa Siew/Koi Kun Som)* cooked by *Pa Siew*	Squeeze weaver ants and lime with fish until fish meat colour changes to white. Mix with salt, glutamate, Lao-style fried rice (roasted rice), and chilli. Serve with *Pak Choi*, dill, *Pak Ka Donh(Careya arborea)*, mint, and young chayote leave, sour leaf (wild).
Lao fish salad *(LapPa)*	Squeeze weaver ants and lime with fish until fish meat colour changes to white. Mix with Lao-style fried rice (roasted rice), galangal, glutamate, salt, grilled chilli, fermented fish, coriander *(Eryngo)*. Serve with *Pak Choi*, dill, *Pak Ka Donh(Careya arborea)*, mint, and young chayote leaves.
Lao fish soup *(Soy Soth)*	Boil head and tail of fish as soup and leave until cool. Cut rest of fish meat in pieces and squeeze with weaver ants until the colour of the fish meat is white. Mix with salt, glutamate, chilli and green onions, and add the fish meat into the soup. Serve with *Pak Choi*, dill, *Pak Ka Donh(Careya arboreal)*, mint, young chayote leave.
Wrap fish in vegetable and sauce *(Soy Cham/Soy Pa/Soy Ta Puern Jiew)*: *Pa Kor (Channa striata - Ophiocephalus striatus)*, *Pa Pak (Hypsibarbus vernayi), Pa Kaeng (Cirrhinus molitorelle)*,or big fish size	Cut fish delicately and squeezing with weaver ants *(Oecophylla smaragdina)* until fish colour has changed to be white. Cooking the sauce from the soup of squeezing fish meat and weaver ants by combining with ingredients below. Add salt, glutamate, galangal, and chilli. Wrap the fish in vegetables and put it into the sauce. Serve with Dill, *Pak Ka Donh(Careya arboreal)*, sour leaf (wild; *Pak Tiew*), *Pak Choi(Brassica rapa var. chinensis)*, morning glory.
Sticky fermented fish sauce *(JiewPa Daek Nuew)*	Use sticky fermented fish (see above). Mix with salt, glutamate, chilli, green onion, and mint. Serve with tamarind and vegetable or eat with only sticky rice.
Papaya salad *(Tam Mak Hoong)*	Shred green papaya. In a mortar pound with salt, glutamate, sugar, tomato, chilli, garlic, raw fermented fish (sticky/liquid fermented fish), and lime juice. Serve with lettuce, cabbage, morning glory, and jackfruit leaf.

infection, resulting in behavioural changes triggered by imitation and adoption; (iii) stronger political commitment to ending raw fish consumption, actively promoted by politicians, health professionals, and media figures at national, regional and local levels.

In Lao PDR, the epidemiological conditions for liver fluke transmission and its health impacts are similar to endemic settings in Thailand. However, information on community knowledge, attitudes and practices related to liver fluke infection and raw fish consumption is scarce in Lao PDR. A previous survey conducted in central Laos showed a low degree of knowledge of liver fluke infection and its associated health problems(Strandgaard et al., 2008). The finding is not very different from that of the present study, although the *O. viverrini* infection rate in the current study area was higher, namely 88.7% in adult population (Phongluxa et al., 2013).

The present study identifies some important local conceptions about raw fish consumption. Many participants considered raw fish dishes such as *"koi pa"* to be safe and well-cooked food, equivalent to boiled, fried or grilled fish, because the fish flesh turned white after it was mixed with weaver ant extract, different spices (like chilli), alcohol and/or warm water. This result is consistent with observations by Wang who mentioned that male villagers liked to consume raw fish with alcohol, which they perceived as "a way of life for generations" (Wang, 2012). In fact, this so-called 'well-cooked' dish is not safe for consumption as metacercariae, the infectious stage of liver fluke, survive. Unless fish is cooked over fire – frying, boiling, roasting, and grilling – it remains infectious (Abdussalam and Kaferstein, 1994).

Another common conception was that one felt vigorous and able to work tirelessly after eating raw fish. This conception is corresponding to the high percentage of raw fish salad consumption *"koi pa"* among the general population in this study district, which was reported in 2007 (75.2%) (Sayasone et al., 2007) and in 2010 (75.4%) (Phongluxa et al., 2013). Eating raw fish salad may indeed transmit *O. viverrini* infection. A recent study confirmed that in *"koi pa"*,*O. viverrini* metacercariae remain viable for considerable time (Prasongwatana et al., 2013). Promoting safe fish dishes and demonstrating their preparation, combined with establishing accurate knowledge of *O. viverrini* life cycle and route of transmission is a promising approach to addressing this problem.

In our study we found that raw fish dishes are often served at secular and religious events and cannot be refused by the attendees; eating the same food means keeping the bonds of friendship and kinship. In other words, “The offering and distribution of food and the act of commensality create bonds between the giver and the receiver, so helping to shape our sense of identity, belonging and hierarchy” (Weichart, 2008). Traditional dishes are of particular importance in religious and community festivities and are special offerings to guests. Refusing to eat these dishes is socially unacceptable and can be interpreted as not participating in the community.

The rich list of raw or insufficiently prepared fish dishes identified in the study reflects a long tradition of raw fish consumption in rural communities in Laos. Many participants stated that they regularly consume several types of raw fish dishes. In rural settings where the population has a relatively low formal educational level, raw fish consumption is widely practiced. Our results correspond to findings from Northeast Thailand that show that eating raw fish salad, *“koi pa”*, is common in fishermen and peasant communities. It is an inexpensive source of protein for the local population and it is well adapted to the livelihoods of local communities (Grundy-Warr et al., 2012). In our study, almost all participants were rice farmers, dependent on fish for protein and on wild vegetable collection (mainly bamboo and mushroom) in the surrounding forests. In general, during the rainy season (from July to October) a lot of fish is available in pond and rivers (Figure 6.2b) and, thus, villagers consume a lot of fish dishes during this season.

The preparation technique for sticky fish salad, *”lap pa nuew”*, might allow for viable *O. viverrini* metacercariae to survive because the preparation techniques do not differ much from those for raw fish salad, *“koi pa”,O. viverrini* metacercariae have been scientifically confirmed for *“koi pa”* (Prasongwatana et al., 2013). Raw fish salad, *“koi pa”,* requires a bigger quantity of fish than does sticky fish salad*”lap pa nuew”*. Therefore, when villagers have only a few fish at hand and want to serve many people (Figure 6.1a), they opt for sticky fish salad, *“lap pa nuew”*. *“Hor som pa”* is a sour fermented fish wrapped in banana leaves that can be kept for a couple of days. It is another fish dish in which the presence of viable *O. viverrini* metacercariae was confirmed in liver fluke endemic villages (Prasongwatana et al., 2013). Though this fish dish is not reported in our study, Grundy-Warr et al. (2012) presented it in their study paper. *“Hor som pa”* is also available and popular in other areas of Lao PDR. Hence, in order to deter this habit of eating raw and insufficiently cooked fish dishes, IEC

campaigns must emphasise that even if a dish is prepared according to long-standing traditions, it might still represent a health risk. Health consequences are mostly invisible and symptoms may start only years after raw fish consumption. These factors must be fully addressed in any future interventions targeting behavioural change regarding food consumption and preparation.

We limited our in-depth study to four villages in Saravane Province. Different areas in Lao PDR or in other liver fluke endemic settings might provide further relevant findings. However, our study results show that a qualitative approach provides relevant insights into the knowledge, attitudes, perceptions and practices of communities, which can improve the quality of future health interventions.

Figure 6.2a: Weaver ant colony on a wattle tree

Figure 6.2b: Cyprinoid fish in the market of a village

6.6 Conclusion

This study assesses the knowledge, attitudes, perceptions and practices of raw and insufficiently cooked fish consumption as it pertains to liver fluke infection in a southern province of Laos. Communities have poor knowledge of the mode of transmission for liver fluke infection and of the health consequences of eating raw fish dishes. Local perceptions suggest that preparing raw fish flesh with weaver ant extract, spices like chilli, ginger, and salt, alcohol and/or warm water is equivalent to well-cooked fish. Raw fish consumption is a long-standing nutritional tradition in Laos and such dishes are served to welcome guests at home and at all social and cultural festivities. Popular dishes served at such events include raw fish salad *"koi pa",* sticky raw fish salad *"lap pa nuew",* Lao fish soup *"soy soth",* and wrapped raw fish flesh with vegetables and dipped in the sauce *"soy cham"*. These raw fish dishes cannot be refused by guests; to eat the same food means to keep the bonds of friendship and kinship. Additionally, raw fermented fish – fish soaked in salty water for more than two months – is widely used as a main ingredient for papaya salad, raw fish salad, and other dishes. These qualitative findings underscore the importance of public health interventions in endemic

communities, particularly health education. Shaping the knowledge of community members (i) on the transmission of liver fluke infection, (ii) on the diseases related to raw and insufficiently cooked fish consumption, and (iii) on safely preparing fish dishes will be an important feature of such health education programmes. Trained health centre staff and village health volunteers are the appropriate mediators through which to provide the right health messages in their own communities and to ensure the sustainability of such a soft intervention.

6.7 Acknowledgements

We express our thanks for the support to all FGD participants, to the village authorities, and to the authorities of District Health Office and Provincial Health Department of Saravane. Our thanks also go to Drs. K. Akkhavong, S. Keodouangchanh, C. Schaetti and Mrs. Audrey. Bochaton for their help. Mrs. A. Briet efficiently edited English language. The study was funded by WHO. Drs. V. Xayaseng and K. Phongluxa received support from the City of Basel and the Rudolf Geigy Foundation.

SECTION II: Assessment of deworming intervention in southern Laos

Chapter 7: Perceived illness drives participation in mass deworming campaigns in Laos

Khampheng Phongluxa[a,b,c], Peter van Eeuwijk[b,c,d], Phonepasong Soukhathammavong[a,b,c], Kongsap Akkhavong[a] and Peter Odermatt[b,c*]

[a] National Institute of Public Health, Ministry of Health, Ban Kaognot, Sisattanak District, Vientiane Capital, Lao PDR

[b] Swiss Tropical and Public Health Institute, Basel, Switzerland

[c] University of Basel, Basel, Switzerland

[d] Institute of Social Anthropology, University of Basel, Münsterplatz 19, CH-4051 Basel, Switzerland

* Correspondence: Peter Odermatt, Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, P.O. Box, CH-4002 Basel, Switzerland. Tel.: +41 61 284 82 14; fax: +41 61 284 81 05; E-mail: peter.odermatt@unibas.ch

This manuscript has been published in Acta Tropica 2014

7.1 Abstract

Multiple helminth infections are very common in communities of southern Laos. Preventive chemotherapy in combination with health education is the mainstay of control. We assessed the knowledge, perception and practices of rural communities related to the endemic helminthiasis and their control during a mass-drug administration (MDA) campaign. Short interviews with household heads (n = 192), direct observations and discussions with attendants of mass drug administrations, and in-depth interviews with local opinion leaders (n = 21) were carried out. Quantitative and qualitative data analysis was performed. Results showed that opinion leaders and villagers were well aware of the importance of attending MDA. Leaders perceived the effectiveness of MDA against severe schistosomiasis and appreciated that it was provided for free and in their village. They encouraged villagers to attend it. Anticipated adverse effect of praziquantel was a barrier for participation. A majority of leaders purchased deworming tablet (mebendazole, albendazole) in a local pharmacy for deworming when MDA is absent in their villages (19/21). Most leaders (20/21) had a good knowledge on severe schistosomiasisthough only a few of them (5/21) described its cause correctly. They knew little about the disease consequences of liver fluke (3/21) and soil-transmitted helminth (4/21) infections but more about their causes. A high risk for worm infection was observed: consumption of raw or insufficiently cooked fish (100%), frequent physical contacts with Mekong River water (76.0%) and low number of latrines (14.5%). In conclusion, MDA is widely accepted in affected communities. Avoiding severe schistosomiasis was the main motivation to comply. Participation rates increased significantly with drugs provided free of charge in the villages. Better knowledge on the consequences of worm infections and its modes of transmission will foster the distribution and acceptance of appropriate preventive treatment and other measures in helminth endemic communities. Where multiple infections require several drugs for MDA, preceding health education and information about MDA and its benefits are a prior condition.

Key words: knowledge, perceptions, mass drug administration, *Opisthorchis viverrini*, *Schistosoma mekongi*, deworming

7.2 Introduction

Preventive chemotherapy campaigns combined with information, education and communication (IEC)are the mainstay of large-scale control of helminthiasis promoted by the World Health Organization (WHO) (Hotez et al., 2006; WHO, 1995; WHO/HTM/NTD, 2011). WHO recommends that more than 75% of an affected population should attend a mass drug administration (MDA) (Hotez et al., 2006). Several drugs are recommended depending on endemic helminthiasis. In area where multiple helminth infections are prevalent several drugs are used simultaneously, e.g., praziquantel (against schistosomiasis) and albendazole (against soil-transmitted helminthiasis [STH]). Areas of multiple parasitic infections are very common.

Lao People's Democratic Republic (Lao PDR, Laos) is committed to preventive chemotherapy. The National Centre for Malariology, Parasitology and Entomology (CMPE) under the supervision of the Ministry of Health is thereby a main body for implementing the corresponding control activities. In the 1980ties and 90ties, MDA has been conducted in Champasack provinces' endemic foci of Mekong schistosomiasis and opisthorchiasis for several years (Montresor et al., 2008; Muth et al., 2010; Urbani et al., 2002) Since 2005, a nationwide annual mass treatment STH in primary school children is carried out through school health programmes (Phommasack et al., 2008). Concurrent helminth infections are very common in the southern provinces of Lao PDR (Sayasone et al., 2007; Sayasone et al., 2009b; Sayasone et al., 2011).

The objective of this study was to better understand knowledge, perceptions and practices in communities on helminth control in areas where the prevalence rates of concurrent helminthiasis infections are very high and thus where MDA based interventions require the use of several drugs.

7.3 Methods

7.3.1 Ethical consideration

Ethical clearance was obtained from the National Ethic Committee on Health Research, MOH, Lao PDR, No 027/NECHR, and the Ethic Committee of Kanton Basel-Stadt 255/06. Informed consent was obtained from interviewees before enrolment.

7.3.2 Study area

The study was carried out on Donelong island, Khong District, ChampasackProvince, Southern Laos (Figure 3.3). The Mekong island area is a most important source of freshwater fish (including Cyprinoid fish species) in southern Laos. Fishery is a main livelihoods together with rice cultivation and livestock (Singhanouvong and Phouthavong, 2002). Widespread rocky banks are suitable habitats for *Neotricula aperta* snail, the intermediate host for *S. mekongi* transmission (Ohmae et al., 2004). Donelong island is highly endemic for the Mekong schistosomiasis (Sayasone et al., 2011). Four villages are on Donelong namely Houalong, Longsong, Longkang and Hanglong. The total population is 2,054 inhabitants (316 households). Most villagers are subsistence farmers and fishermen. MekongRiver is a main water source for household and cultivation activities. A pharmacy and health facilities do not exist on the island. The nearest pharmacy is located in Meaungsen village on the mainland, approximately 30 minutes by motorboat. The closest health facility is the Khong district hospital which is accessible by motorboat and then by road, roughly within a one hour travel time. There is no drug revolving fund scheme in these four villages. In Khong District (including Donelong Island) *S. mekongi* control started in the 1980 ties (Muth et al., 2010; Urbani et al., 2002). Several MDA rounds combined with health education were conducted between 1984 and 1999 using praziquantel and mebendazole/albendazole (Urbani et al., 2002). In 2006, multiple helminth infections were documented at high prevalence rates on Donelong. Infection with *S. mekongi* and *O. viverrini* reached 68.0%and 92.0%, respectively. STH were very common (hookworm 76.8%, *Ascaris lumbricoides* 31.7%, *Trichuris trichiura* 25.0%) and *Taenia* spp. (1.8%) (Sayasone et al., 2011) and minute intestinal flukes (e.g., *Haplorchis taichui* 30.6%) were also reported (Lovis et al., 2009). In 54% of the examined Donelong population 3-6 simultaneous helminth specie infections were diagnosed, and in addition intestinal protozoa such as *Giardia intestinalis* (3.0%) were detected (Sayasone et al., 2011).

On Donelong, profound liver and intestinal morbidity was frequent due to *S. mekongi* infection (Muth et al., 2010). Co-infection with *O. viverrini* aggravated the liver morbidity (Sayasone et al., 2012). In addition bile duct morbidity associated to *O. viverrini* such as dilated bile ducts were frequent and of considerable severity (Sayasone et al., 2012). They are a risk factor for the development of cholangiocarcinoma, a fatal bile duct cancer (Sripa et al., 2011).

7.3.3 Study population and data collection

Data collection was carried out in June 2007 when a MDA campaign took place on Donelong. The research team spent four days and nights in each study village. Three methods of data collection were pursued: (i) short interviews with household heads, (ii) direct observations of attendees during MDA, and (iii) in-depth interviews with key informants (i.e., opinion leaders) such as head of village, village health volunteer, head of Lao Women Union, trained birth attendant, teacher and monk.

All heads of household who have participated in the MDA were interviewed using pre-tested structured interview in Lao language. It consisted of the general demographic characteristics of the respondents, household data like household assets, and type of house, risk factors for helminth infections like habit of eating raw or insufficiently cooked fish, possession of latrine, and having contact with the Mekong River like washing, bathing and fishing and previous participations in deworming campaigns. Each interview lasted 10 to 15 minutes.

During the distribution of deworming medicine, one researcher observed the MDA attendees as well as assessed their willingness to attend the treatment. The discussions during the waiting period before and after receiving the medicine were noted. All collected information about perceived importance of the medicines, their effects on worms and health, and the reasons for MDA participation were noted. The results of the observations were also written down during the four days in each village. The mass treatment was provided by the district and provincial authorities. Albendazole (400mg, oral, single dose) and praziquantel (40mg / kg BW, single dose) was given to all villagers except (i) children below four years of age, (ii) pregnant and breast-feeding women, (iii) people with any sickness on treatment day and (iv) persons under tuberculosis and epilepsy treatment.

In-depth interviews with opinion leaders of each village were performed. The interviews followed a pre-tested and pre-established discussion guide consisting of questions related to knowledge on MDA, on risk factors for helminth infections and on relationship between infection and disease, and to the perception and practices with respect to deworming in the community. Each interview lasted between 30 and 45 minutes. The

physical presence and availability during the survey days decided on whom the research team could interview.

7.3.4 Data management and analysis

Quantitative data was entered into Epidata freeware (www.epidata.dk). Descriptive analysis was performed with SPSS program (version 11.5). Qualitative data from the individual interviews were transferred into a notebook in Lao language and restored in full sentences after each interview. Interesting statements were directly quoted. All field notes were typed into a MS Word document in English. Subsequently, themes related to the general objectives of the study were marked. Information collected through direct observation was summarized daily. The interesting ideas and discussions among MDA attendees were quoted. Field notes from observation and qualitative statements from interviews constitute the qualitative data set. Finally, all these qualitative data were categorized, analysed and interpreted.

7.4 Results

During the interviews and observations, several Lao terms related to intestinal worms, worm infections, the associated disease and their treatments were mentioned by the villagers. They are presented in table 7.1 together with their literal translation and equivalent medical terms. A relatively rich terminology was found. Many of the Lao terms used by villagers are a description of the adult parasite (e.g., “worm with round body” for Ascaris lumbricoides), or its location in the body (e.g., “worm of liver leaves” for liver fluke parasite) or relate to the way of transmission (e.g., “snail disease” for schistosomiasis).

7.4.1 Interviews with heads of household

The interviews with 192 heads of household from four villages indicate a low variation of the answers between the villages. The socio-demographic profile shows that most interviewees were male (80.7%); the average age was 43.8 years (17-89 years; SD 12.9); more than half of them (54.5%) attended primary school. Most of them (77.6%) were farmers with a considerable amount of household assets: about half of the households (47.4%) owned cattle, and at least one motorboat (48.4%) while about one

third of the households had a motorbike (31.8%) and a TV set (39.1%). Almost eighty per cent (79.2%) of their houses were permanent, with wooden walls and floors and iron sheet roofs (Table 7.2).

Risk factors for helminth infections and transmission were highly prevalent in these households. All heads of household reported to consume regularly raw or insufficiently cooked fish dishes. Less than one sixth of the households had a latrine (14.5%). Almost two-thirds of households pumped water directly from the Mekong into the household (63.0%), and three quarter of villagers took regularly a bath in the river (76.0%)(Table 7.2).

Asked about deworming programmes in the community, 50.5% of the interviewees replied that they had already participated in earlier MDA campaigns: 63.9% of them attended MDA after the year 2000 while 36.1% of them participated even before the year 2000. Adverse effects after treatment with praziquantel (PZQ) were reported by 10.3% (Table 7.2).

7.4.2 Direct observations and discussions with MDA attendees

The distribution of the drugs took place in the central part of each village, at the ground floor of a villager's house. Benches and tables served as seats where health staff (two national, one provincial and one district health staff) arranged the materials and provided the treatment. MDA attendeeswere waiting nearby on benches and plastic chairs. The MDA campaign was carried-out between 7.30 am and 5 pm.

Most attendees were aware of the importance of MDA. They attended although the MDA took place during the rain-fed farming season where the majority of villagers were intensively working in the paddy fields or stayed in their distant fields, they were informed previously by relatives. They attended the treatment either in the early morning or in the late afternoon.

Some villagers refused the treatment due to their experience with adverse effects from previous mass treatments. A frequent topic of conversation during drug distribution was the issue of medicine causing tiredness. Thus, some mentioned that not all household members should attend the treatment on the same day in order to maintain the physical strength for field work. A woman who just took the medicine said: "After taking the

medicine today I do not go back to the field anymore. I will take a rest. I know that this medicine causes tiredness. I experienced that from a previous campaign".

During the MDA, some attendees experienced adverse effects after PZQ treatment. One girl (5 years old) had an allergic reaction just 15 minutes after her treatment whereas other treated villagers had neurological and gastrointestinal symptoms: dizziness, stomach-ache, vomit, and light diarrhoea. Apart from these "bad" symptoms people were glad that they received this drug treatment.

We observed that village leaders encouraged their community to participate in the treatment. A teacher announced: "Please take this opportunity, you know you cannot find this drug in the pharmacy. It is a good chance for you. I heard from the visit of the health staff that the more snail diseases you have, the more serious the side effects may occur. Myself, I think these side effects are common, you must be patient if you want to be healthy."

7.4.3 In-depth interviews with key informants

In-depth interviews were carried out with 21 opinion leaders. Three of them were teachers, one was a laboratory technician, and seventeen of them were farmers. Six were women; their mean age was 44.6 years (ranged 25-55 years), which was not different from the mean age of men (45.9 years, ranged 25-76 years; Table 7.3).

7.4.3.1 Schistosomiasis related discussion

Almost one fourth of opinion leaders (5/21, 23.8%) were aware that swimming or staying in Mekong River was a risk of acquiring infection with schistosomiasis. They obtained this knowledge from the health staff when they visited their village since quite some time. In contrast, many opinion leaders (15/21, 71.4%) believed that the snail disease was caused by drinking the water from rocky river banks; and a few persons believed that schistosomiasis resulted from their previous generations as a punishment because they drunk the cursed water and by this they were accused of doing 'bad things'.

Almost all interviewees (20/21) knew that this severe disease resulting from an infection with a parasite. They described the illness with developing a "big belly" and becoming "slim" and "pale". All of them had observed patients with severe schistosomiasis in their

village before the MDA were conducted. Today this condition is rarely seen anymore. They said that the most severe cases vomited a lot of blood, and once this symptom happened, they were never cured and have died.

7.4.3.2 Soil-transmitted helminth discussion

Most opinion leaders (20/21) understood that eating raw meat, not using latrines, not hand-washing before eating, and being bare-footed when walking outside the house were the risk factors for worm infection and transmission. However, when they were asked about the type of worms, none of the leaders could describe them.

The villagers were encouraged by most leaders (20/21) to follow the three rules of hygiene and cleanliness: proper eating, proper living and proper clothing. In addition, they stimulated the villagers to use latrines and to avoid eating raw meat. They gained this knowledge from friends, during visits of health staff, and through radio and TV. They have been never been formally trained. Only a few leaders (4/21) could describe the effects of a worm infection such as exhaustion, dizziness, rash, and nausea.

None of the opinion leaders thought to be infected with worms because no worms were expelled with faeces. In addition, they stated that an infection with worms was clearly not so harmful for their health like malaria, diarrhoea and fever, where they push people to seek care urgently.

7.4.3.3 Liver fluke infection discussion

More than the half of the opinion leaders (14/21) understood that eating raw fish was a risk factor for an infection with liver fluke while most of them (18/21) did not know the consequences of this infection. When asking them to make a relationship between a liver fluke infection and corresponding illness symptoms, only three leaders (3/21) stated that an infected person would become sick and could develop tiredness very easily, and showing tap kheng (hard liver).

Two leaders (2/21) reported that they themselves and fellow villagers believed that the sour nature of lemon juice killed the worms in fresh fish meat; therefore, when preparing raw fish salad, they added a lot of lemon juice. A leader (aged 50 years) said: “Most villagers including me believe that when we put a lot of lemon juice in the raw fish meat,

it is equivalent to fish meat being well cooked because the sour juice of lemon kills the worms."

7.4.3.4 Deworming in community

All opinion leaders (21/21) were aware of the drug called PZQ and its therapeutic effect against the snail disease. They recalled that the shape of a praziquantel tablet is elongated and has four segments.

They were convinced that after the villagers had participated in the MDA conducted in the community, the cases with big belly were rarely seen, and people's health was better today than before. For instance, children gained weight and did not suffer any longer from paleness. A head of a village (aged 46 years) said: "Have you seen Mr. Meo who is staying in Longkang village? He had a big belly when he was a child. His parents gave him the drug for the snail disease. Today he is very healthy and married, and has three children. This drug is so effective."

No one of the opinion leaders (0/21) understood that the deworming tablets were also provided as a medicine against STH. Few leaders (3/21) thought that MDA campaigns and drugs were effective also against the liver flukes.

All leaders perceived the positive effect of drug against schistosomiasis. All were aware that the drug was not available in the local pharmacy and was provided free of charge during the deworming activities Therefore, they actively encouraged their villagers to attend the deworming activity whenever it was conducted in their villages.

All opinion leaders reported to have participated in the MDA when it took place in their villages. In absence of deworming activities leaders reported that villagers treated worm infections as soon as they would observe worms in their faeces. They bought drugs directly from a pharmacy from the mainland without any prescription. They learned about the drug from own experience, friends, radio, TV, and the owner of the pharmacy. Some few leaders (2/21) used traditional medicine for treatment of tapeworms namely mark keua (a wild and bitter fruit) and ya louk korn (a small lump with the grinded bark of the peuark had tree).

7.5 Discussion

Our study assessed knowledge, perceptions and practices on worm infections and their control in rural communities of Southern Laos where multiple intestinal helminth infections are endemic. Mekong schistosomiasis, opisthorchiasis, STH and other helminthiasis are highly endemic and other intestinal parasitic infections such as taeniasis, intestinal protozoa and minute intestinal flukes are also prevalent. In addition, in a recent study one quarter of the Donelong population was diagnosed with *Strongyloides stercoralis* the most neglected among the neglected tropical infections.

Our results showed that MDA was accepted as an effective measure for the control of *S. mekongi* in the community; however, it was less known that MDA was also an effective treatment of other parasitic infections such as opisthorchiasis and STHs. The interviewed villagers recognized that the health status in their community has fairly improved after a MDA was conducted in their village: cases with a big belly were today rarely seen in a village, and children were looking much healthier than before. Opinion leaders knew the positive effect of the treatment program against schistosomiasis only by means of observing the health changes in their community. Our study also shows that in previous MDA opinion leaders did not receive sufficient health education about efficacy of medicine against different worms. In addition, we found that leaders preferred the MDA program in their village because it provides medicine free of charge and directly in the village which meant that villagers had immediate access to treatment without travelling to a specific place without spending additional resources. Furthermore they recognise that the praziquantel treatment was not available in local pharmacies.

Other studies report similar observations: people attend the MDA because this medication is free of charge and very convenient to be obtained (Gunawardena et al., 2007; Katsivo et al., 1993). It is because of this pragmatic perception that the opinion leaders in this study are so eager to stimulate their community to participate and to get treatment in this current MDA. A high MDA compliance rate in the community can be certainly reached if the deworming program is provided for free in the villages. This finding shows very distinctly that community participation in a MDA deworming program depends to a great extent on the provision of free medication for the villagers. Affordability in relation to availability – and by this less the villagers understanding and

notion on the therapeutic effects of this medication – is thus one major reason to increase the MDA participation rate once the MDA is available in the villages.

It was interesting to note that many local terms were derived from the physical characteristics of the worm, e.g., worm with round body" for the roundworm *(A. lumbricoides)* or "worm with hook mouth" for hookworms. Most probably this community knowledge originated from exposure to health education programs provided to the community.

Due to its observable severity and its life-threatening nature of a long-lasting infection with *S. mekongi* opinion leaders were much more aware of Mekong schistosomiasis, its consequences the risk factors for infection than of other infections. The four study villages are also located in endemic zone for *S. mekongi*; people's daily life is very much depending on the water from the MekongRiver, and they share therefore a very high risk of *S. mekongi* infection. Surprisingly however the knowledge on transmission of *S. mekongi* was limited. Thus health education is most essential element to strengthen knowledge of the community members on the issues which may eventually help to cope with it (Acka et al., 2010). Certainly, transmission is not easily prevented given the environment (Mekong is the only water source) and socio-economic status of the villages in the area. However, with little efforts e.g., construction of showers in the households could reduce the exposure to the Mekong substantially and hence reduce transmission. To achieve this improvement a better knowledge of community on the transmission and its importance for disease development is required.

Most leaders in this study knew the risk factors for opisthorchiasis but only a few understood the relation between infection and this disease. It is noted that this illness is diagnosed only by stool examination. At low intensity of infection, opisthorchiasis manifests in an asymptomatic way, while at moderate or high intensity the disease develops non-specific gastric symptoms but later shows complicated symptoms (Fürst et al., 2012b). A long standing infection can lead to cholangiocarcinoma (Jinawath et al., 2007; Sripa et al., 2011). By this it is understandable that opinion leaders could not recognize the health impact of opisthorchiasis at a low intensity of infection; furthermore, when the disease appears people suspect another disease unless they have been informed or educated by health staff.

We found that opinion leaders were able to cite risk factors for acquiring worm infections. However, they could not describe the type of worm present and negative impact of worm infections on health. Though most leaders told their villagers to observe the three hygienic rules (hygienic eating, living and clothing) and urged their villagers to use latrines, they have never been trained in a formal way. In Lao PDR, the concept of the three hygienic rules is promoted nationwide through mass-media and health staffs who work in communities (albeit in irregular intervals). Therefore, in order to support a sustainable and effective control of helminthiasis in the community, local opinion leaders should be trained properly on this issue.

Our study shows that with the absence of MDA in community all opinion leaders said that they bought deworming drug from pharmacy and few using traditional medicine like "*mark keua*" a wild and bitter fruit and "*ya louk kone*" a small lump with the grinded bark of the peuark had tree for treatment of tapeworm only in case they observed worms expelled in faeces. In pharmacies, only albendazole and mebendazole are available but not praziquantel. Praziquantel can be found only in institutions that deal with helminth control due to it is donated drug such as CMPE, Provincial and District Malaria Stations, occasional it is available in Provincial or District Health Facilities but not available at health centres. It is also rarely found in a big pharmacy in a big city (grade 1) pharmacy.

The consumption of raw and insufficiently cooked fish in these four communities is widely practiced which is similar to other studies conducted in Laos (Sayasone et al., 2007; Tomokawa et al., 2012). This practice will sustain the spreading of *O. viverrini* infections in the community. Sayasone and colleagues reported that the consumption of raw and insufficiently cooked fish dishes had strongly associated with infection of *O. viverrini* (Sayasone et al., 2007) and raw fish dish like *Koi Pa* was scientifically confirmed to contain hundreds of viable *O. viverrini* metacercariae (Prasongwatana et al., 2013). A similar nutritional practice exists also in north-eastern Thailand where a high prevalence of opisthorchiasis was found; but after training sessions using video tapes and researchers talked about cholangiocarcinoma in villages, community members are now aware of the danger of opisthorchiasis (Wongba et al., 2011).

It is an interesting point that opinion leaders in this study think that the sour juice of lemons kills the worm in the fish: if they put a lot of lemon juice, they believe that it is equivalent to a well-cooked dish. This perception is one major reason that the eating of

raw fish in the villages is very common. Similar findings to our study are reported in another survey recently conducted in southern Saravane district, Saravane province, Laos. Communities believed that after squeezing hundreds of weaver ants – this ant contains a sour juice – over the fish meat this would turn to white colour which was comparable to a well-cooked dish and was therefore safe for eating (Xayaseng et al., 2013). Nevertheless, health education can support people to change their practices as reported from Thailand (Sornmani et al., 1984) and Lao PDR (Strandgaard et al., 2008).

In all four villages helminth infections were not perceived to be as important as other infectious diseases such as malaria, diarrhoea, and fever symptoms. This attitude is evidently represented by the curative practice of most opinion leaders who applied self-medication for helminthiasis, but only after they have observed worms in their faeces. We conclude that the communities prioritize in general only those diseases which cause serious health problems for their members and are considered to be life-threatening.

This study was conducted during the provision of mass drug treatment in the four study villages. We could investigate the pretension of opinion leaders, heads of household and villagers that they to do their best while we were there. However, by the application of the three methods for data collection – individual interview, observation, and in-depth interview – we could reassess this pretended engagement in comparison with everyday health practices by means of this methodological triangulation.

7.6 Conclusion

MDA is regarded by village members as a widely accepted measure for helminth control in affected communities with multiparasitism. However, researchers and the concerned institutions need a clear understanding about the many different drugs, which poses particular problems such as the distribution of appropriate information about possible adverse effects of a certain medication and its correct management as well as about its effectiveness against different worms. A better knowledge of community members about the health consequences of opisthorchiasis and STHs infections will foster further preventive measures such as altered practices of defecation, of nutrition and of personal hygiene. This is particularly true for opisthorchiasis which may lead finally to a deadly cancer – a sad fact which is not yet well recognised by the local communities.

7.7 Acknowledgements

We sincerely thank the Ministry of Health, the Champasack Provincial Health Department, and the Provincial Malaria Station, Khong District Health Office, community leaders, all study participants and the field team for their great support and collaboration. PK was generously supported by the Rudolf Geigy Foundation, the *Stiftung für Freiheitliche Medizin*, Basel, Switzerland, and the Commission for Research Partnerships with Developing Countries (www.KFPE.ch), BernSwitzerland. This study got financial support from the Swiss National Science Foundation and the Swiss Agency for Development and Cooperation (Project no NF3270B0-110020).

Table 7.1: Lao terms mentioned during intervention and discussion and their meaning and biomedical terms for helminth infections

Lao term	Meaning	Biomedical equivalent term
Helminth infection		
Mae thong to kom	Worm with round body	*Ascaris lumbricoides* (roundworm)
Mae thong to pea	Worm with flat body	*Taenia* (tapworm)
Mae thong pak khor	Worm with hook mouth	Hookworm
Xeua pha yat bai mai nai tap	Worm of liver leaves	*Opisthorchis viverrini* (liver fluke)
Xeua pha yat hoi	Worm of snail disease	*Schistosoma mekongi* (blood fluke)
Mae pha yat	Worm	Helminth
Disease		
Pha yat bai mai nai tap	Liver leave disease	Opisthorchiasis (liver fluke disease)
Tap kheng	Hard liver	Cirrhosis (
Pha yat hoi	Snail disease	Schistosomiasis
Pha yat thong poung	Big belly	Schistosomiasis
Khai gnoung	Mosquito fever	Malaria
Khai malaria	Malaria fever	Malaria
Thork thong	Discharge from abdomen	Diarrhoea
Khai	Fever	Fever
Treatment		
Khong kanh pha yat hoi	Project for snail disease	MDA
Ya pha yat hoi	Drug for snail disease	Praziquantel
Ya thay pha yat	Drug for worms	Deworming medicine
Ya thay mae thong	Drug for worms	Deworming medicine
Khao lap	Afraid of side effect	
Thay pha yat	Deworming	

Table 7.2: Results of interviews with heads of household Donelong island (n=192)

Items	Houalong (n=59)	Longsong (n=50)	Hanglong (n=44)	Longkang (n=39)	Total (n=192)
	n (%)	n (%)	n (%)	n (%)	n (%)
1. General characteristic of heads of household					
Age					
Mean	43.1	43.7	44.3	44.7	43.8
Range	20-70	21-72	20-89	17-75	17-89
SD	11.1	12.8	14.2	14.5	12.9
Sex					
Male	49 (83.1)	39 (78.0)	40 (90.9)	27 (69.2)	155 (80.7)
Female	10 (16.95)	11 (22.0)	4 (9.0)	12 (30.8)	37 (19.8)
Education					
Primary school	19 (35.2)	28 (59.6)	26 (68.4)	23 (62.2)	96 (54.5)
Secondary school	12 (22.2)	10 (21.3)	6 (15.8)	5 (13.5)	33 (18.8)
High school	7 (12.9)	0	2 (5.3)	1 (2.7)	10 (5.7)
Illiteracy	1(1.9)	0	0	0	1 (0.6)
Missing	15 (27.8)	9 (19.1)	4 (10.5)	8 (21.6)	36 (20.4)
Occupation					
Farmer	40 (67.8)	39 (78.0)	40 (90.9)	30 (76.9)	149 (77.6)
2. Economic status of households					
Household assets					
Cattle (cow and buffaloes)	15 (25.4)	31 (62.0)	30 (68.2)	15 (38.5)	91 (47.4)
Motorboat	22 (37.3)	33 (66.0)	22 (50.0)	16 (41.0)	93 (48.4)
Bicycle	15 (25.4)	10 (20.0)	8 (18.2)	3 (7.7)	36 (18.7)
Motorbike	26 (44.1)	17 (34.0)	7 (15.9)	11 (28.2)	61 (31.8)
TV	23 (38.9)	23 (46.0)	16 (36.4)	13 (33.3)	75 (39.1)
Mobile phone	18 (30.5)	12 (24.0)	12 (27.3)	6 (15.4)	48 (25.0)
House condition					
Permanent house	40 (67.8)	41 (82.0)	40 (90.9)	31 (79.5)	152 (79.2)
3. Risk factors for helminth infection					
Having latrine	8 (13.6)	9 (18.0)	6 (13.6)	5 (12.8)	28 (14.5)
Eating behaviour					
Consumption of raw fish	100	100	100	100	100
Exposure to MekongRiver					
Pump water from MekongRiver	32 (54.0)	27 (54.0)	37 (84.1)	25 (64.1)	121 (63.0)
Regular bathing in MekongRiver	41 (69.5)	37 (74.0)	39 (88.6)	29 (74.4)	146 (76.0)
4. Deworming received in communities					
Received MDA with praziquantel	27 (45.8)	22 (44.0)	21(47.7)	27 (69.2)	97 (50.5)
Received before the year 2000	6 (22.2)	16 (72.7)	9 (42.9)	4 (14.8)	35 (36.1)
Received after the year 2000	21 (77.8)	6 (27.3)	12(57.1)	23 (85.2)	62 (63.9)
Report of adverse effect	3 (11.1)	2 (9.1)	2 (9.5)	3 (11.5)	10 (10.3)

Table 7.3: Formal position of interviewed opinion leaders (n=21) in 4 villages on DonelongIsland

Position in the village	Houalong			Longsong			Hanglong			Longkang			Total
	sex	age	Occ	sex	age	Occ	sex	age	Occ	sex	age	Occ	
HV	M	50	Fa	M	60	Fa	M	57	Fa	M	46	Fa	4
DHV										M	37	Fa	1
TBA	F	52	Fa	F	55	Fa				F	40	Fa	3
VHV	M	30	Fa	M	55	Fa	M	42	Fa	M	25	Fa	4
Zone health worker							F	48	Lab				1
LWU	F	25	Fa				F	48	Fa				2
Youth Union	M	30	Fa										1
Monk	M	76	Fa	M	31	Fa							2
Teacher	M	50	T	M	50	Fa				M	50	T	3

Note: Male (M); female (F); farmer (Fa); teacher (T); laboratory technician (Lab); occupation (Occ); traditional birth attendant (TBA); village health volunteer (VHV); Lao Women Union (LWU); deputy head of village (DHV); head of village (HV)

Chapter 8: Evaluation of the effectiveness of community-directed intervention against liver fluke and STH in southern Laos

Khampheng Phongluxa[1,2,3], Vilavanh Xayaseng[1,2,3], Youthanavanh Vonghachack[2,3,5], Kongsap Akkhavong[1], Peter van Eeuwijk[2,3,4], Peter Odermatt[2,3*]

1. National Institute of Public Health, Ministry of Health, Lao PDR;
2. Department of Public Health and Epidemiology, Swiss Tropical and Public Health Institute, Basel, Switzerland;
3. University of Basel, Basel, Switzerland;
4. Institute of Social Anthropology;
5. University of Health Science, Ministry of Health, Lao PDR

* Corresponding author: Assoc. Prof. Dr. Peter Odermatt, Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, P.O. Box, CH-4002 Basel, Switzerland. Tel.: +41 61 284-8214; fax: +41 61 284-8105; E-mail: peter.odermatt@unibas.ch

Manuscript is prepared for submittion to PloS Neglected Tropical Diseases

8.1 Abstract

Food-borne trematodiasis and STH are a major public health concern in Southeast Asia and particularly in Lao People Democratic Republic. Lao Ministry of Health is emphasized a preventive chemotherapy along with health education to address helminth infections, and implemented through vertical programs. We evaluated an innovative approach, community-directed intervention (CDI), against liver fluke infections in southern Lao PDR.A cross-sectional survey was conducted in ten randomly selected villages in 2010, 2011 and in 2012. Two stool samples obtained from individuals aged ≥2 years of selected households were examined using Kato Katz method. Household heads and individuals were interviewed. Focus group discussion (FGD) and direct observation were performed. Baseline data was compared with after intervention data with an accepted significant level at 0.05. A textual content analysis was performed for qualitative data. After running two rounds of CDI the prevalence of *O. viverrini*, hookworm, roundworm, and whipworm infection was reduced by 26.4%, 38.1%, 45.9%, and 30.3%, respectively. A reduction of multiple helminth infection was observed. Household heads had better knowledge on liver fluke, hookworm, and whipworm infection, on means for liver fluke prevention, and on correct association of risk factors between hookworm and whipworm infection. Misleading conceptions on acquiring roundworm infection through eating any raw food could be corrected. A decrease in eating raw fish was observed which was consistent with statements of FGD participants that after treatment they did not want to eat raw fish anymore and some were afraid of getting liver fluke infection again. Participants understood that the intervention treated worm infections and prevented diseases. In conclusion, this intervention reduced liver fluke and STH infections and improved local knowledge, attitudes, and practices regarding worm infection, its risk factors and the intervention itself. The CDI approach has a highly potential to control liver fluke in endemic areas.

Author Summary (197 words)

Food-borne trematodiasis and STH are public health problem in Southeast Asia and in Laos. A community-directed intervention against liver fluke and intestinal co-infection as an innovative approach was conducted in southern Laos. We evaluated the effectiveness of this intervention. Two stool samples obtained from each study subjects were examined and found that infection with liver fluke,hookworm, roundworm, and whipworm and infection with more than two worm species were declined. Household heads had better knowledge regarding worm infection including ways of its transmission and prevention. They rarely consumed raw or insufficiently cooked fish dishes as they feared an infection with liver fluke again and felt not to eat these dishes anymore after treating with praziquantel. Most household heads perceived benefits of using latrine and personal hygienic practice. They recognized that mass treatment treated worms and prevented worm infection. We observed treatment coverage in mass treatment round two had sharply decreased comparing to the first round, it was because of unpleasant side effect induced by praziquantel occurred among those who took treatment and then afterwards many people did not take treatment as cited by most community-drug distribution. FGD's result was consistent with the result of interviewed household heads.

8.2 Introduction

Food-borne trematodiasis (FBT) and soil-transmitted helminthiasis (STH) are neglected tropical diseases and prevalent in resource-poor countries where they pose a major public health problem (WHO/HTM/NTD, 2011). Preventive chemotherapy alongside with health education is the most important approach for helminth control (Hotez et al., 2006). The combination of two single dose drugs, praziquantel (PZQ) and albendazole (ALB) (and/or mebendazole), is highly effective against trematodiasis that co-exists with STH (WHO, 2004; WHO/FAO, 2004). Endemic countries agreed in the World Health Assembly (WHA) resolution 54.19 in 2001 that at least 75.0% of affected persons should have access to appropriate treatment by 2010. However by 2008, millions of people in need of treatment had not access to a regular deworming (WHO/HTM/NTD, 2011). Community-directed treatment (CDT) against Onchocerciasis is considered as best practice for increasing access to deworming (TDR/WHO, 2008). CDTi against Onchocerciasis is performed under the direction of the community itself including planning and implementation (Katabarwa et al., 2002). The intervention achieved a high degree of treatment coverage (Amazigo et al., 2007) and achieved vast reduction of Onchocerciasis in Cameroon and Uganda although its transmission persisted (Katabarwa et al., 2008). In Western Kenya a community-directed intervention (CDI) was implemented against schistosomiasis and STH also with considerable success (Mwinzi et al., 2012).

In Lao PDR, over 2 million people are infected with *Opisthorchis viverrini* liver fluke and suffer related morbidity (Sayasone et al., 2007; Sithithaworn et al., 2012). Other intestinal helminthic infections such as minute intestinal flukes (MIF) and cestodes are prevalent (Chai et al., 2013; Lovis et al., 2009). About 1.6 million people are at risk for STH (Montresor et al., 2008). Preventive chemotherapy combined with health education is a main strategy for the Ministry of Health (MOH) to control helminth infections in the country. The intervention program is implemented via vertical lines, which requires substantial health staff, transport and financial support in addition to the distributed medicine. Therefore, sustaining preventive chemotherapy approach over a long-term and at large-scale is highly challenging. In addition, this top-down approach leaves community with a low degree of ownership for this kind of intervention which might affects directly the intended sustainability of liver fluke control in endemic sites.

A CDI approach was developed directed against the highly prevalent FBT, liver fluke, and intestinal co-infections for the Lao setting, and piloted it in highly liver fluke endemic areas in Saravane district in southern Laos between 2010 and 2012 as a novel model for liver fluke control. This study aimed to evaluate the effectiveness of the intervention in terms of prevalence of helminth infection, of existing local knowledge, attitudes and practices regarding worm infection, its risk factors and mass treatment, treatment coverage and implementation of intervention.

8.3 Methods

8.3.1 Ethics statement

Ethical clearance was obtained from the National Ethic Committee on Health Research, Ministry of Health, Lao PDR (Ethical Clearance No 169/NECHR, 1 April 2008). The proposal and inform consent document were approved by WHO ERC (Geneva, dated 17.2.2009). Household heads were informed about the study aim, the detailed procedures and the voluntary participation, their right to stop participation at any time, and were then asked to sign the informed consent. The consent form was read to those who were unable to read and write and asked them to sign with a fingerprint. We provided treatment to all diagnosed infections based on the national treatment guideline (Lao MOH, 2004).

8.3.2 Description of the scheme of community-directed intervention

CDI intervention was initiated in a consensus meeting with the Saravane Provincial Health Department (PHD), the Saravane District Health Office (DHO). The National Institute of Public Health (NIOPH) of Ministry of Health (MOH) in collaboration with the Swiss Tropical and Public Health Institute (SwissTPH) provided a technical support to provincial level. PHD and DHO provided information regarding the intervention to community level for a consensus. A workshop was organized at DHO. Representatives from community level: health center staff, village group officer, and village leaders from each village (a head of village and a village health volunteer) were invited for a workshop. In workshop information on mass treatment procedures, knowledge of infection with liver fluke and STH were provided. DHO provided deworming medicine, treatment record sheets, and education materials pertaining life cycle of infection with

liver fluke and STH to the village through the monthly meeting of health center at DHO. At community level, trained health center staff monitored and supervised trained village leaders regarding the mass treatment. Trained village group officer encouraged and promoted the anti-liver fluke intervention in community. After each mass treatment, trained village leaders returned the treatment records and remaining drug to the DHO (Figure 3.5).

8.3.3 Description of launching community-directed intervention

In March 2010 a CDI against liver fluke and intestinal co-infection was launched in 30 villages of Saravane district, Saravane province, covering 21,422 inhabitants (white dots, Figure 3.2). Prior the intervention a one-day training workshop was organized at Saravane DHO. A workshop was chaired by Saravane district's governor and co-chaired by a Director of NIOPH and a Director of Saravane PHD. Two village leaders, one head of village group, one health center staff from each health center across Saravane district, three health staff from DHO and one health staff from provincial station for malariology, entomology, and parasitology were invited to a workshop. In workshop the knowledge of mass treatment procedures: how to administer the deworming drug, to cope with the adverse effects and transfer the case to the nearest health facilities, and to record the treatment, and knowledge of infection with liver fluke, opisthorchiasis and STH including their mode of transmission, clinical manifestation, and means for prevention were provided. The guideline for the mass treatment procedures and knowledge regarding worm infection were developed by NIOPH in line with the Lao treatment guidelines for tropical diseases of the Ministry of Health (Lao MOH, 2004). Existing education materials were used such as life cycle of infection with liver fluke, *O. viverrini*, hookworm, whipworm, and roundworm, and proper personal hygienic practice. Deworming drugs, education materials, and treatment record sheets were distributed during a monthly meeting of health center at Saravane DHO. Health center staff brought them for its own catchments area. Trained community leader took them from its health center. For those villages that were closely located to Saravane DHO, the trained community leaders picked them up.

8.3.3.1 Distribution of deworming drug

The distribution of deworming drug was provided once a year. Trained community leaders (community drug distributors [CDDs]) distributed the drug in their village. Each treatment was recorded on the registration sheet and the treatment record was sent back to the DHO together with the remaining drugs. On the day of the mass treatment the trained heads of village group provided support and encouraged their community members to attend the treatment and the drug distributors to perform their task actively whereas a trained health center staff supervised the treatment. Additionally, Saravane DHO authorities provided administrative and technical support when needed.

8.3.3.2Deworming drug dose

A single dose of PZQ (40mg per kilo of body weight) and one tablet of ABZ (400mg) were orally administered to eligible individuals aged ≥4 years. Children 2 to 4 years of age received only the ABZ. Pregnant and breastfeeding women, children under 2 years of age, sick people on the day of mass drug treatment, persons who have been diagnosed for kidney and liver diseases, people with epilepsy, mentally ill individuals, and people taking drug against tuberculosis were excluded from this treatment.

8.3.4Study areas and population

This study was conducted in 10 randomly selected villages out of 30 villages which participated in the CDI in Saravane district, Saravane province (red dots in Figure 3.2). Saravane district with the provincial capital city is located in a low and fertile plain (Bolaven Plateau) with a total population of 94,965 people (48,636 women) living in 179 villages and 13,239 households. The per capita annual income is 627 USD. The annual fertility rate is 2.4%. A provincial hospital with 70 beds is located in Saravane district. Saravane district has no hospital but nine health centres which cover 71.0% of the villages, 19 pharmacies, 91 village drug kits, 67 health workers, and at least one village health volunteer (VHV) exists in each village (unpublished report of Saravane district Health Office, 2009). In 2002, a national parasitology survey indicated that 21.5%, 11.9%, 10.9% and 5.4% of primary school children in Saravane Province were infected with *O. viverrini*, *Ascaris lumbricoides*, hookworm, and *Trichuris trichiura,* respectively (Rim et al., 2003) whereas in 2007, the prevalence of *O. viverrini* infection was reported

to reach 58.5% (range 20.0% - 85.5%); eating raw or insufficiently cooked fish dish was commonly practiced (75.1%); poor access to latrines was reported; and 60% of 23 species of cyprinoids fish consumed in this district were infected with *O. viverrini* metacercariae (Sayasone et al., 2007). In addition, mass drug treatment against *O. viverrini* infection has never been executed in this district (verbal report of Director General of Saravane Provincial Health Department, 2010).

8.3.5Study design

A cross-sectional survey was carried annually in February-March 2010, 2011 and 2012 before CDI(Figure 8.1). Two-stage cluster sampling scheme was used to identify study households and participants in the selected villages. All members in selected household aged ≥2 years were enrolled in these surveys. Two stool samples were obtained from each enrolled study participants on two consecutive days. Household heads of selected households were interviewed. Total eight focus group discussions (FGDs) were carried out in four villages; two FGDs were conducted in each village, one among men and another among women. Direct observation was performed in all ten villages. With regards to the assessment of treatment coverage of three-year CDI (2010-2012), we collected the mass treatment records completed by CDDs from 30 intervention villages. We summarized and showed the average rate of compliance to treatment in each year (2010, 2011, and 2012). In addition, we interviewed CDDs in 10 study villages in 2011 and 2012 regarding the implementation of intervention.

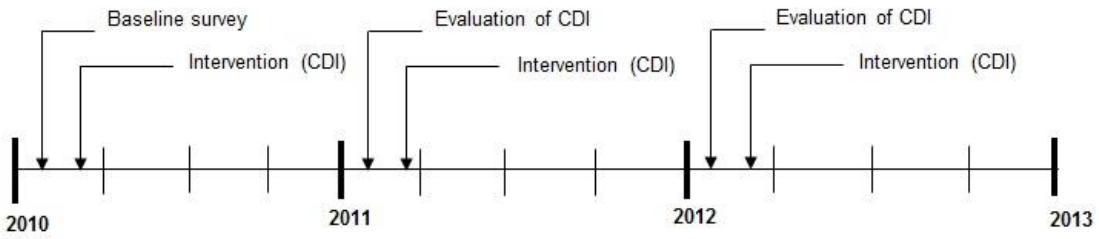

Figure 8.1: Time sequence for survey in Saravane district

8.3.6 Field and laboratory procedures

The village heads and household heads were informed about purpose and procedure of the study. Field research team went from house to house to interview heads of selected households using a structured questionnaire where information on socio-demographic household characteristics, household assets, and on knowledge, attitudes, perceptions and practices regarding *O. viverrini* and STH infections (e.g., raw fish consumption, hygiene and sanitation behaviour) were collected. FGD participants were randomly selected from households that were not yet selected for the stool examination. Team leader made direct observation during visit in the communities regarding the cleanliness of the village, the consumption of raw fish dishes, personal hygiene practices, wearing shoes, and the presence of sanitation facilities.

Two stool examinations were prepared for each enrolled person. Stool containers labelled with date, ID, name, age, and sex of participant were handed-out over to the household members after having obtained the written informed consent. Heads of households were instructed on how to collect stool samples. On the collection day, people who gave a first stool sample received a second pre-labelled container to use for the following day. All collected samples were kept in a cool box and were transported by car to the provincial hospital's laboratory in Saravane within one hour after collection. For each stool sample, one Kato Katz thick smear slide was prepared, using standard 41.7 mg templates (Katz et al., 1972). After a clearance time of 30 minutes the slide was examined under a light microscope (100x magnifications). All samples were examined on the day of collection. The presence or absence of parasite eggs was counted and recorded for each parasite species separately.

8.3.7Data management and analysis

Data were entered twice (double entry) and validated in EpiData Software, version 3.1 (Epidata Association; Odense, Denmark) and validated. Only participants with two stool samples were retained in the analysis. Analysis was performed using Stata software, version 10.1 (Stata Corp., College Station, TX, USA). Descriptive statistics were calculated (counts, percentages, means and standard deviations [SD]). The intensity of helminth infections was expressed in terms of egg count per gram faeces (EPG). According to Maleewong *et al* and Sayasone *et al* (Maleewong et al., 1992; Sayasone et

al., 2007), for the infection with *O. viverrini* and STH, the following light, moderate, and high intensity groups were established based on the EPG counts: Hookworm, 1-1999 EPG, 2000-3999 EPG, and ≥4000 EPG; *A. lumbricoides*, 1-4999 EPG, 5000-49,999 EPG, and ≥50,000 EPG; and *T. trichiura* and *O. viverrini*, 1-999 EPG, 1000-9999 EPG, and ≥10,000 EPG. Pearson's Chi-square test and Fisher's exact tests were used to compare proportions. P-values less than 5% considered significant.

Qualitative data from FGDs were transcribed from notes and tape recording, then translated from Lao to English, typed into Microsoft Word and imported to MAXQDA software (version 10) for textual analysis. Statements were coded and categorized according to the following themes: knowledge about *O. viverrini*, hookworm, whipworm, roundworm, and tapeworm, raw fish consumption, hand washing before eating, hand washing after latrine use, and deworming. Coded data were retrieved and exported to MSExcel form for frequency and content analysis.

Socio-economic status (SES) of households was assessed using multiple correspondence analysis (MCA) approach (Booysen F et al., 2008). The technique has been used before for categorical data (Forrer et al., 2012). Household assets, materials used for house construction, water source, and possession of latrine were used to construct a socio-economic indexe. Households were classified into one of five quintiles: most poor, very poor, poor, less poor and least poor, using the socio-economic index.

8.4 Results

8.4.1 Treatment coverage

A treatment coverage in the CDI between 2010 and 2012 obtained from treatment records completed by CDDs showed that with the total population in the intervention areas of 21,422, an average of compliance to mass treatment in 2010 was 69.4% (ranged 12.1% -99.3%), in 2011 it was 39.3% (ranged 7.1% -87.4%), and in 2012 it reached 47.2% (ranged from 21.9% - 94.6%; Figure 8.2). In contrast, results of our survey from interviewed subjects enrolled for stool examination in 10 study villages showed that 76.2% (292/383) and 80.2% (256/319) reported to have taken a mass treatment in 2010 and 2011, respectively.

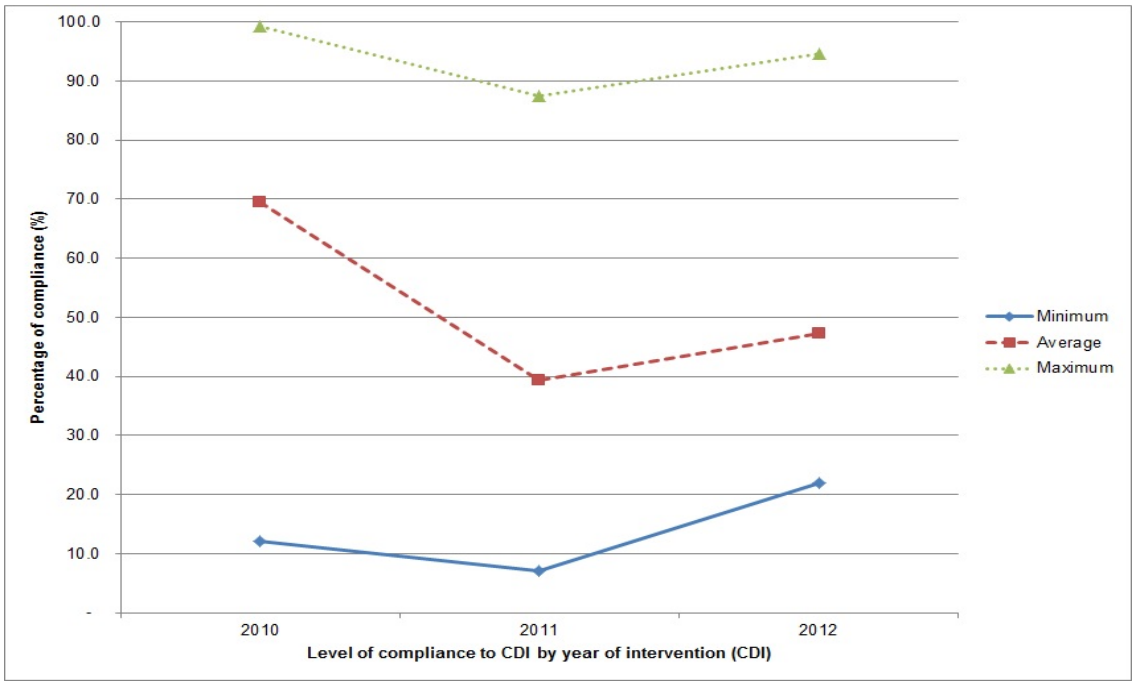

Figure 8.2: Treatment coverage for intervention obtained from treatment records completed by community-drug distributors (CDDs)

8.4.2 Results of in-depth interview community drug distributors

With a total of 17 CDDs in 2011 and 18 CDDs in 2012 were in-depth interviewed, the majority of them were male (17/17 in 2011 and 17/18 in 2012); mean age was 44.4 years (32 – 58 years) in 2011 and 45.5 years (ranged from 35 – 59 years) in 2012; More Laoloum CDDs in 2011 (9/17) while more Laotheung CDDs in 2012 (10/18). CDDs mostly attended primary school (12/17in 2011 and 12/18 in 2012). All were rice farmers.

When asking the CDDs that why the number of people taking treatment had declined in the following years?, most CDDs mentioned of the side effect induced by PZQ occurred among those who took treatment afterwards many people who heard about it did not take the treatment even in the same year (16/17 in 2011 and 16/18 in 2012) though the villagers appreciated the efficacy of PZQ as it helped to stay healthier and having better sleep and appetite after treated (cited by all in both surveys). Few CDDs in 2012 stated additional reasons: absenteeism from villages (4/18), pregnancy (1/18), breastfeeding (1/18), and villagers did not pay attention to their health (2/18). The most frequent side effects in 2011 were dizziness, nausea, headache, and abdominal pain (68.7%, 56.2%,

43.7%, and 31.2%, respectively) whereas in 2012 there were dizziness, nausea, vomit 2-3 times, and headache (94.4%, 88.9%, 72.2%, and 22.2%, respectively).

Distribution of deworming drug in a village was mainly conducted without the presence of trained health center staff in a village on the day of treatment, only CDDs together with untrained leaders from 7 responsible units in the village: party secretary, Lao Women Union, Youth Union, Senior union, security, education, and economy managed it (8/17 in 2011 and 16/18 in 2012). In the second year of intervention (2011), CDDs in 9 villages opted to distribute deworming drug at the evening after dinner instead of morning due to observing less side effects while a CDD in one village did not change because villagers disliked to take it at night due to worrying about the access to health facility or village health volunteer at night in case of having side effects. In addition, health education pertaining worm infection was conducted in a village (16/17 in 2011 and 18/18 in 2012). It was conducted through any events in a village (7/16 in 2011) and during a meeting held in a village (6/16 in 2011 and 16/18 in 2012).

8.4.3 Characteristics of study population

A survey was conducted in 2010 (at baseline) and in 2011 and 2012. In each year the survey took place before the intervention. The highest mean age of household heads was found in 2011, namely 41.2 years (SD=13.6) in 2010, 47.2 years (SD=10.3) in 2011, and 45.5 years (SD=13.0) in 2012; most of them belonged to the Laoloum ethnic group (52.3%, 60.2% and 50.5%) and had attended primary school (56.9%, 61.0%, and 47.7%); almost all of them were rice farmers (93.1%, 96.6% and 92.5%); and a sex ratio for male was 1.13, 1.27, and 0.88, respectively (Table 8.1).

Individuals enrolled for stool examination in the baseline survey show a mean age and standard deviation of 25.5 years (SD=18.2) whereas 28.9 years (SD=19.4) in 2011 and 29.1 years (SD=19.8) in 2012. Most subjects in the survey in 2011 belonged to the age group 6–15 and 40–49 years ($p<0.001$) which was different from other surveys. Sex ratio for male was 0.99, 0.82, and 0.73 in 2010, 2011, and 2012, respectively (Table 8.2).

There were 67 FGD participants in 2010 and 75 in 2012. Most of them were women. The mean age and age range were similar: 40.6 years (15-173 years) in 2010 and 41.9 years (16-75 years) in 2012; most of them belonged to the Laotheung ethnic groups in 2010

while in 2011 to the Laoloum ethnic groups (71.6% and 56.0%) and had attended primary school (55.2% and. 50.7%); all of them worked as rice farmers.

8.4.4 Prevalence of helminth infections

Results indicated that after CDI implemented in 2011 and 2012, the prevalence of all helminth species decreased significantly in particular *O. viverrini* and hookworm infections. *O. viverrini* infection rate went down from 88.7% to 76.2% in 2011 and 65.2% in 2012 and a reduction of hookworm infection was observed from 86.6% to 59.0% in 2011 and 53.6% in 2012 (Figure 8.3). The highest reduction of *O. viverrini* infection was identified among subjects under 6 and 6-15 years of age whereas the highest reduction of hookworm infection was observed among adults aged 40-49, 50-59 and 60 years and older.

A reduction of multiple helminth infection with two species was detected. It decreased from 52.4% in the baseline study to 38.6% in 2011 and 34.2% in 2012, and multiple infection with three species went down from 27.2% in 2010 to 15.9% in 2011 and 10.7% in 2012 (Figure 8.4).

A notable reduction of infection intensity of some helminth species was observed. A high infection intensity of *O viverrini* dropped down from 12.6% in a baseline study in 2010 to 3.8% in 2012 (p=0.001, Figure 8.5); and a moderate infection intensity of *T. trichiura* was declined from 12.7% in 2010 to 3.8% in 2012 (p=0.049, Figure 8.6). In contrast, the light infection intensity of *O. viverrini* increased from 51.3% in 2010 to 64.4% in 2012 (Figure 8.5).

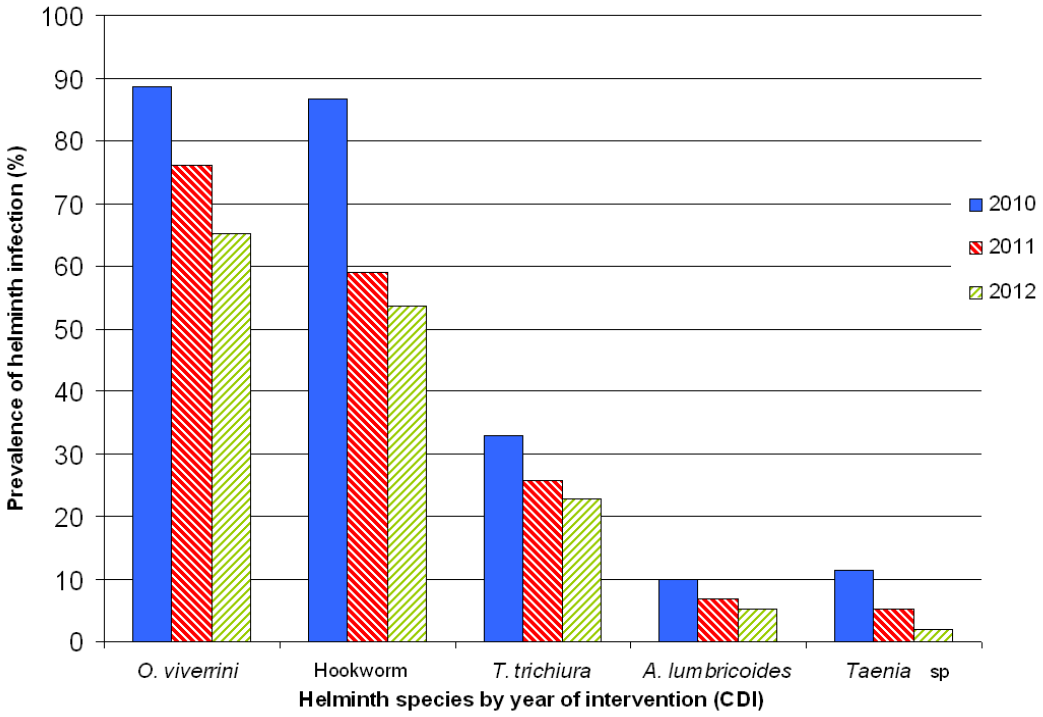

Figure 8.3: Prevalence of parasitic infections at baseline in 2010 and after community-directed intervention (praziquantel and albendazole) in 2011 and 2012, Saravane district

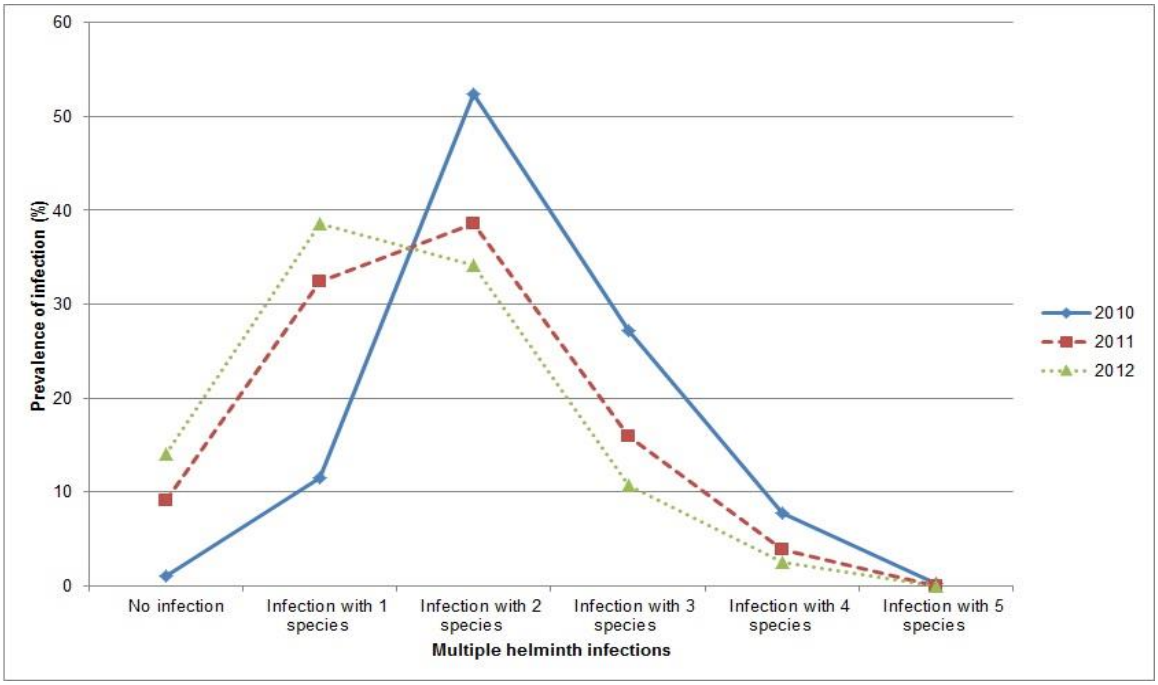

Figure 8.4: Multiple helminth infections at baseline in 2010 and after community-directed intervention (praziquantel and albendazole) in 2011 and 2012, Saravane district

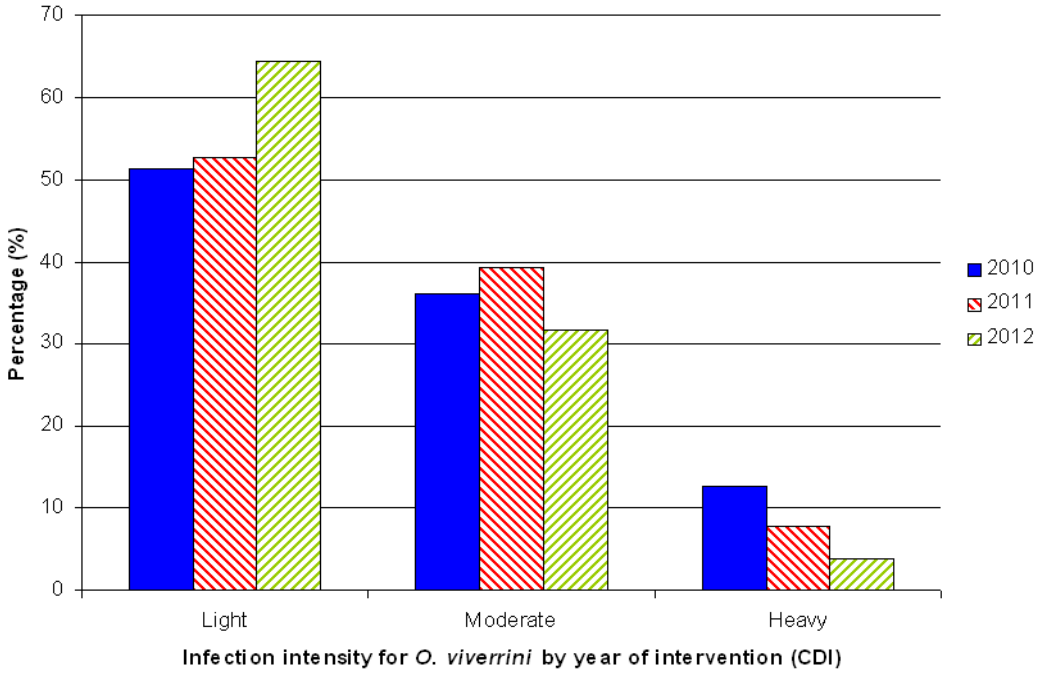

Figure 8.5: Infection intensity for *O. viverrini* at baseline in 2010 and after community-directed intervention (praziquantel and albendazole) in 2011 and 2012, Saravane district

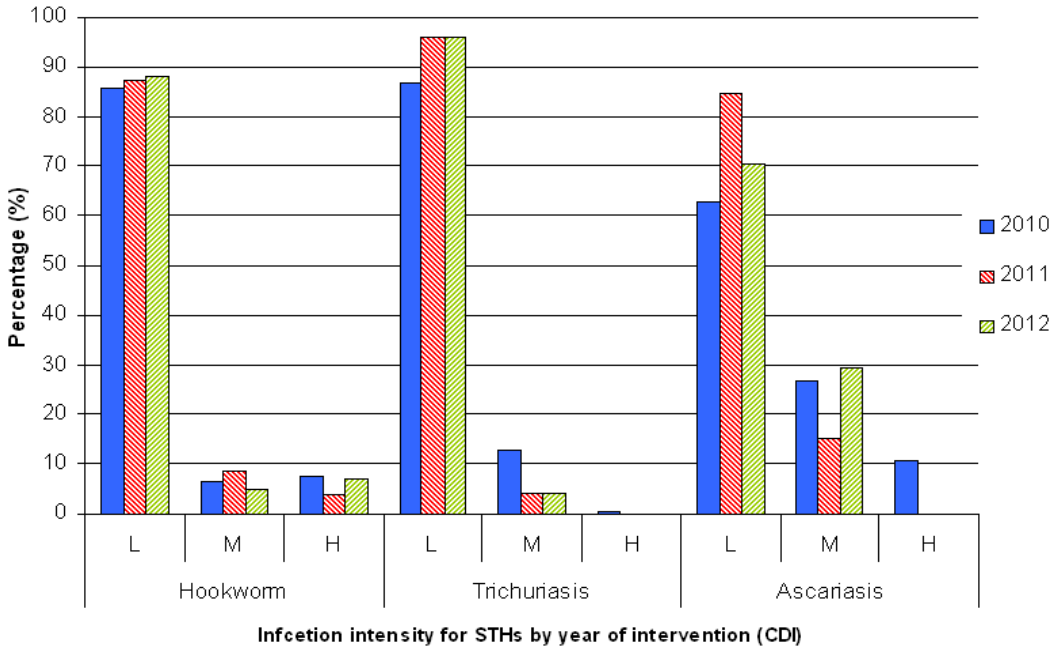

Figure 8.6: Infection intensity for STHs at baseline in 2010 and after community-directed intervention (praziquantel and albendazole) in 2011 and 2012, Saravane district (L=light; M=moderate; H=heavy)

8.4.5 Knowledge, attitudes and practices of household heads regarding worm infections

Results indicated that after intervention in 2010 and 2011, the knowledge of household heads regarding worm infection has improved if compared with the baseline study in 2010; most of them heard about liver fluke (37.7% versus 55.1% and 62.6%, p<0.001), and specified a correct preventive measure, for instance, not eating raw or insufficiently cooked fish dishes (14.3% versus 52.3% and 53.7%, p<0.001), not eating raw sour fermented fish dishes (0% versus 6.1% and 7.5%, p=0.142), and not eating raw fermented fish (0% versus 12.3% and 5.9%, p=0.032, Table 8.3); knowledge on STH infection has fairly improved particularly for hookworm (8.5% versus 15.2% and 14.1%, p=0.219) and whipworm (1.5% versus 7.6% and 10.3%, p=0.008). The interviewed heads of household linked hookworm infection with walking barefoot outside (0% versus 27.8% and 40.0%, p=0.051) and playing on the ground (0% versus 11.1% and 13.3%, p=0.340) and whipworm infection with not hand washing before eating (0% versus 33.3% and 18.2% , p=0.708) and after defecation (0% versus 0% and 18.2%, p=0.529) and not cleaning vegetables before eating (0% versus 11.1% and 27.3%, p=0.669). Moreover, better knowledge on the mode of transmission for roundworm infection was generally observed (Table 8.3).

After the interventions, more heads of households thought that both hand washing before eating and after defecation and the use of latrines could prevent any diseases and their transmission (50.0% versus 72.0% and 78.5%, p<0.001; 57.7% versus 72.0% and 74.8%, p=0.009; 40.0% versus 70.3%, and 66.4%, p<0.001) at the baseline study in 2010 and after treatment in 2011 and 2012, respectively (Table 8.4).

Heads of households reported of consumption raw or insufficiently cooked fish dishes was lower frequencies after the intervention (75.4% versus 61.9% in 2011 and 57.0% in 2012, p=0.008); most of them consumed raw or insufficiently cooked fish dishes one or two times in a year and this habit was not observed in the baseline survey (p<0.001); actually, the pattern of eating raw beef salad was in change (71.5% versus 68.6% in 2011 and 52.3% in 2012, Table 8.4).

After the interventions, more household heads reported to wash their hands after defecation (from 83.1% in the baseline study to 86.9% in 2012, p<0.001); they washed

their hands with soap (from 11.7% in 2010 to 18.4% in 2011 and 17.8% in 2012, p<0.001) and possessed a latrine (15.4% in the baseline study, 29.7% in 2011, and 23.4% in 2012, p=0.026); however, the use of latrine every day remained a poor practice (76.2% in the baseline study, 40.0% in 2011 and 72.0% in 2012, p=0.005).

8.4.6 Knowledge, attitudes and practices of household heads regarding community-directed intervention

After exposed to CDI during two years, the number of interviewed heads of households who understood that the CDI provided effective treatment against worms and liver fluke in the community has increased from 61.0% (2011) to 85.9% (2012) (p<0.001) and the misperception as perceived that it was effective against any diseases in our body had dropped (6.8% versus 0%, p=0.007, respectively, Table 8.5).

When we asked about the perceived benefits of mass treatment, heads of households stated that intervention can prevent diseases (10.2% versus 12.1%, p<0.001 after exposed to intervention in 2011 and in 2012, respectively, Table 8.5).

Heads of households reported to have taken mass treatment in the first and second rounds of mass treatment was not different (78.8% (93/118 in round 1) and 85.0% (91/107 in round 2), p=0.215), respectively. However those who took treatment in mass treatment round 1 got side effects more than those who took treatment in round 2 (52.7% vs 31.9%, p=0.004). We observed that the reasons for taking and not taking treatment among those who took and did not take treatment were not statistically significant different (Table 8.5).

8.4.7 Results of focus group discussions (FGD)

8.4.7.1 Knowledge, attitudes, and practices regarding worm infection and its risk factors

After the intervention in 2012, almost all FGD participants heard about liver fluke or *san tap* (50.7% versus 96.0%) and most of them associated this infection with eating raw fish dishes (11.9% versus 60.0%); all heard about roundworm (77.6% versus 100%) and a half of them linked it to bad personal hygiene (0% versus 50.0%). Notably the knowledge of hookworm and whipworm had positively changed greatly (4.5% versus 77.3% and

2.9% versus 29.3%, respectively); they could connect hookworm infection with walking barefoot outside (0% versus 29.3%). However, nobody mentioned a correct cause of whipworm infection in both surveys.

A fewer FGD participants reported to have eaten raw fish dishes after intervention (49.3% vs. 33.3%); most of them were men (53.1% versus 51.3%); the frequency of eating raw fish dishes was indicated to be one or two times per year whereas before (i.e., in the baseline survey) it was yet once a month. Of those who have stopped eating raw fish dishes after the intervention, 22.0% (11/50) of them said that they were afraid of getting liver fluke again. However, all FGD participants and that after taking this medicine (i.e., PZQ) in the village they had the feeling that they do not want to eat raw fish dish any more unlike before.

After the intervention in 2012, FGD participants assumed that the use of latrines could prevent disease and its transmission (14.9% versus 88.0%) and that hand washing before eating and after defecation will hold infections off (4.5% versus 82.7%) and maintain health (4.5% versus 38.7%). By this, most of the FGD participants discussed that they washed their hand before eating (46.3% versus 85.3%) and after defecation (0% versus 41.3%) after they have passed through this intervention.

8.4.7.2 Knowledge, attitudes and practices towards community-directed intervention

Before the intervention (before March 2010) the community members had never taken the mass treatment against liver fluke except pre-school children and women in reproductive age who had received a deworming drug against STH either from outreach activities of health centres or at school (primary school children). After the intervention, 42.7% (32/75) of the FGD participants understood that a current intervention has provided treatment against worm diseases such as *san tap* or *pha yat bai mai nai tap* (liver fluke), tapeworm and other worms and that the deworming drug may also cause dizziness, nausea and vomit. 12.0% (9/75) of the participants said that the government paid some attention to community health and helped them to get rid of diseases and that is why the government distributed drug for free of charge.

Most FGD participants (62/75) took the drugs during the mass treatment in their own village. The reasons for taking treatment were heterogeneous: to cure any diseases in our body (6/62); to treat worms (12/62); it was free of charge (19/62); to stay healthy (17/62); it received so much attention from the government (9/62); fear of being infected with liver fluke (2/62); and fear of getting sick and of dying (5/62). Villagers did not take the treatment (13/75) mentioned that they were absent from home on the day of distributing drug in village (2/13), fear its side effects as it has already happened to other villagers (6/13), and pregnant or breastfeeding (4/13). When asked about the reasons why some people in the village refused to get a treatment, 23 of 75 participants indicated that villagers were really afraid of adverse effects induced by PZQ because many villagers in the village suffered from it.

Of those people who took treatment some had actually experienced some adverse events, for instance, dizziness (34/64), nausea (20/64), drowsiness (3/64), vomiting 2-3 times, abdominal pain (2/64), and diarrhoea (1/64).

When we discussed the benefits of mass treatment, participants stated that MDA supports them to stay healthy (51/75), to prevent diseases or infections (27/75), to get deworming for free of charge (23/75), to be provided with effective drugs against different worms (26/75), and to eradicate worm infections in their community (12/75). Surprisingly, the big majority of them (59/75) stressed the perception that after taking this drug (PZQ) in their village, they did not feel to eat raw fish dish again as they did it before – and that they started to consume it only occasionally. A man (35 years) from Chantai village said: "…*I think this drug encourages us to stop eating raw fish…*", and a woman (25 years) at Nahinlong village said:" *…Honestly, after taking this medicine (PZQ) from the village, I do not feel to eat raw fish anymore….*"

8.4.8 Direct observations

After the CDI in 2012, we saw that one more village namely Nongboua village had latrines (before there were five villages at least some had latrines); however, only about 20.0% of the households owned a latrine. The Saravane DHO provided the materials and supervised the construction while the community contributed the roof and walls as well as the labour for their construction. Furthermore, we observed no longer households preparing fish dishes during our survey in ten villages whereas the baseline study in

2010 identified some households which prepared still raw fish meals. Nonetheless, we found animals like cows, buffaloes, and pigs roaming unattended in the villages and children who walked barefoot outside their houses.

8.5 Discussion

We developed, implemented and evaluated the effectiveness of CDI that had been implemented in 30 villages in liver fluke endemic areas in Saravane district, southern Laos since 2010. A cross-sectional survey was conducted in the same 10 randomly selected villages in a baseline survey in 2010 and after CDI in 2011 and 2012. Stool examinations were applied to all enrolled household members aged ≥2 years. Structured interviews with all household heads and household members were performed. FGDs were organized in four villages, two gender-segregated FGDs were held in each village. Direct observation was carried out in all study villages. Collection of treatment registration sheets completed by CDDs from 30 intervened villages.

Our results show that the CDI has significantly reduced the helminth infection rate and improved knowledge, attitude, and practices of villagers regarding worm infection and mass treatment. The prevalence of *O. viverrini*, hookworm, roundworm, and whipworm was reduced by 26.4%, 38.1%, 45.9%, and 30.3%, respectively. Moreover, a reduction of multiple helminth infection was observed, and more household heads heard about liver fluke, hookworm, and whipworm infection. As a consequence community members stopped eating raw fish dish as they related it to the prevention of liver fluke, they no longer walk barefoot and play on the ground due to their understanding on hookworm infection, and they wash their hands before eating and after defecation in order to prevent whipworm infection. The mistaken notion that roundworm is acquired through any types of raw food was reduced by 56.7%. The number of household heads who ate raw fish dishes regularly and after taking treatment did not feel to eat raw fish dish anymore increased. We met more and more household heads who understood that mass treatment cured worms including liver fluke, and who perceived disease prevention as general health benefits.

The highest reduction of *O. viverrini* infection rate was found in the age group less than 16 years. Persons aged 16 years and above might get easily re-infected with *O. viverrini* since the consumption of raw fish is an integral part of some important social and

religious events which are restricted to adolescents and adults. Nevertheless, we found that most infected persons could be grouped into the category 'light infection intensity' of *O. viverrini* after mass treatment. Moreover, *O. viverrini* infection that was co-infected with hookworm was reduced by half. This result confirms the consideration of WHO in reducing worm infection morbidity and sustaining the reduction of its transmission by applying preventive chemotherapy along with health education (WHO, 2006). It is known that morbidity of food-borne trematodeis closely linked to the high infection intensity of worms or worm burden (WHO/FAO, 2004).

The CDI is considered to be an effective approach against different worm infections. In Western Kenya, a CDI against schistosomiasis and STH was evaluated after six months of mass treatment; the study revealed that helminth infection rate was significantly decreased by 33.2%, 69.4% and 42.6% in the prevalence of schistosomiasis, hookworm, and *T. trichiura,* respectively; this approach is a well-accepted and effective strategy in the treatment of schistosomiasis and STH infections in resources-constrained communities (Mwinzi et al., 2012). In Cameroon and Uganda, after a decade of implementation of CDTi against onchocerciasis, the evaluation conducted in 2005 and 10 months prior to the last annual treatment showed a significant reduction of onchocerciasis from 70.1% to 7.04% in Cameroon, and from 71.9% to 7.49% in Uganda. The CDTi could also maintain a high treatment coverage (Amazigo et al., 2007). Moreover, a three-year intervention against liver fluke conducted in two villages and two schools in north-eastern Thailand showed a vast reduction in liver fluke infection rate by 83.4% (from 58.3% to 9.5%) in the intervention villages whereas the schools could be declared as free of liver fluke (Sornmani, 1987).

Our study observed similar processes as mentioned above. Currently, the rate of helminth infection is yet as high as it was originally in Cameroon, Uganda and Thailandbut there is high hope in the reduction of helminth infection in the near future because this process coincides with an increasing knowledge of community members on worm infections and positive changes in their worm infection related health practices as well as with a growing understanding of the mass treatment interventions and their benefits.

Our study has revealed that after communities were exposed to health education their related health knowledge has improved and they accept to attend these health

interventions. For instance, in India after communities were exposed to community-based pre-MDA education which were additionally coupled with health education on lymphatic management, the villagers had gained better knowledge on the causes of lymphatic filariasis (LF), they knew that everyone was at risk for LF, and how to manage the LF, and most of them attended the mass treatment against LF in comparison with the provision of only a pre-MDA education (Cantey et al., 2010). Moreover, communities had a better knowledge on hookworm infection after they watched a related film (Bieri et al., 2013), and they were able to name the infection almost with its scientific name, knew the route of its transmission, and associated it correctly with the diseases (Gazzinelli et al., 2010). Acka et al confirmed that improved community knowledge on schistosomiasis if it is compared to school-based interventions (Acka et al., 2010). Health education is in fact very important in raising awareness of the community. Therefore, in current CDI approaches health education on community level has to be provided along with mass treatment; particularly, it has to focus on the life cycle of liver fluke, on the preparation of safe fish dishes, on the link between risk factors and infection, and on a growing knowledge on STH.

Treatment coverage in this current CDI which is based on records completed by drug distributors (65.3% in 2010, 29.6% in 2011, and 37.5% in 2012) is lower than survey-based results in 2011 and 2012 with interviewed individuals (above 75.0%). During the survey we found that household heads had some notions about the intervention as they were aware that it treats worm infection and prevents diseases. The high treatment coverage rate in the survey-based study may have occurred due to interviewees' misunderstandings when they received the deworming drug during the EPI day in a village. However, we hope that the treatment coverage will be increased gradually in the long run after people have gained a better and bigger understanding about liver fluke and STH. But this process of change takes its time as the CDTi against onchocerciasis has shown: almost two decades were needed (TDR/WHO, 2008).

Our CDI against liver fluke in Lao PDR has translated experiences from CDTi against onchocerciasis and from community participation against liver fluke in Thailand into the Lao context. We employed trained community leaders (i.e., a head of village and a village health volunteer of each village) to implement an annual mass treatment along with the provision of health education on liver fluke and STH infections, on health practices related to helminth infections such as eating raw fish dish, open defecation,

and lack of personal hygiene – either on the day of the drug distribution or during any community gatherings in the village. We did not apply a case-selective treatment after diagnosis or demonstrations of parasites through microscope and displays of intermediate hosts in a show room as done in two villages and two schools in liver fluke endemic areas of Thailand (Sornmani, 1987) because it is not feasible for an extensive intervention, it requires a substantial fund for its implementation and only a small part of a community can be reached.

8.6 Conclusion

The CDI approach is novel control of approach against liver fluke in endemic areas of southern Lao PDR. This study evaluated our CDI approach. Our results indicate that this approach reduces liver fluke, *O. viverrini*, and STH infections as well as helminth infection intensity and multiple helminth infections. In addition, we observed a significant improvement of health knowledge and practices on worm infections: a majority of heads of household is now aware of the risks of liver fluke, hookworm, and whipworm infection; they know that the prevention of liver fluke means a stop of eating raw fish and that walking barefoot and playing on the ground may lead to hookworm infection; they also understand that not to wash their hands before eating and after defecation can lead to whipworm infection; and existing misunderstandings about the causes of roundworm infection were corrected. Many villagers stopped eating raw fish after mass treatment and health education in their villages due to the perceived fear of being re-infected with liver fluke, and they were aware of the multiple benefits of mass treatment for their health conditions. This context-adapted approach has proved to be highly effective against liver fluke and its co-infection with STH and is therefore qualified to be scaled up in other highly endemic areas of liver fluke infection in Lao PDR.

8.7 Acknowledgements

We would like to express our sincere thanks to the authorities of the Ministry of Health, the Saravane Provincial Health Department, the Saravane District Health Office, health centres, village authorities, participants who participated in this study, and my field research team. My words of thanks also go to Ms. Audrey Bochaton and Armelle Forrer for their great help. The generous support from the Rudolf Geigy Foundation and the WHO (Geneva) is highly acknowledged.

8.8 Author contributions

KP and PO conceived the study idea, and designed and analyzed the data, and interpreted results together with PvE. KP coordinated and conducted field work and drafted the manuscript; VX carried out data collection and sample collection; YV carried out laboratory work; KA had overall responsibility for data collection; PvE and PO revised the manuscript. All authors read and approved the final submission.

Table 8.1: Characteristics of study household heads at baseline in 2010 and after community-directed intervention in 2011 and 2012, Saravane province, Laos

	2010 n = 130	2011 n = 118	2012 n = 107	P-value
Gender :				0.371
Male	69 (53.1)	66 (55.9)	50 (46.7)	
Female	61 (46.9)	52 (44.1)	57 (53.3)	
Sex ratio for male	1.13	1.27	0.88	
Age (years)				
Mean (SD)	41.2 (13.6)	47.2 (10.3)	45.5 (13.0)	
Range	20 - 81	24 - 76	22 - 87	
Age group (in year)				
20 - 29	28 (21.5)	5 (4.2)	11 (10.3)	< 0.001
30 - 39	41 (31.5)	22 (18.6)	28 (26.2)	
40 - 49	26 (20.0)	41 (34.7)	27 (25.2)	
50 - 59	20 (15.4)	36 (30.5)	26 (24.3)	
60+	15 (11.5)	14 (11.9)	15 (14.0)	
Marital status				
Single	1 (0.8)	2 (1.7)	4 (3.7)	0.434
Married	121 (93.1)	105 (88.9)	96 (89.7)	
Other	8 (6.1)	11 (9.3)	7 (6.5)	
Ethnicity				
Laoloum	68 (52.3)	71 (60.2)	54 (50.5)	0.289
Laotheung	62 (47.7)	47 (39.8)	53 (49.5)	
Education				
No schooling	38 (29.2)	35 (29.7)	42 (39.2)	0.074
Primary school	74 (56.9)	72 (61.0)	51 (47.7)	
Secondary school	12 (9.2)	10 (8.5)	11 (10.3)	
College or university	1 (0.8)	0	3 (2.8)	
Other	5 (3.8)	1 (0.8)	0	
Occupation				
Farmer	121 (93.1)	114 (96.6)	99 (92.5)	0.305
Teacher	1 (0.8)	1 (0.8)	0	
State employee	0	1 (0.8)	0	
Other	8 (6.1)	2 (1.7)	8 (7.5)	
Socio-economic status				
Most poor	21.5	16.7	20.4	
Very poor	19.2	17.6	20.4	
Poor	20.8	26.5	19.4	
Less poor	20.0	20.6	20.4	
Least poor	18.4	18.6	19.4	

Table 8.2: Characteristics of study population at baseline in 2010 and after community – directed intervention in 2011 and 2012, Saravane province, Laos

Item	2010 (n = 574)	2011 (n = 383)	2012 (n = 319)	p-value
Age (years)				
Mean(SD)	25.5 (18.2)	28.9(19.4)	29.1 (19.8)	
Range	2 - 81	2 - 76	2 - 87	
Sex ratio (male/female)	0.99	0.82	0.73	0.09
Age group (in year)				
< 6	73 (12.7)	27 (7.0)	33 (10.3)	< 0.001
6 - 15	154 (26.8)	119 (31.1)	81 (25.4)	
16 - 29	125 (21.8)	52 (13.6)	52 (16.3)	
30 - 39	92 (16.0)	51 (13.3)	49 (15.4)	
40 - 49	58 (10.1)	58 (15.1)	42 (13.2)	
50 - 59	42 (7.3)	54 (14.1)	39 (12.2)	
60+	30 (5.2)	22 (5.7)	23 (7.2)	
Ethnicity				< 0.001
Laoloum	306 (53.3)	230 (60.1)	144 (45.1)	
Laotheung	268 (46.7)	153 (39.9)	175 (54.9)	
Individual accessed to latrine in households	100 (17.4)	124 (32.4)	82 (25.7)	< 0.001
Participants by village				< 0.001
Nakhoisao	36 (6.3)	28 (7.3)	30 (9.4)	
Hangphounoy	44 (7.7)	45 (11.7)	10 (3.1)	
Dongkoneua	53 (9.2)	26 (6.8)	35 (10.9)	
Lanong	40 (6.9)	30 (7.8)	53 (16.6)	
Khoneleng	61 (10.6)	33 (8.6)	26 (8.1)	
Chantay	66 (11.5)	13 (3.4)	25 (7.8)	
Nahinlong	80 (13.9)	64 (16.7)	30 (9.4)	
Naphengyai	82 (14.3)	59 (15.4)	47 (14.7)	
Songkhone	46 (8.0)	34 (8.9)	28 (8.8)	
Nongboua	66 (11.5)	51 (13.3)	35 (10.9)	

Table 8.3: Knowledge on liver fluke (O. viverrini) and STHs of heads of households baseline in 2010 and after community-directed intervention in 2011 and 2012, Saravane province, Laos

Item	2010 (n = 130)	2011 (n = 118)	2012 (n = 107)	p - value
Heard about liver fluke infection	49 (37.7)	65 (55.1)	67 (62.6)	< 0.001
Source of information:				
From television	5 (10.2)	7 (10.8)	2 (2.9)	0.185
From radio	13 (26.0)	8 (12.3)	6 (8.9)	0.024
From health staff	15 (30.6)	32 (49.2)	38 (56.7)	0.019
From relative/friend	6(12.2)	9 (13.8)	8 (11.9)	0.941
knowledge on prevention of liver fluke :				
Not eating any raw like meat, shrimp etc	21 (42.9)	6 (9.2)	19 (28.4)	< 0.001
Not eating raw fish dishes	7 (14.3)	34 (52.3)	36 (53.7)	< 0.001
Not eating raw sour fermented fish	0	4 (6.1)	5 (7.5)	0.142
Not eating raw fermented fish	0	8 (12.3)	4 (5.9)	0.032
Keep good hygiene and sanitation	2 (4.1)	0	2 (2.9)	0.315
Taking deworming medicine	3 (6.1)	0	6 (8.9)	0.035
Not smoking/drinking alcohol	1 (2.0)	0	4 (5.9)	0.077
Do not know about that	15 (30.6)	17 (26.1)	16 (23.8)	0.717
Liver fluke could be re-infected	20 (40.8)	22 (33.8)	34 (50.7)	< 0.001
Heard about hookworm infection	11 (8.5)	18 (15.2)	15 (14.1)	0.219
Transmission route for hookworm infection:				
Not wearing shoes outside	0	5 (27.8)	6 (40.0)	0.051
Playing on ground	0	2 (11.1)	3 (13.3)	0.340
Not clean vegetables	0	2 (11.1	3 (20.0)	0.340
Eating any raw food	2 (18.2)	0.0	1 (6.7)	0.171
Getting from food	1 (9.1)	0.0	0	0.250
Heard about whipworm infection	2 (1.5)	9 (7.6)	11 (10.3)	0.008
Transmission route for whipworm infection:				
Not hand washing before eating	0	3 (33.3)	2 (18.2)	0.708
Not hand washing after defecation	0	0	2 (18.2)	0.529
Not clean vegetables	0	1 (11.1)	3 (27.3)	0.669
Heard about roundworm infection	92 (70.8)	78 (66.1)	78 (72.9)	0.519
Transmission route for roundworm infection				
Hand washing before eating	8 (8.7)	12 (15.4)	26 (33.3)	< 0.001
Hand washing after defecation	0	2 (2.6)	9 (11.5)	< 0.001
Eating any raw food	84 (91.3)	35 (44.9)	27 (34.6)	< 0.001
Playing on ground	0	8 (10.3)	9 (11.5)	0.001

Table 8.4: Perception towards personal hygiene and sanitation and risk behaviour at baseline in 2010 and after community-directed intervention in 2011 and in 2012, Saravane province, Laos

Item	2010 n = 130	2011 n = 118	2012 n = 107	p-value
Perceived benefits of latrine use:				
Prevention of diseases / no transmission of diseases	52 (40.0)	83 (70.3)	71 (66.4)	< 0.001
Convenience: do not go to forest/not making open defecation/not getting wet from rain	34 (26.1)	24 (20.3)	21 (19.6)	0.429
Clean environment: stool will not be dispersed around the village	23 (17.7)	44 (37.3)	40 (37.4)	< 0.001
Animal do not eat human feces	2 (1.5)	8 (6.8)	2 (1.9)	0.054
It is good for health	0	5 (4.2)	0	0.006
No mosquitoes in villages	0	1 (0.8)	0	0.634
No idea	19 (14.6)	6 (5.1)	7 (6.5)	0.027
Perceived benefits of hand washing before eating:				
Prevent infectious diseases/diarrhoea/abdominal pain	65 (50.0)	85 (72.0)	84 (78.5)	< 0.001
Stay healthy/it is good for health	17 (13.1)	6 (5.1)	5 (4.7)	0.022
Maintain good hygiene for ourselves: clean hand/ not getting dirty hand	41 (31.5)	48 (40.7)	23 (21.5)	0.008
Due to worm infection	3 (2.3)	4 (3.4)	7 (6.5)	0.232
No idea	15 (11.5)	4 (3.4)	1 (0.9)	0.001
Perceived benefit of hand washing after defecation:				
Prevent infections/diseases	75 (57.7)	85 (72.0)	80 (74.8)	0.009
Maintain good hygiene for our body	38 (29.2)	48 (40.7)	18 (16.8)	< 0.001
It is good for health	0	6 (5.1)	6 (5.6)	0.027
Not getting worms	0	4 (3.4)	2 (1.9)	0.116
No idea	7 (5.4)	4 (3.4)	3 (2.8)	0.556
Risk behaviour:				
Eating raw fish dishes	98 (75.4)	73 (61.9)	61 (57.0)	0.008
Eating raw fish dishes in the last three days	NA	12 (11.4)	16 (26.2)	0.165
Allow children to eat raw fish dishes	64 (49.2)	28 (23.7)	21 (19.6)	< 0.001
Eating raw pickle fish	59 (45.4)	33 (27.9)	39 (36.4)	0.018
Eating raw pickle fish in the last three days	NA	4 (12.1)	1 (2.6)	0.112
Eating raw fermented fish	82 (63.1)	66 (55.9)	52 (48.6)	0.082
Eating raw fermented fish in the last three days	NA	34 (51.5)	27 (51.9)	0.965

Table 8.5: Compliance to community-directed intervention in 2010 and 2011 among heads of households, Saravane province

	2010 (n = 118)	2011 (n = 107)	p-value
Attendance to mass treatment	93 (78.8)	91 (85.0)	0.215
Having adverse effect	49 (52.7)	29 (31.9)	0.004
	n = 49	n = 29	
Dizziness	47 (95.9)	29 (100)	0.527
Nausea	13 (26.5)	8 (27.6)	0.919
Vomit	12 (24.5)	4 (13.8)	0.385
Diarrhoea 2-3 time	1 (2.0)	0	1
Urticaria	0	1 (3.4)	0.372
Other	0	0	0
Severity of adverse effects :			
No severe	22 (44.9)	22 (75.9)	0.008
Mild	11 (22.4)	1 (3.4)	0.026
Moderate	12 (24.3)	6 (20.7)	0.786
Intense	4 (8.2)	0	0.291
Life threatening	0	0	0
Reasons for compliance to treatment :	n = 93	n = 91	
Treatment any diseases	38 (40.9)	36 (33.6)	0.857
Treatment of worm	26 (27.9)	36 (33.6)	0.267
Want to be healthy	19 (20.4)	20 (18.7)	0.797
Community leaders informed us/gov. support	14 (15.0)	14 (13.1)	0.950
Drug is free of charge	8 (8.6)	3 (2.8)	0.213
Drug is effective	3 (3.2)	0	0.246
Reasons for not compliance to treatment :	n = 25	n = 16	
Sick on the day of distributing drug	6 (24.0)	1 (6.2)	0.215
Afraid of adverse effects	6 (24.0)	4 (25.0)	1.000
Not in the list for deworming/ I was not selected for deworming	3 (12.0)	3 (18.7)	0.662
I got it before	1 (4.0)	0	1.000
Breastfeed baby/pregnancy	5 (20.0)	2 (12.5)	0.685
Absence on the day of distribution of drug	4 (16.0)	6 (37.5)	0.150
Knowledge about MDA	n = 118	n = 107	
Treatment of any diseases to our bodies	8 (6.8)	0	0.007
Treatment of worms and liver fluke	72 (61.0)	92 (85.9)	<0.001
Community will be healthier	3 (2.5)	7 (6.5)	0.199
Perceived benefit of MDA	n = 118	n = 107	
Community will be healthier	61 (51.7)	67 (62.6)	0.099
Prevent diseases	12 (10.2)	13 (12.1)	<0.001
Free of charge	3 (2.5)	5 (4.7)	0.483
Government concern community's health	7 (5.9)	5 (4.7)	0.772
After eating this drug people feel not eating raw fish anymore	5 (4.2)	0	0.061
People will be free of worms/all worms killed	27 (22.8)	18 (16.8)	0.257
Drug is effective	1 (0.8)	2 (1.9)	0.606

Chapter 9: Factors influencing the compliance to mass treatment distribution during a community-directed intervention (CDI)

Khampheng Phongluxa[1,2,3], Armelle Forrer[2,3], Vilavanh Xayaseng[1,2,3], Kongsap Akkhavong[1], Peter van Eeuwijk[2,3,4], Peter Odermatt[2,3*]

[1] National Institute of Public Health, Ministry of Health, Vientiane, Lao PDR

[2.] Swiss Tropical and Public Health Institute, Basel, Switzerland

[3] University of Basel, Basel, Switzerland

[4] Institute of Social Anthropology, Basel, Switzerland

* Corresponding author: Assoc. Prof. Peter Odermatt, Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, P.O. Box, CH-4002 Basel, Switzerland. Tel.: +41 61 284-8214; fax: +41 61 284-8105; E-mail: peter.odermatt@unibas.ch

Working paper

9.1 Abstract

Preventive chemotherapy in combination with health education is a main strategy for the helminth control in Laos since decades. However, its access is still limited for many affected communities. An innovative approach, community-directed intervention, is implemented in endemic liver fluke areas of southern Laos. We assessed the factors being associated with drug compliance among community members who attended and did not attend treatment, and the performance of community drug distribution (CDDs). A cross-sectional survey using the Explanatory Model Interview Catalogue (EMIC), a semi-structure interviews, and in-depth interviews with CDDs was conducted in 30 intervention villages. Comparative analysis was doneamong those who attended and did not attend treatment, and univariate and multivariate logistic regression analysis were performed using Stata software version 10.1. MAXQDA software version 10 was applied for qualitative data analysis. Of 600 interviewed, 46.5% attended treatment. A majority of respondents who attended treatment were from poor households (p=0.013), heard about intervention (p<0.001), knew that this intervention provided treatment of liver fluke (p<0.001) and abdominal pain (p=0.028), and recognized tapeworm (p=0.016). Most respondents had low level of knowledge regarding liver fluke and STHs though a substantial proportion heard about liver fluke and roundworm infections. Treatment compliance was associated with poverty (very poor (OR=2.13, p=0.018 and poor (OR=2.07, p=0.022), with knowledge about the effectiveness of intervention against liver fluke (OR=1.57, p=0.035), and with recognition of tapeworm infection (OR=2.95, p=0.037). CDDs performed their task fairly well though they received less attention from the professional health centre staff. In conclusion, treatmentparticipation is strongly associated with poverty, with knowledge that this intervention is effective against liver fluke, and with the recognition of tapeworms – but it is not related to knowledge on liver flukes and STHs. CDDs perform their task reasonably well in liver fluke interventions but they need regular refreshing trainings particularly on worm infections in order to transfer more effectively this knowledge to the affected communities.

Key words: liver fluke, soil-transmitted helminth, community-directed treatment, compliance, attending treatment, not attending treatment

9.2 Introduction

Food-borne trematode (FBT), *Opisthorchis viverrini (O. viverrini)*, and soil-transmitted helminths (STH) form part of the neglected tropical diseases (NTD). They represent a major public health problem in Southeast Asia (Keiser and Utzinger, 2007a; Keiser and Utzinger, 2009). Since decades World Health Organization (WHO) and its member states have committed to control neglected tropical diseases (NTD) (WHO, 2002; WHO/FAO, 2004). By 2008, about 670 million people from 75 countries had benefited from preventive chemotherapy; it is confirmed that where the treatment coverage reached the specific threshold set by the World Health Assembly (WHA) in 2001 – that is to say at least 75% of affected school-aged children have access to appropriate treatment –, the prevalence rate has significantly decreased (WHO/HTM/NTD, 2011). However, there are many causes influencing the rate of compliance like socio-demographic factors, fear of side effects, absenteeism, lay knowledge and attitudes regarding worm infections as well as people's perception and experience of deworming interventions (Amarillo et al., 2008; Cantey et al., 2010; Gunawardena et al., 2007; Krentel et al., 2006; Mathieu et al., 2004; Nuwaha et al., 2005). Today, a community-directed intervention (CDI) is considered to be an alternative and innovative approach for a sustainable helminth control. It has been successfully applied in several African countries for the control of onchocerciasis; it is a low-cost intervention but yields high treatment coverage on local level; additionally, it reaches the most helminthiasis-affected communities where their members and local health staff initiate, organize, implement and evaluate this control activity on its own terms (CDI study group, 2010; Katabarwa et al., 2008; Katabarwa et al., 2002).

Infections of STHs are directly linked with poor personal hygiene practices and poor sanitation (WHO, 1995), and *O. viverrini* is associated with the habit of consumption raw and insufficiently cooked fish dishes and poor sanitation (Sayasone et al., 2007) and the belief of consumption raw fish dishes in order to increase vigour, strength and health (WHO, 1995; Xayaseng et al., 2013). *O. viverrini* is confirmed as a carcinogenic for cholangiocarcinoma, a cancer of the bile duct (Bouvard et al., 2009; Fürst et al., 2012a; Sripa et al., 2011). A recent estimation for the burden of disease of FBTs resulted in 665,352 DALYs (lower estimate: 479,490 and upper estimate: 859,051 DALYs) (Fürst et al., 2012a).

In Laos, over 2 million people are infected with *O. viverrini* mostly in central and southern Laos (Sithithaworn et al., 2012); this infection often co-occurs with other minute intestinal flukes (MIF) and STHs (Sato et al., 2010; Sayasone et al., 2011). Though preventive chemotherapy in combination with health education is emphasized by the Lao Ministry of Health (MOH) for the control of helminthiases, mass treatment for liver fluke is intermittent and praziquantel is not available in peripheral health facilities due to shortage of resources. In 2008, about one third of the people who were at risk of helminth infections took mass treatment against different worms (Montresor et al., 2008). An innovative intervention (CDI) was therefore applied for the control of liver fluke and STH in Saravane province, an endemic liver fluke area in southern Laos. We assessed perception and experience of those community members who attend and did not attend the mass treatment during the CDI regarding worm infection and mass treatment intervention, we identified causes related to the intervention compliance of communities and we evaluated their view of the performance of CDDs.

9.3 Methods

9.3.1 Community-directed intervention

CDI against liver fluke has been implemented in 30 villages in liver fluke endemic areas of Saravane District, SaravaneProvince, since 2010. Prior to the health intervention community leaders (for instance, a head of village and a village health volunteer of each village) had received a one-day training as so-called community drug distributors at Saravane District Health Office (DHO). Trained CDDs led the intervention and distributed deworming medicine in their own village and provided health education about worm infections; they gave this education to the community members also on the occasion of other community gatherings. CDDs also encouraged community members to attend the mass treatment on the day of drug distribution. Trained health centre staff supervised the distribution of deworming drug and to handle side effects. Deworming was provided once a year, in general in March before Lao New Year. A single oral dose of PZQ (40 mg per kilo of body weight) and a tablet of ABZ (400 mg) were used for treatment. Mass treatment records were completed by CDDs and returned to Saravane DHO together with the remaining drugs. Deworming drug was distributed during the monthly meeting of health centre at Saravane DHO. Health centre staff brought the deworming drugs for its own catchments villages and some CDDs took the drugs directly

from their own health centre. For those villages close to the Saravane DHO, the CDDs took the drugs by themselves.

9.3.2 Ethics statement

Ethical clearance was obtained from the National Ethic Committee on Health Research, Ministry of Health, Lao PDR No 169/NECHR and dated 1st April 2008. Potential respondents were informed about their voluntary participation and their right to stop the participation in this study at any time. Afterwards, a signed informed consent form was obtained from them prior to the interview. Those respondents who could not write and read were allowed to agree with their personal fingerprint.

9.3.3 Study area

This study was conducted in 30 villages in Saravane district in the southern Saravane Province (Figure 1) from April to May 2011. The total number of inhabitants residing in these 30 villages was 21,422. About 13,980 (65.3% in 2010) and 6,333 (29.6% in 2011) people attended already a mass treatment (Figure 3.3 and 3.4). In 2010 a parasitological survey was carried out in 10 of these 30 villages: It indicated high infection rates of *O. viverrini* (88.7%) and hookworm (86.6%) while the rates of whipworm, roundworm and tapeworm infections were 32.9%, 9.8%, and 11.5%, respectively; this survey identified also multiple helminth infections with two and three worm species (Phongluxa et al., 2013).

Saravane District covers an area of 2,441 km^2 and is located on the Bolaven Plateau in southern Laos. Its 89,068 inhabitants (female: 45,520) live in 178 village and 13,239 households. The two main ethnic groups in this district are the Laotheung and Laoloum. The annual income per capita is 627 USD. Saravane District Health Office (DHO) supervises nine health centres that cover 71.0% of all villages, the remaining 29.0% are administered directly from the Saravane DHO; the district has 19 pharmacies plus two private clinics and 91 villages are equipped with drug kits; two village health volunteers exist in each village and 13 outreach teams visit the villages (Report Saravane DHO, 2008). In 2002, a national parasitology survey indicated that 21.5%, 11.9%, 10.9% and 5.4% of primary school children in Saravane Province were infected with *O. viverrini*, *Ascaris lumbricides*, hookworm, and *Trichuris trichiura,* respectively (Rim et al., 2003). In

2004, the prevalence of *O. viverrini* infection was reported to reach 58.5% (ranging from 20.0% to 85.5%); consumption raw or insufficiently cooked fish dishes was considered to be common nutritional practice (79.7%); only a few households had latrines, and a majority of local fish species that were consumed in this district were infected with *O. viverrini* metacercariae (Sayasone et al., 2007). In 2010, the rate of liver fluke infection was higher than a previous survey reported (88.7% in 2010 vs. 58.5% in 2004) (Phongluxa et al., 2013).

9.3.4 Study design

A cross-sectional study was conducted in all 30 intervention villages one month after the second round of implementation of CDI. A systematic sampling procedure selected 20 households from a Saravane DHO compiled household list of each village, which made a total of 600 households. A semi-structured Explanatory Model Interview Catalogue (EMIC) (Weiss, 1997) was used to study views of respondents who took and did not take treatment, on helminth infections and current CDI intervention. In-depth interviews with trained CDDs were made to understand the performance of intervention. The EMIC questionnaire consisted of socio-demographic characteristics, two vignettes that depicted non-severe and severe symptoms of liver fluke, perceived causes, experienced illness, and preventive measures for liver fluke and STH, and perceptions of the implementation of the current CDI intervention. Using an in-depth interview guideline we asked CDDs how they implement the distribution of deworming drug, about their perceived benefits of intervention, their motivation for this work, and the strength and weakness of this intervention.

A vignette for non-severe symptoms represented a patient who had symptoms of oesophagus influx, stomach-ache, flatulence, and hot sensation on the right upper quadrant of abdomen while a vignette for severe symptoms for liver fluke portrayed a patient with symptom of jaundice, anorexia, loss weight, fatigue, weakness, and a big abdomen with ascites.

9.3.5 Data collection and field procedures

Five trained interviewers carried out data collection (i.e., three from the National Institute of Public Health [NIOPH] and two from Saravane DHO). Village authorities assisted our field team to reach each selected household. The head of household was approached with regard to the interview; in case of his absence on that day of survey, the respective representative (his wife or the oldest child) was interviewed. Prior to each interview the signed informed consent was obtained. Each interview was tape-recorded, but only after granted permission. Each interview lasted for about 40-50 minutes. In addition, we conducted in-depth interviews with trained CDDs, health centre staff, heads/deputy heads of village, trained birth attendants, and members of Lao Women Union. Before leaving the village each interview was checked up by the field team on completeness and the field supervisor revised again all interview forms.

9.3.6 Data processing and analysis

Quantitative data were double entered and validated in Epidata version 3.1 (freeware) and analysed using Stata software version 10.1. With regards to data analysis of those persons who took and did not take mass treatment, we retained only those respondents who reported to take the treatment and their name also appeared in the mass treatment records completed by CDDs in 2010 and 2011 for our analysis. These mass treatment records showed that of 21,422 people from the 30 intervention villages 69.4% (ranging from 12.1% - 99.3%) in 2010 and 39.3% (ranging from 7.1% - 87.4%) in 2011 attended the mass treatment.

With regards to EMIC interview, the knowledge on liver fluke including its vignette for non-severe and severe signs, on STHs, perceived benefits of intervention, perceived strength and weaknesses of intervention were coded: Value of 2 was set for spontaneous answer, 1 for answers upon probe, and 0 if respondent did not apply to any kind of response; value of 3 was set for the most important perceived cause or means for prevention and the most troubling perceived symptoms. The cumulative prominence by respondents was ranging from 0 to 5, which was used to calculate the mean or mean prominence for each category. Descriptive statistical analysis was assessed for socio-demographic characteristic, perceived liver fluke as health problem in family, community, and province, and the severity of liver fluke and STHs, and knowledge on mass

treatment. Pearson's X^2 and Fisher's exact tests were used where appropriate. Wilcoxon ranksum test was performed to compare the mean prominence of each category whereas Kruskal Wallis test was used to compare the normal mean. We assessed the variables to predict their associations. All explanatory variables that were significant on univariate logistic regression analysis at level 0.25% were subsequently put in a multivariate logistic regression analysis. The significant level was accepted at $p<0.05$. Narrative data was typed into the EMIC frame 'rtf' format and imported as file into MAXQDA software version 10.1, a program for qualitative textual analysis. The narrative data were analysed and used to complement and enrich the quantitative data where necessary.

9.4 Results

9.4.1 Socio-demographic characteristics

Forty-six point five per cent (46.5%) or 279 from 600 respondents attend a mass treatment at least once in 2010 or 2011. Compared to those individuals who did not participate in mass treatment they were rather young and mainly between 30 and 39 years old (p=0.003), they had attended primary school (56.9% of treatment participants vs. 43.3% of non-participants, p=0.006), worked as farmers (97.8% vs. 91.9%, p=0.009), and lived in households with poor quintile such as 23.4% vs. 16.9% in very poor, 22.9% vs. 16.9% in poor quintiles. The members of the Laoloum ethnic group were highly represented among those respondents who did not take treatment (59.1% vs. 67.6%, p=0.032). Gender did not result in significant differences (p=0.269, Table 9.1).

9.4.2 Knowledge and perceptions of community-directed intervention (CDI)

Almost all respondents heard about CDI (96.3%). However, more respondents who took treatment reported about it than those who did not take treatment (99.3% vs. 93.8%, p<0.001); most of them thought that the intervention provided a treatment for liver fluke infection (68.6% vs. 54.5%, p=0.001) and abdominal pain (4.3% vs. 1.3%, p=0.028), but they did not know that it was also against hookworm disease compared to those who did not take treatment (0% vs. 2.7%, p=0.008) (Table 9.2).

Respondents participated in drug treatment because they wanted to stay healthy (97.8%), to be free from worm diseases (96.4%), and they have been informed by CDDs about the mass treatment (96.4%), due to convenience (95.3%), because it was free of charge (84.9%), they suspect themselves being infected by worms because of abdominal pain and nausea (67.4%), and they discussed it with friends before they attended the treatment (66.3%). Only the first three items were spontaneously reported compared to the respondents who ignored the treatment (Table 9.3).

When we evaluated the respondents and their reasons for not taking part in the treatment, the highest total spontaneous reply was attributed to absenteeism due to work outside the village (15.3%), to not being informed by CDDs about the treatment intervention (12.1%), to pregnancy or breastfeeding a baby (12.1%), and to the notion that they do not have worms and thus do not need any deworming treatment (11.5%) (Table 9.3).

The perceived benefits of intervention that were mentioned by those who took treatment were related to the following statements: in connection with a healthy life, to be free from worm infections and not to suffer from any side effects (98.9% vs. 72.9%, $p<0.001$); because it was free of charge and the location was convenient (99.6% vs. 72.9%, $p<0.001$); due to the good performance of the CDDs (99.6% vs. 72.9%, $p<0.001$); and CDDs were assigned officially by the village authority (98.6% vs. 72.6%, $p<0.001$). In contrast, some constraints of intervention were mentioned such as drug induced side effects (71.3% vs. 48.9%, $p<0.001$), CDDs were not health professionals (40.9% vs. 25.9%, $p<0.001$). The most frequently referred side effects were drowsiness, nausea and headache (Table 9.4).

9.4.3 Knowledge and perceptions of liver fluke infection

Eighty-one per cent (81.0%, 486/600 respondents) had heard about liver fluke and we did not observe a significant difference between those who took and did not take treatment (Table 9.2).

Fewer respondents who took treatment linked the following causes with liver fluke infection than those who did not take treatment, such as eating raw fish dishes (for example *Koi Pa* or *Lap Pa*) and raw sour fermented fish (94.7% vs. 99.2%, $p=0.006$),

and consuming any raw food such as eating raw vegetables, raw shrimps and crabs, raw beef salad and pork (95.6% vs. 99.6%, p<0.001, Table 9.6).

There was no significant difference between the respondents who took and those who did not take treatment with regards to the perceived symptoms or distress, and severity of liver fluke infection although more than 80.0% of the respondents in both groups mentioned some symptoms due to liver fluke infections as health problems in their community.

9.4.4 Vignettes with non-severe and severe cases of liver fluke

The vignette for non-severe liver fluke infection revealed that the respondents who took and did not take treatment regarded this disease as gastritis and perceived it as a serious health problem (50.9% vs. 51.1%, p=0.962; 54.5% vs. 55.9%, p=0.755, respectively). Most of them spontaneously pointed at the habit of eating raw fish (31.0% vs. 33.0%, p=0.895), of eating any raw food (33.0% vs. 36.0%, p=0.059), and of drinking unsafe water or eating very spicy food (34.0% vs. 30.0%, p=0.440). The vignette was thus not significantly different between the two groups of respondents.

Similarly to the vignette for severe cases of *O. viverrini*, our study did not observe any distinct difference between respondents who took and did not take treatment. Both categories thought that it was a liver disease (12.9% vs. 14.9%, p=0.470), a liver fluke disease (12.9% vs. 9.4%, p=0.165), that it was dangerous (87.8% vs. 88.8%), and that the consumption of raw fish dishes (49.0% vs. 40.0%) and of any raw food (42.0% vs. 38.0%) was linked with this disease.

9.4.5 Knowledge and perception of soil-transmitted helminths and other worms

As to the STHs, both respondents who took and did not take the treatment were well aware of roundworm; however, it did not show any significant difference.

In terms of perceived cause, symptom and severity of STHs, our study did not find any significant differences between those who took and did not take treatment. They even correlate both the consumption of raw fish dishes with the infection of any species of STHs.

Tapeworm was in contrast a well-known parasite and most prominently and significantly reported by those respondents who took treatment (15.1% vs. 8.7%, p=0.016, Table 9.5).

9.4.6 Causes associated with treatment compliance

Univariate logistic regression analysis resulted in three groups of predicted variables: socio-demography; knowledge on current intervention; and knowledge on worm infection; they were significant at level of 0.25 and included in the multivariate logistic regression analysis. The three identified variables of treatment compliance were significantly related to poverty (very poor quintile [OR=2.13; p=0.018], poor quintile [OR=2.07, p=0.022]), to perceived the current intervention as effective intervention against liver flukes (OR=1.57, p=0.035) and to the recognition of tapeworm infection (OR=2.95; p=0.037; Table 9.7).

9.4.7 Results of in-depth interviews with community drug distributors

Ninety per cent (90.0%) of 50 interviewed CDDs were male; their mean age was 45.3 years (age range 42.8 - 47.7 years); 50.0% had attended primary school and 46.0% secondary school; 62.0% were members of the Laoloum ethnic group.

9.4.7.1 Quality of performance of trained community drug distributors

CDDs were responsible for the distribution of drugs (64.0% [32/50]), of which 23 (from 32) were trained VHV, and for the weighing (56.0%) and registration (38.0%); some CDDs (44.0%) performed both weighing and distributing the drugs at the same time and very few (6.0%) carried out all three tasks. Prior to the mass treatment they gathered the community (76.0%) and gave some instructions such as having some food before taking medicine (70.0%), staying at home after medicine administration due to possible side effect (56.0%), consulting with CDDs if any side effect might happen (38.0%) and about possible exclusion criteria for treatment (34.0%). They also talked about worm infection to the community by reading training materials and showing posters which they obtained from their training courses and they encouraged the community members to eat cooked food (42.0%).

The majority of CDDs (84.0%) distributed medicine through their village unit (i.e. consisting of 10-13 households) in order to cover the whole community. On the day of treatment all village authorities assisted the CDDs in general works and encouraged the community members to attend the treatment (cited by 46.0%). Some CDDs (38.0%) had received supervision from the trained health centre staff. Most CDDs (40 from 50) opted to distribute medicine after dinner in the second year of intervention due to fewer side effects.

9.4.7.2 Motivation to work as community drug distributors

CDDs performed the mass treatment in their villages because they wanted their community members to stay healthy (58.0%), they were concerned with community health (26.0%), they tried to reduce the infectious diseases in their community (19.0%), they showed self-respect because they were assigned by the village authority (14.0%), and they were keen to prevent liver fluke disease in their community (14.0%).

9.4.7.3 Community drug distributors and perceived benefits and constraints of current intervention

CDDs perceived many benefits of current intervention: equal access to deworming treatment regardless of social-economic status (100%), convenient implementation (98.0%), showing dignity in their society and being respectful towards all community members (98.0%), increase in knowledge of CDDs in controlling worms (96.0%), prevention of diarrhoea (96.0%) and of re-infection of worms (94.0%), prevention of abdominal pain (94.0%), high attention of the government paid to the community (90.0%), and deworming for free of charge (90.0%), prevention of any diseases in their village (80.0%), and reduction of worm diseases in their community (62.0%).

Some constraints were reported by CDDs, for instance, side effects induced by PZQ (cited by 70.0%) such as dizziness (86.4%), nausea (54.5%), headache (52.7%), vomit (34.1%), allergy (20.4%), and diarrhoea (18.2%). Moreover, some CDDs complained that no stool examination was performed before treatment and all people got the same treatment.

Two CDDs in Chantai village where the treatment coverage in 2010 was less than 20% said that *"when we distributed medicine at the first day, a lot of people were gathering*

and waiting for the treatment because it was the first time to provide deworming for the entire population; once they saw that some got side effects like dizziness, nausea, and vomit … those who have not yet taking treatment run away from treatment, although we encouraged them not to worry about that". However, persons who suffered from side effects after the treatment reported to CDDs that they appreciated the effectiveness of PZQ anyway because they felt healthier such as 'feeling light in the body' and having a good sleep and appetite.

Two CDDs, one in Mak Nao Noy and another in Nong Fang Gnong village, told similar narratives that *"someone in the village who had been a health assistant said that treatment with the PZQ needed a check of liver function in advance otherwise it would not good to take it, therefore the majority of community member refused treatment"*.

This above statement in connection with mentioned side effects resulted in a relatively sharp decline of treatment compliance in 2011 in the 30 intervention villages by contrast with the high rate in 2010. Lay information from health professionals as well as rumours and gossip about adverse side effects from drugs have a meaningful impact on treatment compliance on local level and have therefore to be considered both in trainings for CDDs and in preparatory work for CDI in the communities.

9.5 Discussion

Community-directed intervention against liver fluke and STHs was introduced for the first time in Lao PDR. This study aimed to describe knowledge and perception of current intervention and worm infections among community members who took and those who did not take treatment, to identify the factors being associated with treatment compliance, and to assess the performance of CDDs in local CDI against liver fluke and STH in liver fluke endemic areas of Saravane District in southern Laos. A combination of quantitative and qualitative research methods was used for data collection.

9.5.1 Socio-demographic characteristics

Our findings show that the socio-demographic characteristics (i.e. age, gender, ethnicity, education, occupation, and wealth) among those who took and did not take treatment were of significant importance except for gender. Those respondents who took treatment

were mainly young adults (30-39 years), attended primary school, belonged to the Laotheung ethnic group, were farmers and among the poor and very poor quintiles. Of these characteristics only wealth (i.e., poverty) was strongly associated with a high rate of treatment compliance due to the treatment provided for free of charge and in a time- and cost-saving way in the village. No other study confirmed a similar finding. A previous survey from Cameroon where the average socio-economic status is not so much different from that in Laos found that the strongest association regarding treatment compliance of onchocerciasis was with ethnicity and education (Brieger et al., 2011) while another survey in Haiti confirmed that gender is strongly correlated with treatment compliance of lymphatic filariasis (LF) (Mathieu et al., 2004).

Previous survey on the factors associated with coverage of praziquantel for schistosomiasis control in the CDI in Mali (West Africa) found that socio-demographic variables like age and ethnicity were associated with the increase of treatment coverage such as most young people tended to take treatment (<15 years of age) compared with people above 15 years of age, and there was significant different compliance between ethnic groups (Dabo et al., 2013). These results are similar to our findings; however after including them into multivariate logistic regression analysis with other significant variables, they are no longer significant.

9.5.2 Knowledge and perception of community-directed intervention

Most respondents in our study heard about this curative intervention; however, a majority of persons who reported about it took treatment. They also knew that the intervention was for treatment of liver fluke and effective against abdominal pains; at the same time they were also well aware that the drug might induce side effects and that CDDs were not trained health professionals. Nonetheless, they had confidence in CDDs because they were selected by the village authority and received proper training. They appreciated that the services for deworming were free and held in their village. The respondents perceived also that they would be in better health and have no more worm infections; they had never experienced any side effects after treatment. However, the most important factor in our study related to a high compliance rate was the personal perception of intervention against liver fluke: People have gained the experience that this intervention cures effectively liver fluke infections which also results in a positively perceived quality of care. Our findings confirmed to studies from India that revealed that

people's perception of the effectiveness of intervention against LF was strongly associated with the compliance of its treatment (Cantey et al., 2010) in contrast, studies from south-western Ethiopia showed that the perception of high risk for the disease, on one's family support, on CDDs work performance, and on measuring body height as the best way to determine the dose for treatment was associated with the compliance to treatment of onchocerciasis (Yirga et al., 2010). In Uganda the most important factor was the perception of the quality of performance of CDDs (Nuwaha et al., 2005), and a study from Sri Lanka reported that the belief in curative intervention providing some benefits was strongly linked with the treatment of LF (Gunawardena et al., 2007).

Our study observed that the most important reason for not taking treatment was absenteeism, followed by not being informed about the treatment, and falling in exclusion criteria such as being pregnant, breastfeeding, and being sick on the day of treatment. These findings are similar to reports from a study in Haiti (Mathieu et al., 2004).

9.5.3 Knowledge and perception of worm infections

Our study indicates that liver fluke was well-known by both groups of respondents; the habit of eating raw fish and any raw food to be a cause for this infection, however, was recognized mostly by those respondents who did not take treatment. Knowledge on signs and symptoms of liver fluke and means for its prevention did not show significant deviation between both groups. Although the majority of respondents in both groups heard about liver fluke infection, the notion about the vignette for non-severe and severe symptoms of liver fluke was poor and not significantly different between the two groups. Knowledge on liver fluke in our study was not at all associated with treatment compliance which is inconsistent with previous findings such as the notion that everyone is at risk for LF (Cantey et al., 2010), the knowledge about the disease and even the ignorance about the cause of the infection (Ukwandu and Nmorsi, 2004), the knowledge of transmission of the infection (Mathieu et al., 2004) and perception of the degree of riskiness of this disease (Gunawardena et al., 2007). Today it is well-established evidence that these cognitive factors have a strong impact on treatment compliance.

Regarding the knowledge on other worm infections, our study observed that both groups of respondents who took and did not take treatment showed poor knowledge on STHs

with the exception of roundworm and the deviation was not significant. Tapeworm, a food-borne trematode, was well-recognized, in particular by those respondents who took treatment. The knowledge about tapeworm was strongly associated with compliance with treatment. This knowledge is similar to what Phongluxa reported in a previous study conducted in the same district as well as in other southern districts; she described consistently that community members were well aware of tapeworm and sought care after they have seen it in their faeces, either by taking traditional medicine or western medicine (Phongluxa et al., 2013; Phongluxa et al., 2014). Phongluxa concluded that the community members had been informed by trained CDDs in the village prior to mass treatment that the drug (particularly praziquantel) is highly effective against different worms including tapeworm – a fact which was discussed in training courses for CDDs. Thus health education that includes also the drug effectiveness against different worms has to be fostered prior to the mass treatment in the villages in order to increase treatment compliance of liver fluke and STHs. This is meaningful particularly where the visual recognition of the worm in faeces is required for the understanding of the urgency of necessary deworming measures (Phongluxa et al., 2013).

9.5.4 Quality of performance of trained community drug distributors

With regards to the quality of CDDs performance, our study observed that they performed their task well on the whole during the interventions; almost half of them received assistance from the village authority which encouraged community members for attending the treatment, and one-third received professional supervision from trained health centre staff. This mutually supporting work is an important step towards a sustainable helminth control on village level. CDDs considered it as their most important task that they gathered community members in advance and talked about mass treatment and worm infections related to the long-standing habit of eating raw fish dishes and to personal hygiene and sanitation; in general, they read training materials which they obtained from their training courses. Most CDDs distributed drugs by units in order to cover all households and individuals. Some opted to distribute the drug after dinner to minimize side effects. CDDs worked in a very active way due to their dedication to maintain the good health of their community members; they support this deworming intervention because it is provided for all members in an equal way regardless whether they are poor or rich, it is free of charge and it took place in their own villages, and because this intervention prevented any other disease and deserved respect and

acceptance from the whole community. Some CDDs recommended that the stool should be examined before the deworming medication. A study on community-directed intervention against schistosomiasis in Mali showed that the presence of health workers in villages to supervise the CDDs at the time of distribution of deworming drug is associated with an increase of compliance rate to mass treatment; the health workers could thus establish reliable interactions between the formal health service and the local people (Dabo et al., 2013).

9.5.5 Side effects and compliance rate

A previous study from India pointed out that drug induced side effects represent one reason why community members kept away from attending mass treatment of LF (Cantey et al., 2010). Based on in-depth interviews with CDDs in our study we found out that the different side effects were considered as one of the major reasons for community member to refuse the treatment of liver fluke – except for the treatment of STHs where ‘round tablets' (i.e., a local term for albendazole [400 mg]) were used and which were very much appreciated by the community members and therefore very popular as preferred treatment. Several community members suffered from adverse events induced by PZQ such as dizziness (62.7%), nausea (56.6%), and headache (54.8%), and one-third of them complained of vomiting; one-fifth were afflicted with allergy and less than one-fifth with diarrhoea. In conclusion, one may note that these mentioned drugs induced side effects which caused strong feelings of worries and uncertainty for household members and discouraged thus people to attend mass drug administration.

9.6 Conclusion

Our study highlights that community members who attend treatment of liver fluke in the village are to a large extent poor villagers, young adults, members of an ethnic minority group (Laotheung), farmers, and people with a low education. Nevertheless, they are well aware of the availability of this intervention and know its effectiveness against liver fluke; the intervention’s benefits of staying healthy and being released from worm infections are well perceived and recognized. Both groups of respondents (i.e., to take and not to take treatment) show a low degree of knowledge on the worm’s transmission, its diseases and its prevention though they have already heard about liver fluke,

roundworm and tapeworm in their villages. Respondents who did not take treatment are mainly members of the Laoloum ethnic group; their main reasons for not attending the treatment intervention are absenteeism, not having been informed by the local CDDs, and falling into the exclusion criteria. The most important causes that determine the rate of treatment compliance are as follows: material and financial wealth; knowledge on the intervention against liver fluke; and knowledge about the tapeworm. The quality of CDDs' task performance (i.e., preparing and implementing the treatment intervention) is for the most part satisfying and well acceptable by the community though they call for a yet intensified supervision from the trained health centre staff; some CDDs recommended a stool examination of the villagers for an accurate diagnosis prior to the mass treatment. To further boost the compliance rate for a CDI, regular refreshing trainings for CDDs are needed in order to disseminate updated and correct health messages within the community as well as regular supervision and guidance by the trained health centre staff during the treatment intervention and, if required and requested, under the general support of the district health office. This study has revealed that a high compliance rate with community-directed intervention for liver fluke treatment on local level is achievable through (1) good accessibility (e.g., provided in the village), affordability (e.g., free of charge), and availability (e.g., concise information being spread to all households); (2) good knowledge of the community members about the procedure of this intervention, the treatment effectiveness, and the benefits of such a medication; (3) good knowledge of household members about potential drug side effects and its prevention and mitigation; and (4) good quality of the CDDs' performance before, during and after the treatment intervention in the village including a reliable external supervision and monitoring system.

9.7 Acknowledgements

We would like to thank to all institutions and people who contributed to this study: Ministry of Health, the Saravane Provincial Health Department, the Saravane District Health Office, health centres, village authorities, participants who participated in this study, and my field research team. My words of thanks also go to Audrey Bochaton for her help to develop the map for study site. The generous support from World Health Organization WHO) in Geneva for this study and the Rudolf Geigy Foundation for Khampheng Phongluxa is highly acknowledged.

Table9.1: Compliance with praziquantel mass treatment against liver fluke analysed for demographic characteristics and socio-economic status, KAP survey in Saravane District 2011

Items	Total (%) (n = 600)	Did not take the treatment (%) (n = 321)	Took the treatment (%) (n = 279)	p-value
Age of respondent				
Mean (SD)	44.8 (14.2)	46.0 (15.3)	43.4 (12.6)	
Age range	18 - 88	18 - 87	19 - 88	
Male:female ratio	1.05	1.14	0.95	
Age group (in year)				0.003
18 - 29	81 (13.5)	48 (14.9)	33 (11.8)	
30 - 39	159 (26.5)	67 (20.9)	92 (32.9)	
40 - 49	144 (24.0)	80 (24.9)	64 (22.9)	
50 - 59	118 (19.7)	61 (19.0)	57 (20.4)	
60+	98 (16.3)	65 (20.2)	33 (11.8)	
Gender				0.269
Male	307 (51.2)	171 (53.3)	136 (48.7)	
Female	293 (48.8)	150 (46.7)	143 (51.2)	
Ethnicity				0.032
Laoloum	382 (63.7)	217 (67.6)	165 (59.1)	
Laotheung	218 (36.3)	104 (32.4)	114 (40.9)	
Education				0.006
Never attended school	180 (30.0)	104 (32.4)	76 (27.2)	
Attended primary school	298 (49.7)	139 (43.3)	159 (56.9)	
Attended secondary school or higher	117 (19.5)	75 (23.4)	42 (15.0)	
Other	5 (0.8)	3 (0.9)	2 (0.7)	
Occupation				0.009
Farmer	568 (94.7)	295 (91.9)	273 (97.8)	
State employee	15 (2.5)	12 (3.7)	3 (1.1)	
Retail seller	7 (1.2)	5 (1.6)	2 (0.7)	
Other	10 (1.7)	9 (2.8)	1 (0.4)	
Socio-economic status				0.013
	n = 538	n = 277	n = 261	
Most poor	108 (20.1)	56 (20.2)	52 (19.9)	
Very poor	108 (20.1)	47 (16.9)	61 (23.4)	
Poor	107 (19.9)	47 (16.9)	60 (22.9)	
Less poor	108 (20.1)	58 (20.9)	50 (19.2)	
Least poor	107 (19.9)	69 (24.9)	38 (14.6)	

Table 9.2: Compliance with treatment analysed for knowledge and perception of community-directed intervention and liver fluke, survey in Saravane district in 2011

Variables	Total (%)	Did not take the treatment (%)	Took the treatment (%)	p-value
	n = 600	**n = 321**	**n = 279**	
Heard about MDA	578 (96.3)	301 (93.8)	277 (99.3)	<0.001
Perception of intervention:		n=301	n=277	
Perceived MDA is against any worm diseases	417 (72.1)	211 (70.1)	206 (74.4)	0.253
Perceived MDA is against liver flukes	354 (61.2)	164 (54.5)	190 (68.6)	0.001
Perceived MDA is against hookworm infection	8 (1.4)	8 (2.7)	0	0.008
Perceived MDA is against whipworm infection	4 (0.7)	4 (1.3)	0	0.125
Perceived MDA is against roundworm infection	48 (8.3)	24 (7.9)	24 (8.7)	0.764
Perceived MDA is against any diseases in our body	11 (1.9)	5 (1.7)	6 (2.2)	0.657
Perceived MDA is against malaria	36 (6.2)	19 (6.3)	17 (6.1)	0.931
Perceived MDA is against diarrhoea	24 (4.1)	14 (4.6)	10 (3.6)	0.531
Perceived MDA is against abdominal pain	16 (2.8)	4 (1.3)	12 (4.3)	0.028
Perceived MDA drug might induce any side effects	177 (30.6)	92 (30.6)	85 (30.7)	0.975
Heard about liver fluke	486 (81.0)	259 (80.7)	227 (81.4)	0.833
	n = 486	n = 259	n = 227	
Perceived liver flukes as health problem in community:				
Liver fluke disease is problem in your house	219 (45.1)	124 (47.9)	95 (41.8)	0.363
Liver fluke disease is problem in your village	336 (69.1)	181 (69.9)	155 (68.3)	0.901
Liver fluke disease is a problem in your province	381 (78.4)	207 (79.9)	174 (76.6)	0.270
Are you afraid of having liver fluke disease?	478 (98.3)	254 (98.1)	224 (98.7)	0.630
Are you afraid that someone of your family members would get liver fluke disease?	465 (95.9)	247 (95.4)	218 (96.0)	0.879
If you were diagnosed with liver fluke: would you immediately seek care?	482 (99.2)	257 (99.2)	225 (99.1)	0.507
Liver fluke causes death	480 (98.8)	254 (98.1)	226 (99.6)	0.238

Table 9.3: Reasons for attending and not attending mass treatment during community-directed intervention, Saravane district in 2011 (n = 600)

Items	Total reported			Took the treatment		
	Total reported	Fraction spon	Mean	Total reported	Fraction spon	Mean
		n = 279			n = 279	
Reasons for taking the treatment:						
Want to be healthy	97.8	0.31	1.14	97.8	0.31	1.28
Want to be treated from worm or no longer living with worm diseases (p = 0.048)	96.4	0.32	1.27	96.4	0.32	1.27
See worms coming out with feces	49.5	0.04	0.50	49.5	0.04	0.51
Feel not good: abdominal pain, nausea	67.4	0.07	0.69	67.4	0.07	0.72
Get it for free of charge	84.9	0.05	0.87	84.9	0.05	0.89
Convenient because in the village (p = 0.035)	95.3	0.01	0.94	95.3	0.01	0.96
VHV informed us	96.4	0.13	1.06	96.4	0.13	1.09
Had discussion with friends	66.3	0.01	0.68	66.3	0.01	0.67
See many people got treatment, then I do so, too	28.3	0.03	0.30	28.3	0.03	0.29
Other	47.0	1.00	0.93	47.0	1.00	0.94
Do not know	1.1	1.00	0.03	1.1	1.00	0.02
		n = 321			n = 321	
Reasons for not taking the treatment:						
Do not see worms coming out with feces	7.8	0.08	0.08	7.8	0.08	0.08
I am not sick (p = 0.001)	11.5	0.19	0.14	11.5	0.19	0.14
Fear of side effects	7.5	0.29	0.10	7.5	0.29	0.10
I do not want to get it (p = 0.006)	6.2	0.45	0.09	6.2	0.45	0.09
I was absent for work in other place (p = 0.030)	15.3	0.86	0.28	15.3	0.86	0.28
Nobody informed us about that (p = 0.001)	12.1	0.79	0.22	12.1	0.79	0.22
Fall into exclusion criteria	12.1	0.95	0.24	12.1	0.95	0.24
Got sick on the day of drug distribution	5.6	0.78	0.10	5.6	0.78	0.10
Other	12.1	1.00	0.24	12.1	1.00	0.24

Table 9.4: Compliance with treatment analysed for community members who perceived benefits from community-directed intervention, Saravane district in 2011 (n = 600)

Perceived benefits of CDI	Did not take the treatment (n = 321)			Took the treatment (n = 279)		
	TR	Fr.Sp.	Mean	TR	Fr.Sp.	Mean
Related to health (p = 0.001)	72.9	0.41	1.03	98.9	0.42	1.41
Feeling healthy	72.6	0.31	0.95	98.2	0.30	1.27
Having no more worm	71.0	0.15	0.82	95.0	0.14	1.08
No adverse effect happened to me	67.0	0.07	0.71	89.6	0.12	1.00
Related to offered services (p = 0.001)	72.9	0.15	0.84	99.6	0.20	1.20
Having deworming for free of charge	72.9	0.12	0.82	99.6	0.17	1.16
Convenient	72.9	0.06	0.77	99.6	0.07	1.07
Related to performance of CDDs (p = 0.001)	72.9	0.03	0.75	99.6	0.03	1.02
Time to distribute drug fits my time	71.7	0.00	0.72	98.6	0.01	0.99
Good performance by CDDs	71.7	0.03	0.74	99.3	0.02	1.01
Having confidence into CDDs	72.6	0.01	0.73	98.6	0.00	0.99
CDDs had been properly trained	72.0	1.00	1.44	97.8	1.00	1.96
Related to drug distributor (p = 0.001)	72.6	0.01	0.73	98.6	0.00	0.99
CDDs were assigned by village authorities	72.6	0.01	0.73	98.2	0.00	0.99
CDDs were people from our village	69.8	0.00	0.70	97.5	0.00	0.97

CDDs: community drug distributors

Table 9.5: Compliance with treatment analysed for community members who heard about soil-transmitted helminths and other parasitic infections, survey in Saravane district in 2011 (n = 600)

Category[a]	Did not take the treatment[b] (n = 321)				Took the treatment[b] (n = 279)				
	Total report (%)	Fraction Spon.	Most imp (%)	Mean prom.	Total report (%)	Fraction Spon.	Most imp (%)	Mean prom.	p-value
Heard about hookworm	37.7	0.48	6.9	0.76	31.9	0.52	4.3	0.61	0.178
Heard about *T. trichiura*	10.9	0.17	0.3	0.14	12.2	0.12	0.0	0.14	0.351
Heard about *A. lumbricoides*	93.8	0.91	49.2	3.26	96.8	0.93	49.1	3.35	0.977
Heard about tapeworm	93.8	0.92	8.7	2.05	97.5	0.95	15.1	2.56	0.016
Heard about pinworm	51.7	0.68	9.7	1.16	54.8	0.71	13.6	1.35	0.129

[a] Category of perceived worm infection; [b] column indicated the percentage of total report, fraction of answer spontaneously to mentioned category, and mean of based on value assigned to each report category (0 = not reported, 1 = reported after probing, 2 = reported spontaneously, 3 = perceived the most importance). Wilcoxon test was used to compare the mean prominence of perceived worm infection between respondents who took treatment and did not take treatment; spon. (spontaneously); imp. (important); prom. (prominence)

Table 9.6: Compliance with treatment analysed for knowledge on causes for *O. viverrini* infection and for community members who took and did not take mass treatment, survey in Saravane district in 2011 (n = 486)

Category[a]	Did not take the treatment[b] (n = 259)			Took the treatment[b] (n = 227)			p-value
	Total reported (%)	Fraction Spon	Mean	Total reported (%)	Fraction Spon	Mean	
Related to eating raw fish:	99.2	0.72	1.71	94.7	0.68	1.59	0.006
Eating raw fish dishes *(KoiPa, LapPa Nuew)*	98.1	0.71	1.68	92.5	0.67	1.54	0.008
Eating raw sour rice-fermented fish	96.9	0.24	1.20	91.2	0.18	1.07	0.007
Eating fermented fish	94.6	0.19	1.12	92.5	0.20	1.11	0.631
Related to eating other raw food:	99.6	0.77	1.76	95.6	0.65	1.58	<0.001
Eating raw vegetables	91.5	0.47	1.34	88.1	0.36	1.20	0.034
Eating raw shrimps, crabs	97.7	0.51	1.47	93.4	0.42	1.33	0.012
Eating raw beef salad, raw pork	91.9	0.50	1.37	90.7	0.39	1.26	0.086
Related to drinking unhealthy water and eating spicy food:	92.3	0.21	1.12	93.8	0.23	1.16	0.689
Drinking un-boiled water	82.6	0.14	0.95	85.5	0.13	0.97	0.663
Drinking alcohol	87.6	0.11	0.97	89.0	0.13	1.01	0.604
Eating spicy food	70.3	0.02	0.71	77.5	0.01	0.78	0.163
Related to health and environment:	86.1	0.02	0.88	86.3	0.05	0.91	0.290
Malnutrition	76.1	0.01	0.76	77.5	0.01	0.78	0.720
Windy	59.1	0.00	0.59	63.9	0.03	0.66	0.032
Mosquito bite	67.2	0.01	0.68	67.0	0.02	0.68	0.575
Bathing in river/pond	68.0	0.02	0.69	64.3	0.00	0.64	0.269
Related to poor hygiene:	92.7	0.08	1.00	89.9	0.08	0.97	0.549
Not wearing shoes	64.1	0.02	0.65	67.8	0.05	0.71	0.273
Not washing hand with soap	89.2	0.01	0.90	85.9	0.01	0.87	0.564
Not washing before eating	90.3	0.07	0.97	87.7	0.05	0.92	0.332
Not washing after using latrine	89.2	0.01	0.90	88.1	0.02	0.90	0.581
Related to poor sanitation:	90.3	0.04	0.94	89.4	0.02	0.91	0.516
Sharing toilet	70.3	0.01	0.71	72.2	0.01	0.73	0.883
Made open defecation	84.6	0.03	0.87	84.6	0.02	0.86	0.622
Defecate where other defecated	86.5	0.00	0.87	87.2	0.01	0.88	0.947
Related to religion and belief:	44.4	0.00	0.44	44.5	0.01	0.45	0.778
Faith	40.5	0.00	0.41	40.5	0.01	0.41	0.775
Punishment	36.3	0.00	0.36	37.0	0.00	0.37	0.473
Ancestor	35.1	0.00	0.35	35.2	0.00	0.35	0.528
Wrong tradition	33.6	0.00	0.34	34.4	0.00	0.34	0.467

[a] Category of perceived cause for *O. viverrini*; [b] column indicated the percentage of total report, fraction of answer spontaneously to mentioned category, and mean of based on value assigned to each report category (0 = not reported, 1 = reported after probing, 2 = reported spontaneously). Kruskal Wallis test was used to compare the mean of perceived cause for *O. viverrini* between respondents who took and did not take the mass treatment (* p = 0.05; ** p = 0.01; *** p = 0.001)

Table 9.7: Correlation of socio-demographic characteristics and knowledge about community-directed intervention and worm infections with mass treatment compliance, survey in Saravane district in 2011

Category	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	p-value	OR	95% CI	p-value
Age group:						
20 - 29 years	Ref					
30 - 39 years	1.99	1.15–3.44	0.013	1.86	0.94–3.69	0.075
40 - 49 years	1.16	0.67–2.02	0.590	1.16	0.56–2.32	0.678
50 - 59 years	1.36	0.77–2.41	0.293	1.19	0.59–2.39	0.626
60+ years	0.74	0.40–1.36	0.330	0.78	0.37–1.65	0.518
Gender:						
Male	0.83	0.60–1.15	0.269			
Female						
Ethnicity:						
Laoloum	Ref					
Laotheung	1.44	1.03–2.01	0.032	1.03	0.68–1.54	0.900
Education:						
No schooling	1.09	0.18–6.72	0.921			
Primary school	1.71	0.28–10.4	0.557			
Secondary school and higher	0.84	0.13–5.23	0.852			
Socio-economic status:						
Quintile 1	1.69	0.97–2.91	0.061	1.58	0.83–3.02	0.162
Quintile 2	2.35	1.36–4.08	0.002	2.13	1.14–3.98	0.018
Quintile 3	2.31	1.34–4.02	0.003	2.07	1.11–3.85	0.022
Quintile 4	1.56	0.90–2.70	0.109	1.40	0.75–2.61	0.287
Quintile 5	Ref					
Knowledge about CDI intervention:						
Heard about mass treatment	9.2	2.13–39.7	0.003	dropped due to collinearity		
Perception that MDA is against any worm diseases	1.24	0.86–1.78	0.253	0.79	0.49–1.27	0.331
Perception that MDA is against liver fluke	1.82	1.29–2.56	0.001	1.57	1.03–2.39	0.035
Experienced side effect as weakness of intervention	34.2	10.67–109.55	<0.001	1.26	0.82–1.92	0.289
Perception that CDDs are not health professionals	25.96	9.39–71.79	<0.001	1.37	0.91–2.07	0.132
Knowledge about worm infection:						
Heard about hookworm	0.61	0.29–1.26	0.181	0.73	0.48–1.11	0.141
Heard about tapeworm	1.85	1.11–3.08	0.017	2.95	1.06–8.19	0.037
Heard about pinworm	1.13	0.81–1.56	0.471			

Chapter 10: Discussion

10.1 Overview for the discussion

This PhD thesis relates to the development of a CDI for the control of the liver fluke and intestinal co-infection in liver fluke endemic areas in southern Laos. Thus, before designing and implementing the CDI, we reviewed knowledge on helminth infection in Laos of the last four decades and we deepened our understanding on epidemiology of helminth infection and associated risk factors in relation to the existing local knowledge, attitudes and practices (KAP) regarding worm infection and deworming intervention in endemic helminthiasis and multiparasitism in southern Laos. Then we developed on CDI and evaluated the effectiveness of a new intervention focusing on prevalence of helminth infection, KAP regarding worm infection and deworming intervention, and factors influencing the compliance to the new intervention.

The justification for the current PhD studies is as follows: The liver fluke infection is a major public health problem in Laos, particularly in the South. In addition the infection is often co-infected with other helminth (STH) particularly hookworm and schistosomiasis which exacerbate the morbidity. As known transmission of liver fluke occurs when open defecation occurs. Human acquire infection by the consumption raw or insufficiently cooked fish dishes. In Laos many survey pointed out that open defecation and consumption raw and insufficiently cooked fish dishes are common practice in community. Today we lack information on clear distribution of helminth infections and associated risk factors in relation to the existing local community's knowledge, attitudes, perceptions and practices regarding worm infection and deworming intervention. Only one study pertaining local perception on liver fluke was conducted in central province of Laos. In addition, preventive chemotherapy along side with health education is prioritized by Lao Ministry of Health for helminth control but it mainly implement via a vertical program which requires substantial amount of staff and funds and, therefore, it is challenging for the government to support long-term interventions, which leaves in turn affected communities without access to adequate health services and in a passive role in the control of helminth infection. Today there is an alternative and successful

approach for the control of parasitic infection such as onchocerciasis in African countries.

10.2 Study limitations

The methodological approach of this PhD work, namely the application of a triangulation (i.e., stool examination, interview with heads of household, FGDs with community members, and direct observation) allowed us to confirm the finding from different and hence to show the strong relationship between the high helminth prevalence rate of helminth infections and the low degree of corresponding awareness and knowledge of selected community members. However, our helminth infection assessment was performed with Kato-Katz technique which does not allow the distinction between *O. viverrini* and minute intestinal flukes (Lovis et al., 2009). Most recent research based on purging infected individuals (Chai et al., 2013) and molecular diagnostic tools showed that in Southern Laos a considerable amount of MIF is present (Lovis et al., 2009) and therefore this PhD reported *O. viverrini* infection rate most probably is over-reported. However, the route of transmission and preventive measures for MIF parasites are the same (Chai et al., 2005; Chai et al., 2007). Thus our findings on the community's low state of knowledge and awareness on the worm infections is valid as well (Chapter 5).

10.3 Discussion on study findings

10.3.1 Helminth infection: *O. viverrini* and soil-transmitted helminth in Laos

We conducted a review on helminth infection in over the last four decades (1970-2013) for Laos. We searched peer-review papers from international journals mainly through PubMed database. We estimated the true prevalence for *O. viverrini* and STH using prevalence data, value of sensitivity for the tools used to diagnose helminth infections and study site. Stata software and WinBUG program were used for the calculation of the true prevalence of helminth infection. Our review highlights that *O. viverrini* has been a public health problem in Laos since the 1970s though the diagnosis of helminth infection was based on Kato Katz method to examining one stool sample obtained from individual. Today the infection with *O. viverrini* is found in central and southern Laos and the infection rate varies by places. With the application of multiple Kato Katz slides per a stool sample to examining two or three stool samples obtained from individual allow to

detect more infection above 90.0% in southern Laos however this high infection rate was not reported in high land areas such as Paksong district of southern province and Nakai plateau of central province.Beside the high prevalence of *O. viverrini*, its control activities are limited and irregular due to mass treatment intervention mainly relies on international supports. Peripheral health facilities in endemic areas PZQ and ABZ are not yet available in stock as well as for essential equipment and devices for diagnosis of helminth infection are leading in most health facilities.

Our review also highlights that currently STH caused by *A. lumbricoides*, *T. trichiura*, and hookworm is relatively low prevalence rate if compared to the 1990s but hookworm infection is predominant species, followed by *T. trichiura* and *A. lumbricoides.* These positive changes might be the result from promoted health education and deworming of STH with single oral dose mebendazole right dose (500mg) by the Ministry of Health since a decade ago through their routine outreach activities and health care services; theschool health deworming program started in 2004 and it covers now all provinces in Lao PDR (Phommasack et al., 2008); and the deworming activities for under 5 years of age and women in reproductive age through health care service at MCH units. It is possible reason that hookworm infection in Laos remains high is because of the use of mebendazole for mass treatment, research in Southeast Asia confirmed that mebendazole 500mg has low efficacy against hookworm if compared with ABZ 400mg (Soukhathammavong et al., 2012; Steinmann et al., 2011). Thus the consideration for the use of ABZ 400mg in deworming intervention is highly recommended and together with health education regarding the transmission route particularly of hookworm and whipworm infections.

After calculation of the prevalence of STH, we noted that all species of STH are elevated in the northern part of Laos. The landscape in the northern part of Laos is dominated by mountains and hilly rugged physical environment which deter to the socio-economic development and access to health care service and only 20% and 50.0% of population in this region had accessed to safe water and sanitation, respectively (Sayasone et al., 2011). Geographical environment in northern part of Laos is similar to the southern part of People’s Republic of China Yunan province where the prevalence of all three STH species was exceeded 85.0% and multiparasitism was identified up to 6 species (Steinmann et al., 2008). Thus intensive health education together with regular

deworming with ABZ (single dose 400mg) through the CDI approach is warranted to address the helminthiases in this region.

We noted that most parasitological surveys were concentrated in central and southern parts of Lao PDR and only one national scale parasitological survey was carried out among primary school aged children in 2003 which documented about STH, *O. viverrini*, *Taenia* sp. and *S. mekongi*. Thus a national scale parasitological survey is identified for future research need. Furthermore, from this review we conclude that all provinces in Central and Southern Laos could benefit from CDI approach. In the Northern provinces the CDI could concentrate on STH infections only. For that purpose it is needed to adapt the approach slightly.

10.3.2 Helminth infection in relation to existing local awareness regarding worm infection and associated risk factors in liver fluke endemic areas

Social science can inform control helminth infection in Southeast Asia, it can recommend research methods to use, training needs, health education, practice guideline, and implementation of evidence-based interventions (Vandemark et al., 2010). Example given, in northern Vietnam local communities were aware of the risks of eating raw fish dish, however, they were less cautious about consumption of raw fish dishes because they thought that with the effective drug they can be easily treated after an infection (Phan et al., 2011). In Laos, one social science research survey was conducted in central province to understand the local perception and practices in regards to liver fluke, *O. viverrini*, infection in two villages. The results pointed that liver fluke infection rate was 62% in one village and 34% was in another village; during FGDs more male participants discussed to eat raw fish dish than did female participants. But most women prepared raw fish dish and tasted it during cooking process without knowing that they could be infected with liver fluke (Strandgaard et al., 2008).

To deepen our understanding on helminth infection in relation to existing local community's awareness on worm infection in liver fluke endemic areas southern Laos, we conducted a cross-sectional survey in 10 randomly selected villages in liver fluke endemic areas in Saravane province southern Laos in 2010 (Chapter 5). Two stool samples obtained from all individuals (aged ≥2 years) of selected households were examined using Kato Katz method. At the same time interview with heads of

households, FGDs, and direct observation were carried out. Our results show that helminth infection was highly prevalent particularly *O. viverrini* and hookworm infections (88.7% and 86.6%, respectively), followed by trichuriasis (32.9%), and ascariasis (9.8%). Taeniasis was detected in 11.5% of participants. Most individuals were infected with two helminth species (52.4%) and infection with 3 helminth species was a quarter. *O. viverrini* was the most frequently co-infected with hookworm (77.3%), of which, 74.7% were children in the age group 6-15 years. This high burden of helminth infections is remarkable and, hence, there is an urgent need for mass treatment against liver fluke and STH for all entire population in endemic liver fluke areas. Liver fluke endemic areas of Southern Laos have never received mass treatment adequate interventions should be implemented as soon as possible.

PZQ (40mg/kg BW) and a single-oral dose of ABZ (400mg) should be used. CDI approach would be the best approach to ensuring the most affected population obtain access to mass treatment which provides the basis that morbidity is reduced.

The reported *O. viverrini* infection rate and its infection intensity in our survey are higher than the previous survey conducted in 2004 by Sayasone *et al*. A possible reason for that this the current survey applied a rigorous method i.e., Kato Katz method with two stool samples obtained from individuals. In addition each sample two Kato smears were established. In previous surveys the diagnose of helminth infection was based on one stool sample only (Sayasone et al., 2007).

Despite the high burden of helminth infection, we found that most heads of households had low level of awareness pertaining to worm infections and associated risk factors. Few head of household linked eating raw or insufficiently cooked fish dishes with the *O. viverrini* infection. Most of those (91.3%) who were aware of roundworm infection associated it with habit of consumption any uncooked food. Habit of consumption of raw or insufficiently cooked fish dishes was common practice (75.4%). Few households possessed latrines (16.1%) and nevertheless those who had latrines not all of them reported to use it. FGD result revealed that participants dislike using latrine due to their bad smell and they were not used to it and they do not know how to do when the latrine filled up. FGD participants also discussed that they would love to eat raw fish dishes every day if fish was always available. Direct observation observed walking barefoot was common, big animals were straying freely in all study villages.

We noted that the notion regarding eating any raw food caused worm infection did not influence the habit of consumption raw or insufficiently cooked fish dishes because most heads of households reported to consume raw fish dishes; this similar finding was also found during the discussion in FGD (chapter 5). Raw fish dishes like *Koi Pa*, *Lap Pa Nuew* are the most preferable local dishes in this community (chapter 6). In addition household heads in our survey are paddy-rice farmers living in rural areas and had simple life; their daily food depends on what they catch from river/creek/paddy rice-field. This reality is similar to what Grundy-Warr and his team described that in fishermen and peasant communities fish is the main source of protein and inexpensive and prepare fish dish also based on local preference such as *koi pa*. Building up and strengthening knowledge on transmission route for liver fluke infection including its life cycle and morbidity particularly cholangiocarcinoma the most dangerous one induced by liver fluke infection is recommended as the most powerful tool to change behaviour of eating raw or insufficiently cooked fish dishes in endemic areas of liver fluke in northeast Thailand.

Our surveys (chapter 5, 7, 8 and 9) document that the environment in our study villages favours the transmission of helminth infection. Only few households possessed latrines and notwithstanding some FGD participants discussed they dislike using latrine due to bad smell and did not know how to do when the latrine filled up. In addition, those who possessed latrine would not use it during the rainy season because they temporally move to stay in the rice field-huts without latrines and defecate directly to the rice field which make the helminth infection spread to proper snail and cyprinoids fish in surrounding environment. Due to this fact, *O. viverrini* infection in liver fluke endemic areas remains high unless health education to increase the knowledge on liver fluke infection and its route of transmission and preventive measures and proper preparation of fish products would address this problem. Health education in the communities is the most suitable approach to building and strengthening community's knowledge on helminth infections.

Based on the problem stated above, concerted action from local authorities together with local health authorities in the control activities of helminth infection in community is required to address the liver fluke and STH infections in liver fluke endemic areas southern Laos. CDI approach is recommended to launch urgently. Men and the Laoloum ethnic group should be targeted for mass treatment and health education.

10.3.3 Consumption of raw fish dishes in relation to liver fluke infection in liver fluke endemic areas southern Laos

It is known that consumption of raw or insufficiently cooked fish dishes is common practice in Southeast Asia and in Laos. In northeast Thailand where infection with liver fluke is pervasive if compared to other regions of Thailand, the habit of eating raw fish dishes is widely practiced due to people preferred traditional raw fish dishes and their taste . In liver fluke endemic areas in Laos, 75.4% of study subjects (chapter 5) reported to consume raw fish dishes such as *"koipa"*, *"lap pa nuew"* which have higher risk for getting infection with liver fluke because *O. viverrini* metacercariae have been scientifically confirmed for *"koi pa"* and "*som pa"*. In addition the survey in chapter 5 points at the habit of eating other raw food in Laos is also common such as eating raw shrimp salad *"koi kung"* and crab (raw crab soak in fermented fish for papaya salad), raw sour sausages of pork *"som mou dip"*, raw beef salad *"lap xin dip"* and uncooked vegetables.

Our survey deepened our understanding on consumption of raw fish dishes in liver fluke endemic areas Saravane district southern Laos in 2010 and applied a qualitative research using eight FGDs, one was among men and another was among women separately in each four villages and direct observation. The findings clarify that most FGD participants discussed to consume raw fish dishes because they perceived that the traditional fish dish preparation (squeezing fish flesh with hundreds of weaver ants) is equivalent to 'well-cooked' and it then is safe for eating, the visual appearance, taste and smell of fish dishes encouraged them to eat, the personal preference and practice since generations were also the reasons for eating raw fish dishes. In addition, there are ten different dishes that use raw or fermented fish were identified in this community which represents that eating raw or insufficiently cooked fish dishes is deeply and culturally rooted in this community. Liver fluke infection never decline if habit of eating raw or insufficiently cooked fish dishes persists because viable *O. viverrini* metacercariae was scientifically confirmed for "*Koi pa"* and *"som pa"* in northeast Thailand where liver fluke infection is very high . Hence community-based interventions against liver fluke are currently based on preventive chemotherapy and information, education and communication (IEC) programmes; building awareness of the health risks of raw fish consumption and changing food consumption behaviour are prerequisites for sustainable control of liver fluke in rural endemic areas. Changing food consumption

behaviour in this context requires formalised health education, as well as (i) information sharing networks within local peer-groups – for instance, from mother to mother on how to safely prepare fish dishes and on the life cycle of *O. viverrini* infection, its mode of transmission and associated health risks – where the implementation of information is socially controlled; (ii) the engagement of prominent 'agents of change' in a village, such as the head of village, village health volunteers, and the head of the Lao Women's Union, who apply safe fish preparation and consumption practices and spread knowledge of *O. viverrini* infection, resulting in behavioural changes triggered by imitation and adoption; (iii) stronger political commitment to ending raw fish consumption, actively promoted by politicians, health professionals, and media figures at national, regional and local levels.

It is noted that the traditional way of raw fish dish preparation in two study sites of our community-based surveys in southern Laos is different. Our survey on consumption of raw or insufficiently cooked fish dishes that were conducted in liver fluke endemic area in Saravane province (chapter 6) discovers that people prepared raw fish meat with hundreds of weaver ants (the ant gives a sour juice) whereas our survey conducted in endemic area of *S. mekongi* in Khong district, Champasack province, found that community leaders prepared raw fish meat with lemon juice instead of weaver ant. However both communities in the two settings perceive the same way that when the raw fish meat turned to white colour after squeezing with either weaver ants or lemon juice, they consider that the fish dish is safe for consumption. They understand that sour juice kills the infectious stages of the worms.

There is a distinct gender difference in the habit regarding the consumption of raw and insufficiently cooked fish dishes. Findings of our quantitative and qualitative surveys are consistent. Our quantitative survey underlines that more male got infected with *O. viverrini* infection than female whereas FGDs participants where men discussed that they prefer to eat raw fish dish such as *koi pa*, *koi pa siew*, and *lap pa nuew*. Eating raw fish dish has become their habit and they would eat this food every day if fish would always be available. The previous knowledge highlighted the similar fact that male tend to have higher incidence rate of *O. viverrini* infection than female; and male loved to eat raw fish dish more than female and prepared the dish "*koi pa*" by themselves based on their preference when they have social gathering otherwise female was the main person who prepared raw fish dish "*koi pa*" in the household and tasting the dish during the

preparation. Hence, appropriate health education messages on flukes and STHs need to address the gender differences and thus tackle men's riskier consumption pattern.

It is important to note that Laoloum ethnic group in our survey (chapter 5) had higher risk for infection with *O. viverrini* than the Laotheung ethnic group did. Laoloum people show a rich cultural life with frequent religious ceremonies and social occasions (e.g., life stage and agricultural events), where raw fish dishes are a prominent marker of socialising commensality and underline the importance of ethnic and religious belonging. In contrast, Laotheung communities do not represent in general this multitude of elaborated ceremonial practices which include also the mandatory consumption of raw or insufficiently cooked fish. Furthermore, Laoloum people are in general wealthier and thus have more frequent the opportunity buy raw fish and prepare its meals, particularly at markets, in shops and food stalls and through street vendors, than Laotheung members who in general live in partly remote areas and hardly accessed to urban centres. In addition Laoloum people settled mainly along the big river or stream thus this is abundant of fish that leads to consume raw fish dish frequently whereas Laotheung live in hilly and rugged physical environment do not have this rich quantity and quality of fish in the creeks and consume consequently raw fish less frequently.

10.3.4 Evaluation of deworming intervention in endemic helminthiasis academic settings

In the context of Lao PDR, health centres (HC) and village health volunteer (VHV) are essential elements of the health services at community level. An average of two VHVs exists in each village. VHVs implement primary health care (PHC) activities assigned by its own catchments health center/directly by district health office in village such as distribution bed nets and its re-dippings, distribution of Vitamin A and deworming drug mebendazole to children under 5 years of age and women in reproductive age, delivery health message pertaining three hygienic rules (hygienic eating, living, and clothing), taking a record about pregnancy, birth and children under5 years of age for vaccination and reporting any health problem occurring in village to health center.

An administrative line at community level, there is a head of village group (=village zone) and a head of village. At village level, beside a head of village, there is a village health committee (VHC). A VHC is consisted of a head of village and seven representatives

come from seven units in the village such as health (it means VHV), education, Lao Women Union, Youth Union, senior committee, security unit, and economic unit. They mutually work in village. The head of village group works closely with village authorities.

10.3.4.1 Evaluation of deworming intervention in endemic areas of *S. mekongi* and multiparasitism

Schistosomiasis mekongi was recognized as a public health problem in Khong district, southern Champasack province since 1957 and current parasitological survey confirmed that *S. mekongi* re-emerged. People in this district had received mass treatment several rounds between 1989 and 1997.

Our study (chapter 7) was conducted in Donelong island of Khong district and its result show that community leaders and community members in *S. mekongi* and *O. viverrini* endemic area perceived that MDA was effective against severe schistosomiasis because they perceived that after MDA in village the cases with big belly and ended up with vomit a lot of blood are rarely seen and health status of people is improved. However they did not know that MDA was effective also against other worm infections such as liver fluke, opisthorchiasis, and STH. This fact shows that community leaders have not yet acquired proper knowledge about MDA program although this endemic area exposed to MDA program against schistosomiasis several rounds. In addition, community leaders preferred the MDA program because it is free of charge and directly in the village which means that villagers have immediate access to deworming without travelling to a specific place for deworming and without spending their own pocket for treatment. Thus they encourage community members to get treatment. Other studies report similar observations: people attend the mass treatment due to it is free of charge and very convenient to be obtained. Moreover those people who attended to MDA in village and regardless any side effects induced by praziquantel due to their perceived life-threatening caused by *S. mekongi* (big belly and ended up with vomit a lot of blood), the efficacy of PZQ against severe schistosomiasis and the experience with big belly.

Our survey found that community leaders in this *S. mekongi* and *O. viverrini* endemic areahave poor knowledge regarding worm infection. They are aware of only observable severity and its life-threatening nature of a long-lasting infection with schistosomiasis but little is known about the cause of infection, which means that prevention for this infection

in this area is still far away from what it should be. Community is this area will continue to highly expose to *S. mekongi* infection because they do not how to prevent it and in addition our survey assessed that people's life in this area is very much depending on the water from the MekongRiver such as bathing, and using for household purposes and livelihood. Moreover, we found that although most community leaders correctly associate opisthorchiasis and STH with their risk factors for infection, they did not know the connection between infections and diseases. In addition all community leaders as well as community members reported to eat raw fish dishes. Only few possessed latrines in households (14.5%). Therefore, risk factors for transmission are highly prevalent.

The problem mentioned above can be addressed if community leaders acquire proper knowledge and afterwards delivery concerned messages in community. Thus CDI against multiparasitism is suitable and ensures that most affected people have access to adequate knowledge and mass treatment. It also recommended that after completion of parasitological survey conducted in this area the results must be immediately disseminated in the community in order to let them be aware of their health problem. Stool examinations and deworming medicine should be available in local health facilities. This is indeed a challenge for the local health services but it must be addressed in the future.

10.3.4.2 Evaluation of the community-directed intervention against liver fluke and STH in liver fluke endemic areas Saravane province southern Laos

We found (Chapter 8) that after implementation of pilot CDI there was a significant reduction of the prevalence rate of multiple helminth infections particularly after the second round of mass treatment. The highest reduction of prevalence rate was observed for *A. lumbricoides* followed by hookworm, *T. trichiura*, and *O. viverrini* infections (by 45.9%, 38.1%, 30.3% and 26.4%, respectively). The highest reduction of *O. viverrini* infection was identified among subjects age group less than 6 years and 6-15 years whereas the highest reduction of hookworm infection was observed among adult aged 40 years up. Our assessment also indicates that CDI intervention provided a significant impact on the community's knowledge, attitudes and practices in relation to helminth infection and its control. Most heads of households heard about liver fluke infection and linked it with the habit of eating raw and insufficiently cooked fish dishes and its health

consequences; more heads of households perceived mass treatment against liver fluke and hookworm; and most of them reported to stop eating raw fish dishes if compared with the baseline data, this result is consistent with the result of FGDs; the FGD participants discussed that after treatment with PZQ they felt not eating raw fish dish anymore. In addition, the CDI gives indirect impact on the latrine construction in community because community members see the need of latrine construction and require support from its local health authorities and saying that they are ready to contribute some basic materials and labour for the construction of latrines. It is true that in previous study reported that community-based intervention is better than school-based interventions in terms of increasing awareness on worm infection.

Our assessment of helminth infection is carried out almost one year after each round of mass treatment. As re-infection with *O. viverrini* occurs, the prevalence rate dropped only with small rates. Our survey did not assess the incidence rate of infection with liver fluke because this pilot intervention did not provide treatment of positive cases like the one conducted in Thailand.Though our intervention made small reduction of *O. viverrini* infection if compare with the previous three-year intervention against liver fluke *O. viverrini* infection conducted in Thailand. But it had a significant impact on the intensity of infection with *O. viverrini* and STH. Indeed, it would be most helpful to study detailed re-infection patterns in the liver fluke endemic areas in order to be clear how intense treatment provision must be in order to limit the infection to low intensities.

Our CDI is effective against liver fluke and STH in liver fluke endemic areas southern Laos. In addition we could show that it is feasible to contribute for the helminth control at community level. Although the trained community leaders in our intervention had relatively little support they showed initiatives for the control of helminth infection in community level. We believe that they acquired ownership of the program for their village and they adapted the mode and time for health education and drug distribution in order to fit with their situation and needs. In addition other non-trained village authorities also presence on the day of treatment to assist in general works.

With regards to compliance to mass treatment during the CDI intervention in villages, our survey in chapter 9 underlines that socio-demography features like poor and poorer quintiles, perceived effectiveness of mass treatment against liver fluke, knowledge on tapeworm, and current get sick of stomach ache encouraged community to take

treatment. However based on in-depth interviews with community leaders, we found that the side effect induced by PZQ was a factor negatively influencing the compliance to mass treatment which is similar to other previous studies.

However, it is a high concern in regards to the treatment coverage when we will scale up this CDI to other liver fluke endemic areas particular in remote areas where education attainment of Lao population including village health volunteer is very low. As we observed in our survey (chapter 8) that based on the treatment records completed by CDDs, the treatment coverage has dramatically decreased in the second round of mass treatment from 65.3% in 2010 to 29.6% in 2011 and it then has a bit increased in the third round to 37.5% in 2012. This dramatic reduction is due to community members are fearsome of potential adverse events induced by PZQ. This fact has to be taken in account for solving problem accordingly. According to our experience in Laos, many village health volunteers in the remote areas had not completed even primary school. Thus we would recommend that in the initial phase of the CDI, it means the first two years of intervention, trained community leaders should receive a supervision from trained health center staff of their own catchments areas to ensuring the treatment coverage on one hand, and on the another hand to ensuring the performance of village health volunteer because by doing so, trained community leaders would have a chance to learn from doing the so called learning by doing and therefore more confidence in performance to this CDI.

It is true that there is a strength point observed in our survey that community leaders at community level they are quite active in conducting the intervention and with the presence of non-trained village authorities on the day of treatment for assisting the general works, it is because of the existing of village health committee in each village as we have mentioned above section(10.3.4) and they mutually work in the village for any issue and event.

10.4 Study implications for liver fluke and STH control in Laos

Study findings presented in this PhD thesis suggest that helminth infection is highly prevalent in Laos. Liver fluke, *O. viverrini*, is predominant in central and southern Laos. Hookworm is predominant species among the STH, followed by trichuriasis but ascariasis is highly reported in hilly environment and northern provinces of Laos. The control activities are limited and mainly mass treatment and health education implemented via vertical program (chapter 4). However findings (chapter 5) imply that beside the high prevalence of helminth infection in liver fluke endemic areas, community have poor knowledge on worm infection. They misconceived the causes of liver fluke and STH infections; eating raw food was suspected for the cause of worm infection in general. Community had a high risk of spreading of helminth infection in community such as eating raw and insufficiently cooked fish is commonly practiced; poor personal hygiene and sanitation, some people expressed that they dislike using latrine.

Nevertheless results (chapter 6) highlight that habits of eating raw or insufficiently cooked fish dish in liver fluke endemic areas in southern Laos are deeply and culturally rooted. Community like to eat raw or insufficiently cooked fish dishes because of they love the visual appearance, taste, and smell of the dish, and perceived that the fish dish is safe to eat after squeezing the fish flesh with hundreds of weaver ants (giving sour juice) and then it turned to white colour; in addition they perceived that it is the traditional recipe for Lao cuisine and practice since ancestors.

Findings (chapter 7) suggest that community leaders and the villagers in endemic areas of *S. mekongi* and *O. viverrini* appreciated the effectiveness of mass treatment campaign in villages due to rare cases of big belly in community and people stay healthier; however they do not aware that mass treatment campaign is also effective against like liver fluke and STH. Community leaders have poor knowledge about the cause of worm infections except the awareness on the severe sings of schistosomiasis cases due to visual appearance in community like big belly and cases ended up with vomiting a lot of blood.

Findings (chapter 8) imply that CDI against liver fluke and STHs that implemented in liver fluke endemic areas Saravane province southern Laos is effective against different helminth infections. The infection with *O. viverrini*, hookworm, *T. trichiura*, and *A. lumbricoides* and *Taenia* sp. had significantly declined. The infection intensity of *O. viverrini* had considerably declined among children aged 6-15 years if compared to adult above 16 years. In addition community's knowledge regarding worm infection has improved significantly. Misconception on acquiring roundworm infection through eating any raw food was abandoned. Reported of eating raw or insufficiently cooked fish dish is rare which is correspondent with FGD participants discussed that after taking treatment they felt not eating raw fish anymore and some were afraid of getting liver fluke again. Community understood that the intervention was for treatment of worms live liver fluke and other worms and viewed that intervention could prevent diseases. Vertical implemented health education and mass-drug administration by health personnel might have resulted in better outcomes, particularly in lower infection rates. However, our results must be seen in the wider context of relatively low economic possibilities of the health services in Laos. Therefore, we must put our findings into an economic perspective. A cost-effectiveness analysis from our CDI will show the absolute strength of CDI and its potential to become a sustainable intervention in all *O. viverrini* endemic provinces in Laos.

Our study in this PhD thesis (chapter 8, 9) suggests that trained community leaders have a potential to contribute to the control of helminth infection in village level. They develop ownership toward the CDI approach and encourage other village authorities to help on the day of treatment.

Chapter 11: Conclusion and recommendations

11.1 Conclusion

We conclude that helminth infections remain a public health problem in Laos particularly liver fluke infection *O. viverrini*, followed by hookworm and trichuriasis while ascariasis threats human health in mountainous areas. In the liver fluke endemic area people harboured with more than two helminth species; children aged 6-15 years old had already infected with high prevalence of both helminth species, *O. viverrini* and hookworm. In addition, we summarize that the high prevalence of helminth infection is resulted from the following determinants: limited helminth control activities against *O. viverrini*, low efficacy of deworming drug against STHs, poor knowledge of community leaders pertaining the effectiveness of mass treatment against different worms; poor community's knowledge, attitudes, perceptions and practices in relation to worm infection and associated risk factors, common practice on consumption of raw or insufficiently cooked fish dishes; high transmission of helminth infection in environment due to lacking of latrine and nevertheless some people disliked to use it due to not familiar, bad smell and do not how to do when the latrine filled up. We also conclude that CDI is accepted by communities as an effective approach for the control of liver fluke *O. viverrini* and STHs. It improved the awareness of community regarding worm infection, and corrected to some extend the habit of eating raw or insufficiently cooked fish dishes; more people perceived benefit of mass treatment and its effectiveness against different worms. In addition community leader was able to manage the distribution of deworming drug in villages though few received supervision from health center staff of their catchments areas. There are some factors that encouraging community to take deworming during mass treatment in villages: 1.) perceived mass treatment against liver fluke, 2.) aware of tapeworm infection, 3.) experience of stomach ache, and 4.) live in households with poor and poorer quintiles.

11.2 Identified future research needs

1. Parasitological survey:

- National scale survey on liver fluke, *O. viverrini*, and STHs should be repeated

2. Public health research in connection with helminth infection

- Household-based study concerning helminth on economic and social relation and information and knowledge and health practices. What happen when somebody has severe morbidity, i.e., cholangiocarcinoma (CCA).
- Feasibility study with regards to the food control in public spaces: food markets and food restaurants
- Comparative study with regards to the community's knowledge, attitudes, perceptions, and practices on helminth infection and its risk factors and control measures in areas exposed to CDI and none expose to CDI.
- Assessment of cost-effectiveness for the CDI against liver fluke in endemic areas southern Laos
- Feasibility study on linkage the helminth control with health fund or health insurance
- Health system research on helminth treatment particular diagnostic capable skill and prevention in endemic areas

3. Research on morbidity induced by *O. viverrini*

- Study on hepatobilliar morbidity in endemic areas of *O. viverrini* in central and southern of Laos: screening for severe morbidity, in particulalr CCA
- Comparative study on hepatobilliar morbidity in endemic areas and none endemic areas of *O. viverrini*in central and southern of Laos: screening for severe morbidity (i.e., CCA).

11.3 Recommendations

- Scaling up community-directed intervention against liver fluke and STH for the whole Saravane province and then afterwards scaling up for the national level in order to be aware that the most affected people have to treatment

- Establish community-directed health education on helminth promotion such as food and nutrition and hygiene and sanitation should be held in high-endemic areas of liver fluke, *O. viverrini,* and soil-transmitted helminth. A combination of informal and formalized health education should be applied
- Include helminth promotion such as food and nutrition and hygiene and sanitation into model healthy village as a part of criteria.
- Community-directed health education in the field of helminth promotion (food and nutrition, and hygiene and sanitation)
- Stronger political commitment to ending the consumption of raw or insufficiently cooked fish dishes
- Establish food inspection services particularly for the fish and its products for the control of infection with *O. viverrini*
- Link helminth control with the health equity fund or any schemes of health insurance

Chapter 12: References

Abdussalam, M. and Kaferstein, F.K., 1994. Food safety in primary health care. World Health Forum 15, 393-399.

Acka, C.A., Raso, G., N'Goran, E.K., Tschannen, A.B., Bogoch, I.I., Seraphin, E., Tanner, M., Obrist, B., Utzinger, J., 2010. Parasitic worms: knowledge, attitudes, and practices in Western Cote d'Ivoire with implications for integrated control. PLoS Negl Trop Dis 4, e910.

Aday and Andersen, 1974. A Framework for the Study of Access to Medical Care. Health Services Report 208-220.

Adeneye, A.K., Mafe, M.A., Appelt, B., Idowu, E.T., Akande, D.O., 2006. Willingness to pay for praziquantel treatment in a hyperendemic community of Ogun State, Nigeria. Res Social Adm Pharm 2, 83-95.

Akogun, O.B., Audu, Z., Weiss, M.G., Adelakun, A.O., Akoh, G.I., Akogun, M.K., Remme, H., Kale, O.O., 2001. Community-directed treatment of onchocerciasis with ivermectin in Takum, Nigeria. Trop Med Int Health 6, 232-243.

Amarillo, M.L., Belizario, V.Y., Jr., Sadiang-Abay, J.T., Sison, S.A., Dayag, A.M., 2008. Factors associated with the acceptance of mass drug administration for the elimination of lymphatic filariasis in Agusan del Sur, Philippines. Parasit Vectors 1, 14.

Amazigo, U., Okeibunor, J., Matovu, V., Zoure, H., Bump, J., Seketeli, A., 2007. Performance of predictors: evaluating sustainability in community-directed treatment projects of the African programme for onchocerciasis control. Soc Sci Med 64, 2070-2082.

Andersen, 1995. Revisiting the Behavioral Model and Access to Medical care: Does it Matter? Health and Social Behavior 36, 1-10.

Barennes, H., Sayasone, S., Odermatt, P., De, B.A., Hongsakhone, S., Newton, P.N., Vongphrachanh, P., Martinez-Aussel, B., Strobel, M., Dupouy-Camet, J., 2008. A major trichinellosis outbreak suggesting a high endemicity of Trichinella infection in northern Laos. Am J Trop Med Hyg 78, 40-44.

Bethony, J., Brooker, S., Albonico, M., Geiger, S.M., Loukas, A., Diemert, D., Hotez, P.J., 2006. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet 367, 1521-1532.

Bieri, F.A., Gray, D.J., Williams, G.M., Raso, G., Li, Y.S., Yuan, L., He, Y., Li, R.S., Guo, F.Y., Li, S.M., McManus, D.P., 2013. Health-education package to prevent worm infections in Chinese schoolchildren. N Engl J Med 368, 1603-1612.

Booysen F, van der Berg S, Burger R, Maltitz MV, Rand GD, 2008. Using an Asset Index to Assess Trends in Poverty in Seven Sub-Saharan African Countries. World Development 36, 1113-1130.

Bouvard, V., Baan, R., Straif, K., Grosse, Y., Secretan, B., El, G.F., brahim-Tallaa, L., Guha, N., Freeman, C., Galichet, L., Cogliano, V., 2009. A review of human carcinogens-Part B: biological agents. Lancet Oncol 10, 321-322.

Brieger, W.R., Okeibunor, J.C., Abiose, A.O., Wanji, S., Elhassan, E., Ndyomugyenyi, R., Amazigo, U.V., 2011. Compliance with eight years of annual ivermectin treatment of onchocerciasis in Cameroon and Nigeria. Parasit Vectors 4, 152.

Brieger, W.R., Otusanya, S.A., Oke, G.A., Oshiname, F.O., Adeniyi, J.D., 2002. Factors associated with coverage in community-directed treatment with ivermectin for onchocerciasis control in Oyo State, Nigeria. Trop. Med. Int. Health 7, 11-18.

Brooker, S., Marriot, H., Hall, A., Adjei, S., Allan, E., Maier, C., Bundy, D.A., Drake, L.J., Coombes, M.D., Azene, G., Lansdown, R.G., Wen, S.T., Dzodozmenyo, M., Cobbinah, J., Obro, N., Kihamia, C.M., Issae, W., Mwanri, L., Mweta, M.R., Mwaikemwa, A., Salimu, M., Ntimbwa, P., Kiwelu, V.M., Turuka, A., Nkungu, D.R., Magingo, J., 2001. Community perception of school-based delivery of anthelmintics in Ghana and Tanzania. Trop Med Int Health 6, 1075-1083.

Brusentsov, I.I., Katokhin, A.V., Brusentsova, I.V., Shekhovtsov, S.V., Borovikov, S.N., Goncharenko, G.G., Lider, L.A., Romashov, B.V., Rusinek, O.T., Shibitov, S.K., Suleymanov, M.M., Yevtushenko, A.V., Mordvinov, V.A., 2013. Low Genetic Diversity in Wide-Spread Eurasian Liver Fluke *Opisthorchis felineus* Suggests Special Demographic History of This Trematode Species. PLoS One 8, e62453.

Bunnag, D. and Harinasuta, T., 1981. Studies on the chemotherapy of human opisthorchiasis: III. Minimum effective dose of praziquantel. Southeast Asian J Trop Med Public Health 12, 413-417.

Bunnag, D., Harinasuta, T., Viravan, C., Garcia, D.P., 1981. Paragonimiasis: endemic foci along the Riparian areas of Mekong River. Southeast Asian J Trop Med Public Health 12, 127-128.

Bunnag, D., Pungpark, S., Harinasuta, T., Viravan, C., Vanijanonta, S., Suntharasamai, P., Migasena, S., Charoenlarp, P., Riganti, M., LooAreesuwan, S., 1984. Opisthorchis viverrini: clinical experience with praziquantel in Hospital for Tropical Diseases. Arzneimittelforschung. 34, 1173-1174.

Cantey, P.T., Rout, J., Rao, G., Williamson, J., Fox, L.M., 2010. Increasing compliance with mass drug administration programs for lymphatic filariasis in India through education and lymphedema management programs. PLoS Negl Trop Dis 4, e728.

CDI study group, 2010. Community-directed interventions for priority health problems in Africa: results of a multicountry study. Bull World Health Organ 88, 509-518.

Chai, J.Y., Han, E.T., Guk, S.M., Shin, E.H., Sohn, W.M., Yong, T.S., Eom, K.S., Lee, K.H., Jeong, H.G., Ryang, Y.S., Hoang, E.H., Phommasack, B., Insisiengmay, B., Lee, S.H., Rim, H.J., 2007. High prevalence of liver and intestinal fluke infections among residents of Savannakhet Province in Laos. Korean Parasitol 45, 213-218.

Chai, J.Y. and Hongvanthong, B., 1998. A small-scale survey of intestinal helminthic infections among the residents near Pakse, Laos. Korean J Parasitol 36, 55-58.

Chai, J.Y., Park, J.H., Han, E.T., Guk, S.M., Shin, E.H., Lin, A., Kim, J.L., Sohn, W.M., Yong, T.S., Eom, K.S., Min, D.Y., Hwang, E.H., Phommmasack, B., Insisiengmay, B., Rim, H.J., 2005. Mixed infections with *Opisthorchis viverrini* and intestinal flukes in residents of Vientiane Municipality and Saravane Province in Laos. J Helminthol 79, 283-289.

Chai, J.Y., Yong, T.S., Eom, K.S., Min, D.Y., Jeon, H.K., Kim, T.Y., Jung, B.K., Sisabath, L., Insisiengmay, B., Phommasack, B., Rim, H.J., 2013. Hyperendemicity of Haplorchis taichui Infection among Riparian People in Saravane and Champasak Province, Lao PDR. Korean J Parasitol 51, 305-311.

Clyti, E., Kheosang, P., Huerre, M., Sayasone, S., Martinez-Aussel, B., Strobel, M., 2006. Cutaneous paragonimiasis with flare up after treatment: a clinical case from Laos. Int J Dermatol 45, 1110-1112.

Conlan, J., Khounsy, S., Inthavong, P., Fenwick, S., Blacksell, S., Thompson, R.C., 2008. A review of taeniasis and cysticercosis in the Lao People's Democratic Republic. Parasitol Int

Courson, M., 1972. Health survey along the Mekong River. Health Serv Rep 87, 205-211.

Dabo, A., Bary, B., Kouriba, B., Sankare, O., Doumbo, O., 2013. Factors associated with coverage of praziquantel for schistosomiasis control in the community-direct intervention (CDI) approach in Mali (West Africa). Infect Dis Poverty 2, 11.

Dawson, S., Manderson, L., Tallo, V.L., 1993. A Manual for the Use of Focus Groups.International Nutrition Foundation for Developing Countries (INFDC), Boston.

Erlanger, T.E., Sayasone, S., Krieger, G.R., Kaul, S., Sananikhom, P., Tanner, M., Odermatt, P., Utzinger, J., 2008. Baseline health situation of communities affected by the Nam Theun 2 hydroelectric project in central Lao PDR and indicators for monitoring. Int J Environ Health Res 18, 223-242.

Fiedler, 1981. A Review of the Literature on Access and Utilization of Medical Care with Special Emphasis on Rural Primery Care. Soc. Sci. & Med 15C, 129-142.

Forrer, A., Sayasone, S., Vounatsou, P., Vonghachack, Y., Bouakhasith, D., Vogt, S., Glaser, R., Utzinger, J., Akkhavong, K., Odermatt, P., 2012. Spatial distribution of, and risk factors for *Opisthorchis viverrini* infection in southern Lao PDR. PLoS Negl Trop Dis 6, e1481.

Freudenthal, S., Ahlberg, B.M., Mtweve, S., Nyindo, P., Poggensee, G., Krantz, I., 2006. School-based prevention of schistosomiasis: initiating a participatory action research project in northern Tanzania. Acta Trop 100, 79-87.

Fürst, T., Keiser, J., Utzinger, J., 2012a. Global burden of human food-borne trematodiasis: a systematic review and meta-analysis. Lancet Infect Dis 12, 210-221.

Fürst, T., Sayasone, S., Odermatt, P., Keiser, J., Utzinger, J., 2012b. Manifestation, diagnosis, and management of foodborne trematodiasis. Brit Med J 344, e4093.

Gazzinelli, M.F., Lobato, L., Matoso, L., Avila, R., de Cassia, M.R., Shah, B.A., Correa-Oliveira, R., Bethony, J.M., Diemert, D.J., 2010. Health education through analogies: preparation of a community for clinical trials of a vaccine against hookworm in an endemic area of Brazil. PLoS Negl Trop Dis 4, e749.

Giboda, M., Ditrich, O., Scholz, T., Viengsay, T., Bouaphanh, S., 1991a. Current status of food-borne parasitic zoonoses in Laos. Southeast Asian J Trop Med Public Health 22 Suppl, 56-61.

Giboda, M., Ditrich, O., Scholz, T., Viengsay, T., Bouaphanh, S., 1991b. Human *Opisthorchis* and *Haplorchis* infections in Laos. Trans R Soc Trop Med Hyg 85, 538-540.

Glinz, D., Silue, K.D., Knopp, S., Lohourignon, L.K., Yao, K.P., Steinmann, P., Rinaldi, L., Cringoli, G., N'Goran, E.K., Utzinger, J., 2010. Comparing diagnostic accuracy of Kato-Katz, Koga agar plate, ether-concentration, and FLOTAC for *Schistosoma mansoni* and soil-transmitted helminths. PLoS Negl Trop Dis 4, e754.

Grundy-Warr, C., Andrews, R.H., Sithithaworn, P., Petney, T.N., Sripa, B., Laithavewat, L., Ziegler, A.D., 2012. Raw attitudes, wetland cultures, life-cycles: socio-cultural dynamics relating to *Opisthorchis viverrini* in the Mekong Basin. Parasitol Int 61, 65-70.

Gunawardena, S., Ismail, M., Bradley, M., Karunaweera, N., 2007. Factors influencing drug compliance in the mass drug administration programme against filariasis in the Western province of Sri Lanka. Trans R Soc Trop Med Hyg 101, 445-453.

Habtamu, K., Degarege, A., Ye-Ebiyo, Y., Erko, B., 2011. Comparison of the Kato-Katz and FLOTAC techniques for the diagnosis of soil-transmitted helminth infections. Parasitol Int

Harinasuta, C., 1984. Epidemiology and control of schistosomiasis in Southeast Asia. Southeast Asian J Trop Med Public Health 15, 431-438.

Haswell-Elkins, M. and Levri E, 2003. Foodborne Trematodes.

Hinz, E., Saowakontha, S., Pipitgool, V., 1994. Opisthorchiasis control in northeast Thailand: proposal for a new approach. Appl Parasitol 35, 118-124.

Hohmann, H., Panzer, S., Phimpachan, C., Southivong, C., Schelp, F.P., 2001. Relationship of intestinal parasites to the environment and to behavioral factors in children in the Bolikhamxay Province of Lao PDR. Southeast Asian J Trop Med Public Health 32, 4-13.

Hotez, P.J., Bundy, D.A.P., Beegle, K., Brooker, S., Drake, L., de, S.N., Montresor, A., Engels, D., Jukes, M., Chitsulo, L., Chow, J., Laxminarayan, R., Michaud, C., Bethony, J., Correa-Oliveira, R., Shuhua, X., Fenwick, A., Savioli, L., 2006. Helminth Infections: Soil-transmitted Helminth Infections and Schistosomiasis. In Jami-son, D.T., Breman, J.G., Measham, A.R., Alleyne, G., Claeson, M., Evans, D.B., Jha, P.,Mills, A., Musgrove, P. (Eds.). Disease Control Priorities in Developing Countries pp. 467-482, Chapter 24.

Huang, Y., Chen, W., Wang, X., Liu, H., Chen, Y., Guo, L., Luo, F., Sun, J., Mao, Q., Liang, P., Xie, Z., Zhou, C., Tian, Y., Lv, X., Huang, L., Zhou, J., Hu, Y., Li, R., Zhang, F., Lei, H., Li, W., Hu, X., Liang, C., Xu, J., Li, X., Yu, X., 2013. The carcinogenic liver fluke, *Clonorchis sinensis*: new assembly, reannotation and analysis of the genome and characterization of tissue transcriptomes. PLoS One 8, e54732.

Jex, A.R., Lim, Y.A., Bethony, J.M., Hotez, P.J., Young, N.D., Gasser, R.B., 2011. Soil-transmitted helminths of humans in Southeast Asia--towards integrated control. Adv. Parasitol. 74, 231-265.

Jia, T.W., Melville, S., Utzinger, J., King, C.H., Zhou, X.N., 2012. Soil-transmitted helminth reinfection after drug treatment: a systematic review and meta-analysis. PLoS Negl. Trop Dis. 6, e1621.

Jinawath, A., Akiyama, Y., Sripa, B., Yuasa, Y., 2007. Dual blockade of the Hedgehog and ERK1/2 pathways coordinately decreases proliferation and survival of cholangiocarcinoma cells. J Cancer Res Clin Oncol 133, 271-278.

Jiraananankul, V., Aphijirawat, W., Mungthin, M., Khositnithikul, R., Rangsin, R., Traub, R.J., Piyaraj, P., Naaglor, T., Taamasri, P., Leelayoova, S., 2011. Incidence and risk factors of hookworm infection in a rural community of central Thailand. Am J Trop Med Hyg 84, 594-598.

Jongsuksuntigul, P. and Imsomboon, T., 1998. Epidemiology of opisthorchiasis and national control program in Thailand. Southeast Asian J Trop Med Public Health 29, 327-332.

Jongsuksuntigul, P. and Imsomboon, T., 2003. Opisthorchiasis control in Thailand. Acta Trop 88, 229-232.

Katabarwa, M., Eyamba, A., Habomugisha, P., Lakwo, T., Ekobo, S., Kamgno, J., Kuete, T., Ndyomugyenyi, R., Onapa, A., Salifou, M., Ntep, M., Richards, F.O., 2008. After a decade of annual dose mass ivermectin treatment in Cameroon and Uganda, onchocerciasis transmission continues. Trop Med Int Health 13, 1196-1203.

Katabarwa, M.N., Habomugisha, P., Richards, F.O., Jr., 2002. Implementing community-directed treatment with ivermectin for the control of onchocerciasis in Uganda (1997-2000): an evaluation. Ann Trop Med Parasitol 96, 61-73.

Katsivo, M.N., Muthami, L.N., Karama, M., Kingori, F., 1993. Perception of a schistosomiasis control project in rural Kenya by the beneficiaries. East Afr Med J 70, 613-616.

Katz, N., Chaves, A., Pellegrino, J., 1972. A simple device for quantitative stool thick-smear technique in *Schistosomiasis mansoni*. Rev Inst Med Trop Sao Paulo 14, 397-400.

Keiser, J. and Utzinger, J., 2007a. Food-borne trematodiasis: current chemotherapy and advances with artemisinins and synthetic trioxolanes. Trends Parasitol 23, 555-562.

Keiser, J. and Utzinger, J., 2004. Chemotherapy for major food-borne trematodes: a review. Expert Opin Pharmacother 5, 1711-1726.

Keiser, J. and Utzinger, J., 2007b. Artemisinins and synthetic trioxolanes in the treatment of helminth infections. Curr Opin Infect Dis 20, 605-612.

Keiser, J. and Utzinger, J., 2008. Efficacy of current drugs against soil-transmitted helminth infections: systematic review and meta-analysis. JAMA 299, 1937-1948.

Keiser, J. and Utzinger, J., 2009. Food-borne trematodiases. Clin Microbiol Rev 22, 466-483.

Kitikoon, V., Schneider, C.R., Bhaibulaya, M., Sittilerd, S., Thirachantra, S., 1975. Mekong schistosomiasis. 4. A parasitological survey of wild rodents, domestic pigs and cattle on Khong Island, Laos. Southeast Asian J Trop Med Public Health 6, 223-229.

Knopp, S., Mgeni, A.F., Khamis, I.S., Steinmann, P., Stothard, J.R., Rollinson, D., Marti, H., Utzinger, J., 2008. Diagnosis of soil-transmitted helminths in the era of preventive chemotherapy: effect of multiple stool sampling and use of different diagnostic techniques. PLoS Negl Trop Dis 2, e331.

Knopp, S., Speich, B., Hattendorf, J., Rinaldi, L., Mohammed, K.A., Khamis, I.S., Mohammed, A.S., Albonico, M., Rollinson, D., Marti, H., Cringoli, G., Utzinger, J., 2011. Diagnostic accuracy of Kato-Katz and FLOTAC for assessing anthelmintic drug efficacy. PLoS Negl Trop Dis 5, e1036.

Kobayashi, J., Vannachone, B., Sato, Y., Manivong, K., Nambanya, S., Inthakone, S., 2000. An epidemiological study on *Opisthorchis viverrini* infection in Lao villages. Southeast Asian J Trop Med Public Health 31, 128-132.

Kobayashi, J., Vannachone, B., Xeutvongsa, A., Manivang, K., Ogawa, S., Sato, Y., Pholsena, K., 1996. Prevalence of intestinal parasitic infection among children in two villages in Lao PDR. Southeast Asian J Trop Med Public Health 27, 562-565.

Krentel, A., Fischer, P., Manoempil, P., Supali, T., Servais, G., Ruckert, P., 2006. Using knowledge, attitudes and practice (KAP) surveys on lymphatic filariasis to prepare a health promotion campaign for mass drug administration in Alor District, Indonesia. Trop Med Int Health 11, 1731-1740.

Kyung, S.Y., Cho, Y.K., Kim, Y.J., Park, J.W., Jeong, S.H., Lee, J.I., Sung, Y.M., Lee, S.P., 2011. A paragonimiasis patient with allergic reaction to praziquantel and resistance to triclabendazole: successful treatment after desensitization to praziquantel. Korean J Parasitol. 49, 73-77.

Lakwo, T.L. and Gasarasi, D.B., 2006. Non-adherence to community directed treatment with ivermectin for onchocerciasis control in Rungwe district, southwest Tanzania. East Afr Med J 83, 326-332.

Lao MOH, 2004. Diagnosis and Treatment in district hospitals. Institut de la Francophonie pour la médicine tropicale, Ministry of Health, Lao PDR. 2,

Lee, J.M., Lim, H.S., Hong, S.T., 2011. Hypersensitive reaction to praziquantel in a clonorchiasis patient. Korean J Parasitol. 49, 273-275.

Levecke, B., Behnke, J.M., Ajjampur, S.S., Albonico, M., Ame, S.M., Charlier, J., Geiger, S.M., Hoa, N.T., Kamwa Ngassam, R.I., Kotze, A.C., McCarthy, J.S., Montresor, A., Periago, M.V., Roy, S., Tchuem Tchuente, L.A., Thach, D.T., Vercruysse, J., 2011. A comparison of the sensitivity and fecal egg counts of the McMaster egg counting and Kato-Katz thick smear methods for soil-transmitted helminths. PLoS Negl Trop Dis 5, e1201.

Lovis, L., Mak, T.K., Phongluxa, K., Aye, S.P., Vonghachack, Y., Keiser, J., Vounatsou, P., Tanner, M., Hatz, C., Utzinger, J., Odermatt, P., Akkhavong, K., 2012. Efficacy of praziquantel against Schistosoma mekongi and *Opisthorchis viverrini*: a randomized, single-blinded dose-comparison trial. PLoS Negl Trop Dis 6, e1726.

Lovis, L., Mak, T.K., Phongluxa, K., Soukhathammavong, P., Sayasone, S., Akkhavong, K., Odermatt, P., Keiser, J., Felger, I., 2009. PCR Diagnosis of *Opisthorchis viverrini* and *Haplorchis taichui* Infections in a Lao Community in an area of endemicity and comparison of diagnostic methods for parasitological field surveys. J Clin Microbiol 47, 1517-1523.

Mairiang, E., Laha, T., Bethony, J.M., Thinkhamrop, B., Kaewkes, S., Sithithaworn, P., Tesana, S., Loukas, A., Brindley, P.J., Sripa, B., 2012. Ultrasonography assessment of hepatobiliary abnormalities in 3359 subjects with *Opisthorchis viverrini* infection in endemic areas of Thailand. Parasitol Int 61, 208-211.

Mairiang, E. and Mairiang, P., 2003. Clinical manifestation of opisthorchiasis and treatment. Acta Trop 88, 221-227.

Maleewong, W., Intapan, P., Wongwajana, S., Sitthithaworn, P., Pipitgool, V., Wongkham, C., Daenseegaew, W., 1992. Prevalence and intensity of *Opisthorchis viverrini* in rural community near the Mekong River on the Thai-Laos border in northeast Thailand. J Med Assoc Thai 75, 231-235.

Mathieu, E., Lammie, P.J., Radday, J., Beach, M.J., Streit, T., Wendt, J., Addiss, D.G., 2004. Factors associated with participation in a campaign of mass treatment against lymphatic filariasis, in Leogane, Haiti. Ann Trop Med Parasitol 98, 703-714.

Mayer, G.J., 1979. Pulmonary paragonimiasis. J Pediatr 95, 75-76.

Meehan, A.M., Virk, A., Swanson, K., Poeschla, E.M., 2002. Severe pleuropulmonary paragonimiasis 8 years after emigration from a region of endemicity. Clin Infect Dis 35, 87-90.

Montresor, A., Cong, D.T., Sinuon, M., Tsuyuoka, R., Chanthavisouk, C., Strandgaard, H., Velayudhan, R., Capuano, C.M., Le, A.T., Tee Dato, A.S., 2008. Large-scale preventive chemotherapy for the control of helminth infection in Western Pacific countries: six years later. PLoS Negl Trop Dis 2, e278.

Mukerjee, C.M., Simpson, S.E., Bell, R.J., Walker, J.C., 1992. Pleuropulmonary paragonimiasis in a Laotian immigrant to Australia. Chest 101, 849-851.

Muth, S., Sayasone, S., Odermatt-Biays, S., Phompida, S., Duong, S., Odermatt, P., 2010. *Schistosoma mekongi* in Cambodia and Lao People's Democratic Republic. Adv Parasitol 72, 179-203.

Mwinzi, P.N., Montgomery, S.P., Owaga, C.O., Mwanje, M., Muok, E.M., Ayisi, J.G., Laserson, K.F., Muchiri, E.M., Secor, W.E., Karanja, D.M., 2012. Integrated community-directed intervention for schistosomiasis and soil transmitted helminths in western Kenya - a pilot study. Parasit Vectors 5, 182.

Ndyomugyenyi, R. and Kabatereine, N., 2003. Integrated community-directed treatment for the control of onchocerciasis, schistosomiasis and intestinal helminths infections in Uganda: advantages and disadvantages. Trop Med Int Health 8, 997-1004.

Ngoc, D.P., Shinohara, A., Horii, Y., Yahiro, S., Habe, S., Vannavong, N., Strobel, M., Nakamura, S., Nawa, Y., 2009. Morphological differences and molecular similarities between *Paragonimus bangkokensis* and *P. harinasutai*. Parasitol Res 105, 429-439.

Nuwaha, F., Okware, J., Ndyomugyenyi, R., 2005. Predictors of compliance with community-directed ivermectin treatment in Uganda: quantitative results. Trop Med Int Health 10, 659-667.

Obrist, B., Iteba, N., Lengeler, C., Makemba, A., Mshana, C., Nathan, R., Alba, S., Dillip, A., Hetzel, M.W., Mayumana, I., Schulze, A., Mshinda, H., 2007. Access to health care in contexts of livelihood insecurity: a framework for analysis and action. PLoS Med 4, 1584-1588.

Odermatt, P., Habe, S., Manichanh, S., Tran, D.S., Duong, V., Zhang, W., Phommathet, K., Nakamura, S., Barennes, H., Strobel, M., Dreyfuss, G., 2007. Paragonimiasis and its intermediate hosts in a transmission focus in Lao People's Democratic Republic. Acta Trop 103, 108-115.

Ohmae, H., Sinuon, M., Kirinoki, M., Matsumoto, J., Chigusa, Y., Socheat, D., Matsuda, H., 2004. Schistosomiasis mekongi: from discovery to control. Parasitol Int 53, 135-142.

Okeibunor, J.C., Ogungbemi, M.K., Sama, M., Gbeleou, S.C., Oyene, U., Remme, J.H., 2004. Additional health and development activities for community-directed distributors of ivermectin: threat or opportunity for onchocerciasis control? Trop Med Int Health 9, 887-896.

Onwujekwe, O.E., Shu, E.N., Nwagbo, D., Akpala, C.O., Okonkwo, P.O., 1998. Willingness to pay for community-based ivermectin distribution: a study of three onchocerciasis-endemic communities in Nigeria. Trop. Med. Int. Health 3, 802-808.

Parker, M. and Allen, T., 2011. Does mass drug administration for the integrated treatment of neglected tropical diseases really work? Assessing evidence for the control of schistosomiasis and soil-transmitted helminths in Uganda. Health Res Policy Syst 9, 3.

Penchansky and Thomas, 1981. The Concept of Access Definition and Relationship to Consumer Satisfaction. Medical Care XIX, 127-140.

Petney, T., Sithithaworn, P., Andrews, R., Kiatsopit, N., Tesana, S., Grundy-Warr, C., Ziegler, A., 2012. The ecology of the *Bithynia* first intermediate hosts of *Opisthorchis viverrini*. Parasitol Int 61, 38-45.

Phan, V.T., Ersboll, A.K., Do, D.T., Dalsgaard, A., 2011. Raw-fish-eating behavior and fishborne zoonotic trematode infection in people of northern Vietnam. Foodborne Pathog Dis 8, 255-260.

Phathammavong, O., Moazzam, A., Xaysomphoo, D., Phengsavanh, A., Kuroiwa, C., 2007. Parasitic infestation and nutritional status among schoolchildren in Vientiane, Lao PDR. J Paediatr Child Health 43, 689-694.

Phommasack, B., Saklokham, K., Chanthavisouk, C., Nakhonesid-Fish, V., Strandgaard, H., Montresor, A., Shuey, D.A., Ehrenberg, J., 2008. Coverage and costs of a school deworming programme in 2007 targeting all primary schools in Lao PDR. Trans R Soc Trop Med Hyg 102, 1201-1206.

Phongluxa, K., van, E.P., Soukhathammavong, P.A., Akkhavong, K., Odermatt, P., 2014. Perceived illness drives participation in mass deworming campaigns in Laos. Acta Trop

Phongluxa, K., Xayaseng, V., Vonghachack, Y., Akkhavong, K., van Eeuwijk, P., Odermatt, P., 2013. Helminth infection in Laos: high prevalence and low awareness. Parasit Vectors 6, 328.

Prasongwatana, J., Laummaunwai, P., Boonmars, T., Pinlaor, S., 2013. Viable metacercariae of *Opisthorchis viverrini* in northeastern Thai cyprinid fish dishes--as part of a rational program for control of *O. viverrini*-associated cholangiocarcinoma. Parasitol Res 112, 1323-1327.

Rangsin, R., Mungthin, M., Taamasri, P., Mongklon, S., Aimpun, P., Naaglor, T., Leelayoova, S., 2009. Incidence and risk factors of *Opisthorchis viverrini* infections in a rural community in Thailand. Am J Trop Med Hyg 81, 152-155.

Renzaho, A.M., Woods, P.V., Ackumey, M.M., Harvey, S.K., Kotin, J., 2007. Community-based study on knowledge, attitude and practice on the mode of transmission, prevention and treatment of the Buruli ulcer in Ga West District, Ghana. Trop Med Int Health 12, 445-458.

Rim, H.J., Chai, J.Y., Min, D.Y., Cho, S.Y., Eom, K.S., Hong, S.I., Sohn, W.M., Yong, T.S., Deodato, G., Hanne, S., Bounlay, P., Yun, C.H., Hoang, E.H., 2003. Prevalence of intestinal parasite infections on a national scale among primary schoolchildren in Laos. Parasitol Res 91, 267-272.

Rim, H.J., Sohn, W.M., Yong, T.S., Eom, K.S., Chai, J.Y., Min, D.Y., Lee, S.H., Hoang, E.H., Phommasack, B., Insisengmay, S., 2008. Fishborne trematode metacercariae detected in freshwater fish from Vientiane Municipality and Savannakhet Province, Lao PDR. Korean J Parasitol 46, 253-260.

Rim, H.J., Sohn, W.M., Yong, T.S., Eom, K.S., Chai, J.Y., Min, D.Y., Lee, S.H., Hoang, E.H., Phommasack, B., Insisiengmay, S., 2013. Fishborne trematode metacercariae in Luang Prabang, Khammouane, and Saravane Province, Lao PDR. Korean J Parasitol 51, 107-114.

Rowley, J. and Slack, F., 2004. Conducting a literature review. Management Research News 27, 31-39.

Sama, M.T., Oyono, E., Ratard, R.C., 2007. High risk behaviours and schistosomiasis infection in kumba, South-west province, cameroon. Int J Environ Res Public Health 4, 101-105.

Santos, F.L., Cerqueira, E.J., Soares, N.M., 2005. Comparison of the thick smear and Kato-Katz techniques for diagnosis of intestinal helminth infections. Rev Soc Bras Med Trop 38, 196-198.

Sato, M., Pongvongsa, T., Sanguankiat, S., Yoonuan, T., Dekumyoy, P., Kalambaheti, T., Keomoungkhoun, M., Phimmayoi, I., Boupha, B., Moji, K., Waikagul, J., 2010. Copro-DNA diagnosis of Opisthorchis viverrini and Haplorchis taichui infection in an endemic area of Lao PDR. Southeast Asian J Trop Med Public Health 41, 28-35.

Sayasone, S., Mak, T.K., Vanmany, M., Rasphone, O., Vounatsou, P., Utzinger, J., Akkhavong, K., Odermatt, P., 2011. Helminth and intestinal protozoa infections, multiparasitism and risk factors in Champasack province, Lao People's Democratic Republic. PLoS Negl Trop Dis 5, e1037.

Sayasone, S., Odermatt, P., Phoumind, N., Vongsaravane, X., Sensombath, V., Phetsouvanh, R., Choulamany, X., Strobel, M., 2007. Epidemiology of *Opisthorchis viverrini* in a rural district of southern Lao PDR. Trans R Soc Trop Med Hyg 101, 40-47.

Sayasone, S., Odermatt, P., Vongphrachanh, P., Keoluangkot, V., Dupouy-Camet, J., Newton, P.N., Strobel, M., 2006. A trichinellosis outbreak in Borikhamxay Province, Lao PDR. Trans R Soc Trop Med Hyg 100, 1126-1129.

Sayasone, S., Rasphone, O., Vanmany, M., Vounatsou, P., Utzinger, J., Tanner, M., Akkhavong, K., Hatz, C., Odermatt, P., 2012. Severe morbidity due to *Opisthorchis viverrini* and *Schistosoma mekongi* infection in Lao People's Democratic Republic. Clin Infect Dis 55, e54-e57.

Sayasone, S., Tesana, S., Utzinger, J., Hatz, C., Akkhavong, K., Odermatt, P., 2009a. Rare human infection with the trematode *Echinochasmus japonicus* in Lao PDR. Parasitol Int 58, 106-109.

Sayasone, S., Vonghachack, Y., Vanmany, M., Rasphone, O., Tesana, S., Utzinger, J., Akkhavong, K., Odermatt, P., 2009b. Diversity of human intestinal helminthiasis in Lao PDR. Trans R Soc Trop Med Hyg 103, 247-254.

Schneider, C.R., Kitikoon, V., Sornmani, S., Thirachantra, S., 1975. Mekong schistosomiasis. III: a parasitological survey of domestic water buffalo (*Bubalus bubalis*) on Khong Island, Laos. Ann Trop Med Parasitol 69, 227-232.

Scholz, T., Ditrich, O., Giboda, M., 1991. Differential diagnosis of opisthorchiid and heterophyid metacercariae (Trematoda) infecting flesh of cyprinid fish from Nam Ngum Dam Lake in Laos. Southeast Asian J Trop Med Public Health 22 Suppl, 171-173.

Seketeli, A., Adeoye, G., Eyamba, A., Nnoruka, E., Drameh, P., Amazigo, U.V., Noma, M., Agboton, F., Aholou, Y., Kale, O.O., Dazie, K.Y., 2002. The achievements and challenges of the African Programme for Onchocerciasis Control (APOC). Ann Trop Med Parasitol 96, S15-S28.

Shaker, Z.A., Hassan, S.I., el-Attar, G.M., Talaat, M., el-Nahal, H.M., el-Behairy, N.M., Mansour, M.M., Kamel, L.M., 1994. Use of Kato and nucleopore techniques for qualitative diagnosis of schistosomiasis. J Egypt Soc Parasitol 24, 656-662.

Shen, C., Choi, M.H., Bae, Y.M., Yu, G., Wang, S., Hong, S.T., 2007. A case of anaphylactic reaction to praziquantel treatment. Am J Trop Med Hyg 76, 603-605.

Siharath, K., Soukphathag, S., Tanyavong, K., Vilaysane, K.D., Chanthavong, M., Intarakhao, C., Mahaweerawat, U., Saowakontha, S., Merkle, A., Schelp, F.P., 2000. Control of intestinal parasitic infection--a pilot project in Lao PDR. Southeast Asian J Trop Med Public Health 31 Suppl 2, 41-50.

Silverman, D., 2007. Doing Qualitative Research. Sage Publications, London.

Singhanouvong and Phouthavong, 2002. Fisheries Baseline Survey in Champasacl province, Southern Lao PDR. 5th Technical Symposium on Mekong Fisheries 11th - 13th Dec. 2002.

Sithithaworn, P., Andrews, R.H., Nguyen, V.D., Wongsaroj, T., Sinuon, M., Odermatt, P., Nawa, Y., Liang, S., Brindley, P.J., Sripa, B., 2012. The current status of opisthorchiasis and clonorchiasis in the Mekong Basin. Parasitol Int 61, 10-16.

Sithithaworn, P. and Haswell-Elkins, M., 2003. Epidemiology of *Opisthorchis viverrini*. Acta Trop 88, 187-194.

Sithithaworn, P., Pipitgool, V., Srisawangwong, T., Elkins, D.B., Haswell-Elkins, M.R., 1997. Seasonal variation of *Opisthorchis viverrini* infection in cyprinoid fish in north-east Thailand: implications for parasite control and food safety. Bull World Health Organ 75, 125-131.

Sithithaworn, P., Sukavat, K., Vannachone, B., Sophonphong, K., Ben-Embarek, P., Petney, T., Andrews, R., 2006. Epidemiology of food-borne trematodes and other parasite infections in a fishing community on the Nam Ngum reservoir, Lao PDR. Southeast Asian J Trop Med Public Health 37, 1083-1090.

Song, H.O., Min, D.Y., Rim, H.J., Youthanavanh, V., Daluny, B., Sengdara, V., Virasack, B., Bounlay, P., 2008. Skin test for paragonimiasis among schoolchildren and villagers in Namback District, Luangprabang Province, Lao PDR. Korean J Parasitol 46, 179-182.

Sornmani, S., 1987. Control of opisthorchiasis through community participation. Parasitol Today 3, 31-33.

Sornmani, S., Pathammavong, O., Bunnag, T., Impand, P., Intrakhao, C., Thirachantra, S., 1974. An epidemiological survey of human intestinal parasites in Vientiane, Laos. Southeast Asian J Trop Med Public Health 5, 541-546.

Sornmani, S., Schelp, F.P., Vivatanasesth, P., Patihatakorn, W., Impand, P., Sitabutra, P., Worasan, P., Preuksaraj, S., 1984. A pilot project for controlling *O. viverrini* infection in Nong Wai, Northeast Thailand, by applying praziquantel and other measures. Arzneimittelforschung. 34, 1231-1234.

Soukhathammavong, P., Odermatt, P., Sayasone, S., Vonghachack, Y., Vounatsou, P., Hatz, C., Akkhavong, K., Keiser, J., 2011. Efficacy and safety of mefloquine, artesunate, mefloquine-artesunate, tribendimidine, and praziquantel in patients with *Opisthorchis viverrini*: a randomised, exploratory, open-label, phase 2 trial. Lancet Infect Dis 11, 110-118.

Soukhathammavong, P., Sayasone, S., Harimanana, A.N., Akkhavong, A., Thammasack, S., Phoumindr, N., Choumlivong, K., Choumlivong, K., Keoluangkhot, V., Phongmany, S., Akkhavong, K., Hatz, C., Strobel, M., Odermatt, P., 2008. Three cases of intestinal capillariasis in Lao People's Democratic Republic. Am J Trop Med Hyg 79, 735-738.

Soukhathammavong, P.A., Sayasone, S., Phongluxa, K., Xayaseng, V., Utzinger, J., Vounatsou, P., Hatz, C., Akkhavong, K., Keiser, J., Odermatt, P., 2012. Low efficacy of single-dose albendazole and mebendazole against hookworm and effect on concomitant helminth infection in Lao PDR. PLoS Negl Trop Dis 6, e1417.

Sousa-Figueiredo, J.C., Betson, M., Atuhaire, A., Arinaitwe, M., Navaratnam, A.M., Kabatereine, N.B., Bickle, Q., Stothard, J.R., 2012. Performance and safety of praziquantel for treatment of intestinal schistosomiasis in infants and preschool children. PLoS Negl Trop Dis 6, e1864.

Sriamporn, S., Pisani, P., Pipitgool, V., Suwanrungruang, K., Kamsa-ard, S., Parkin, D.M., 2004. Prevalence of *Opisthorchis viverrini* infection and incidence of cholangiocarcinoma in Khon Kaen, Northeast Thailand. Trop Med Int Health 9, 588-594.

Sripa, B., Bethony, J.M., Sithithaworn, P., Kaewkes, S., Mairiang, E., Loukas, A., Mulvenna, J., Laha, T., Hotez, P.J., Brindley, P.J., 2011. Opisthorchiasis and

Opisthorchis-associated cholangiocarcinoma in Thailand and Laos. Acta Trop 120 Suppl 1, S158-S168.

Sripa, B., Brindley, P.J., Mulvenna, J., Laha, T., Smout, M.J., Mairiang, E., Bethony, J.M., Loukas, A., 2012. The tumorigenic liver fluke *Opisthorchis viverrini*--multiple pathways to cancer. Trends Parasitol 28, 395-407.

Sripa, B., Kaewkes, S., Intapan, P.M., Maleewong, W., Brindley, P.J., 2010. Food-borne trematodiases in Southeast Asia epidemiology, pathology, clinical manifestation and control. Adv Parasitol 72, 305-350.

Stehr-Green, J.K. and Schantz, P.M., 1986. Trichinosis in Southeast Asian refugees in the United States. Am J Public Health 76, 1238-1239.

Steinmann, P., Du, Z.W., Wang, L.B., Wang, X.Z., Jiang, J.Y., Li, L.H., Marti, H., Zhou, X.N., Utzinger, J., 2008. Extensive multiparasitism in a village of Yunnan province, People's Republic of China, revealed by a suite of diagnostic methods. Am J Trop Med Hyg 78, 760-769.

Steinmann, P., Utzinger, J., Du, Z.W., Jiang, J.Y., Chen, J.X., Hattendorf, J., Zhou, H., Zhou, X.N., 2011. Efficacy of single-dose and triple-dose albendazole and mebendazole against soil-transmitted helminths and Taenia spp.: a randomized controlled trial. PLoS One 6, e25003.

Stensvold, C.R., Saijuntha, W., Sithithaworn, P., Wongratanacheewin, S., Strandgaard, H., Ornbjerg, N., Johansen, M.V., 2006. Evaluation of PCR based coprodiagnosis of human opisthorchiasis. Acta Trop 97, 26-30.

Strandgaard, H., Johansen, M.V., Agaard-Hansen, J., Petlueng, P., Ornbjerg, N., 2008. Local perceptions and practices in regard to opisthorchiasis in two villages in Lao PDR. Southeast Asian J Trop Med Public Health 39, 19-26.

Strandgaard, H., Johansen, M.V., Pholsena, K., Teixayavong, K., Christensen, N.O., 2001. The pig as a host for *Schistosoma mekongi* in Laos. J Parasitol 87, 708-709.

Strecher and Rosenstock, 1997. The Health Belief Model. 2, 41-59.

Strobel, M., Veasna, D., Saykham, M., Wei, Z., Tran, D.S., Valy, K., Odermatt, P., Dreyfus, G., 2005. [Pleuro-pulmonary paragonimiasis]. Med Mal Infect 35, 476-481.

Suwansrinon, K., Wilde, H., Burford, B., Hanvesakul, R., Sitprija, V., 2007. Human trichinellosis from Laos. J Travel Med 14, 274-277.

Tanner, S., Chuquimia-Choque, M.E., Huanca, T., McDade, T.W., Leonard, W.R., Reyes-Garcia, V., 2011. The effects of local medicinal knowledge and hygiene on helminth infections in an Amazonian society. Soc Sci Med 72, 701-709.

Tarafder, M.R., Carabin, H., Joseph, L., Balolong E Jr, Olveda, R., McGarvey, S.T., 2010. Estimating the sensitivity and specificity of Kato-Katz stool examination technique for detection of hookworms, *Ascaris lumbricoides* and *Trichuris trichiura* infections in humans in the absence of a 'gold standard'. Int J Parasitol 40, 399-404.

Taybouavone, T., Hai, T.N., Odermatt, P., Keoluangkhot, V., anos-Gregoire, N., Dupouy-Camet, J., Strobel, M., Barennes, H., 2009. Trichinellosis during pregnancy: a case control study in the Lao Peoples' Democratic Republic. Vet Parasitol 159, 332-336.

Taylor, R.G. and Moose, J.W., 1971. The egg from a human case Schistosomiasis in Laos. J Parasitol 57, 78-80.

TDR/WHO, 2008. Community-Directed Interventions for major health problems in Africa: a multi-country study; final report. World Health Organization, Geneva Switzerland

Tomokawa, S., Kobayashi, T., Pongvongsa, T., Nisaygnang, B., Kaneda, E., Honda, S., Moji, K., Boupha, B., 2012. Risk factors for *Opisthorchis viverrini* infection among schoolchildren in Lao PDR. Southeast Asian J Trop Med Public Health 43, 574-585.

Ukwandu, N.C. and Nmorsi, O.P., 2004. The perception, beliefs and practices toward genitourinary schistosomiasis by inhabitants of selected endemic areas (Edo/Delta States) in south-eastern Nigeria. Rev Inst Med Trop Sao Paulo 46, 209-216.

Urbani, C., Sinoun, M., Socheat, D., Pholsena, K., Strandgaard, H., Odermatt, P., Hatz, C., 2002. Epidemiology and control of Mekongi schistosomiasis. Acta Trop 82, 157-168.

Utzinger, J., Bergquist, R., Olveda, R., Zhou, X.N., 2010. Important helminth infections in Southeast Asia diversity, potential for control and prospects for elimination. Adv Parasitol 72, 1-30.

Vandemark, L.M., Jia, T.W., Zhou, X.N., 2010. Social science implications for control of helminth infections in Southeast Asia. Adv Parasitol 73, 137-170.

Vannachone, B., Kobayashi, J., Nambanya, S., Manivong, K., Inthakone, S., Sato, Y., 1998. An epidemiological survey on intestinal parasite infection in Khammouane Province, Lao PDR, with special reference to *Strongyloides* infection. Southeast Asian J Trop Med Public Health 29, 717-722.

Wang, Y.C., 2012. Examining landscape determinants of *Opisthorchis viverrini* transmission. Ecohealth 9, 328-341.

Weichart, G. and van Eeuwijk, P., 2008. Food chains: eating, drinking, feeding - framing social relations. Preface Anthropol Food S3. 1-5.

Weiss, M.G., 1997. Explanatory Model Interview Catalogue (EMIC):Framework for comparative study of illness. Transcultural Psychiatry 34, 235-263.

WHO, 1995. Control of foodborne trematode infections. Techincal Report Series 849, Geneva.

WHO, 2002. Prevention and control of schistosomiasis and soil-transmitted helminthiasis. Techincal Report Series 912, WHO, Geneva.

WHO, 2004. Training Manual on Diagnosis of Intestinal Parasites. 98.2, WHO, Geneva.

WHO, 2006. Negleted Tropical Diseases: Preventive Chemotherapy and Transmission Control. WHO/CDS/NTD/2006.3a.

WHO/FAO, 2004. Food-borne trematode infections in Asia. Report Series number: RS/2002/GE/40 (VTN).

WHO/HTM/NTD, 2011. Working to overcome the global impact of neglected tropical diseases - Summary. Wkly Epidemiol Rec 86, 113-120.

Wittes, R., MacLean, J.D., Law, C., Lough, J.O., 1984. Three cases of schistosomiasis mekongi from northern Laos. Am J Trop Med Hyg 33, 1159-1165.

Wongba, N., Thaewnongiew, K., Phathee, K., Laithavewat, L., Duangsong, R., Promthet, S., Tangsawad, S., 2011. Liver fluke prevention and control in the northeast of Thailand through action research. Asian Pac J Cancer Prev 12, 1367-1370.

World Health Organization, 2010. Working to overcome global impact of neglected tropical diseases.

Xayaseng, V., Phongluxa, K., van Eeuwijk, P., Akkhavong, K., Odermatt, P., 2013. Raw fish consumption in liver fluke endemic areas in rural southern Laos. Acta Trop 127, 105-111.

Yahiro, S., Habe, S., Duong, V., Odermatt, P., Barennes, H., Strobel, M., Nakamura, S., 2008. Identification of the human paragonimiasis causative agent in Lao People's Democratic Republic. J Parasitol 94, 1176-1177.

Yangco, B.G., De, L.C., Lyman, G.H., Price, D.L., 1987. Clinical study evaluating efficacy of praziquantel in clonorchiasis. Antimicrob. Agents Chemother. 31, 135-138.

Yee, B., Hsu, J.I., Favour, C.B., Lohne, E., 1992. Pulmonary paragonimiasis in Southeast Asians living in the central San Joaquin Valley. West J Med 156, 423-425.

Yirga, D., Deribe, K., Woldemichael, K., Wondafrash, M., Kassahun, W., 2010. Factors associated with compliance with community directed treatment with ivermectin for onchocerciasis control in Southwestern Ethiopia. Parasit Vectors 3, 48.

Ziegler, A.D., Andrews, R.H., Grundy-Warr, C., Sithithaworn, P., Petney, T.N., 2011. Fighting liverflukes with food safety education. Science 331, 282-283.

Ziegler, A.D., Petney, T.N., Grundy-Warr, C., Andrews, R.H., Baird, I.G., Wasson, R.J., Sithithaworn, P., 2013. Dams and disease triggers on the lower Mekong river. PLoS Negl Trop Dis 7, e2166.

Curriculum vitae

1. Personal data:	**Name and Surname**: Khampheng PHONGLUXA **Marital status**: Married; **Sex:** Female **Date of birth**: 31/12/1966 **Place of birth**: Vientiane Capital, Laos; N**ationality**: Lao
2. Current working place:	National Institute of Public Health (NIOPH), Ministry of Health
3. Qualification:	1. Master of Science in Community Health & Health Management 2. Medical Doctor (MD);
4. Language Proficiency:	English: very good; Bulgarian: very good
5. Education:	1.Master of Science in Community Health and Health Management in Heidelberg University, Germany 2004. 2. Diploma of General Medicine, VarnaMedicineUniversityBulgaria in 1994

6. Working experiences:

1. 1995 to 1999	Public health research assistant in Health System Research Dept. (3 years) and Health Information System Dept. (2 years) of Council of Medical Sciences, MOH
2. 2000	Taking English course in AustralianCollege based in Laos for 9 months.
3. 2001 to 2003	Working at the office of the NIOPH's Director, and participating in public health researches
4. 8/2003 to 2004	Taking Master of Science in Community Health and Health Management in Developing Countries in Heidelberg University; Germany
5. 2004 to 2013	Working at the Dept. of Health Information System; NIOPH, MOH
6. 2008	PhD candidate at Swiss Tropical and Public Health Institute (Swiss

	TPH), University Basel, Basel, Switzerland
7. Current	Working at the Dept. of Ethic for Health Research, NIOPH, MOH

7. Public health research experiences:

1995 to 2005	• Participating in public health research projects: anaemia among pregnant women (1996); health facility survey in two provinces (1999); national health survey (2000), health research system analysis in Laos (2001), health development project in Savannakhet (2001-2002); Lao health survey as part of world health survey (2003), knowledge Transfer Education (2003)
2002-2005	• Assisting the National Assembly works of NIOPH's Director twice a year in SVNK Prov.
5-6/2004	• Conducting research as a part of master thesis on knowledge, attitude, practices and behaviour of religious leaders in the fight against HIV/AIDS in Tanga region, Tanzania, Africa
2006	• Lecturer on health information system for decision making in eight northern provinces
2007	• PI for the project titled "community's knowledge, attitude, and practice on malaria after an evidence based health education intervention at high risk area of SaravaneProvince, Laos"
2007-2013	• Assisting a longitudinal research on morbidity induced by food-borne and water-borne trematodes infections, Khong, district, southern Champasak province (Swiss TPH project in collaboration with NIOPH, Laos) (3-5/2007)
	• Team leader for mass drug administration against *S. mekongi* in Khong District, Champasak province, southern Laos (Swiss TPH project in collaboration with NIOPH) (8/2008)
	• Conducted a survey on perception pertaining deworming in endemic community of *S. mekongi* and multiparasitism in Donelong, Khong District, Southern Champasak Province (8/2008)
	• Team leader for developing profile on health research for Laos as a part of COHRED's country profile on health research website (in 2008)
	• Short term consultant for Concern Worldwide pertaining clinical training

need assessment in Houaphanh province northern Laos (in 2008)

- Team leader for salt survey in Vientiane Capital (10/2012) and team leader for KAP survey on micronutrient powder (MNP) project in SaravaneProvince, southern Laos (7/2013)

8. PhD candidate at Swiss TPH

2008
- Joint Swiss Society Meeting on Tropical Medicine and Parasitology and
- Oral presentation on severe disease outcome drives participation in mass deworming in Laos at session for PhD student's meeting in 2008
- Oral presentation on severe disease outcome drives participation in mass deworming in Laos at student meeting at SwissTPH in 2008

2011
- Attended Liver fluke conference in Khon kaen, Thailand

2011
- Taking course for scientific writing in Alabang, The Philippines

2010-2012
- Conducting 3 years-community-directed intervention against liver fluke and intestinal c-infections in liver fluke endemic areas Saravane district, Saravane province southern Laos; the findings have been used for a PhD dissertation; I was a main researcher for this intervention.

9. Funding for PhD

- Personal stipend from Rudolf Geigy Foundation
- Project grant: World Health Organization (WHO)

10. Publications

Phongluxa, K., van, Eeuwijk, P., Soukhathammavong, P.A., Akkhavong, K., Odermatt, P., 2014. Perceived illness drives participation in mass deworming campaigns in Laos. Acta Trop.http://dx.doi.org/10.1016/j.actatropica.2014.03.022

Phongluxa, K., Xayaseng, V., Vonghachack, Y., Akkhavong, K., van Eeuwijk, P., Odermatt, P., 2013. Helminth infection in Laos: high prevalence and low awareness. Parasit.Vectors.6, 328.

Xayaseng, V., **Phongluxa, K**., van Eeuwijk, P., Akkhavong, K., Odermatt, P., 2013.Raw fish consumption in liver fluke endemic areas in rural southern Laos. Acta Trop 127, 105-111.

Soukhathammavong, P.A., Sayasone, S., **Phongluxa, K**., Xayaseng, V., Utzinger, J., Vounatsou, P., Hatz, C., Akkhavong, K., Keiser, J., Odermatt, P., 2012. Low efficacy of single-dose albendazole and mebendazole against hookworm and effect on concomitant helminth infection in Lao PDR. PLoS Negl. Trop Dis. 6, e1417.

Lovis, L., Mak, T.K., **Phongluxa, K**., Aye, S.P., Vonghachack, Y., Keiser, J., Vounatsou, P., Tanner, M., Hatz, C., Utzinger, J., Odermatt, P., Akkhavong, K., 2012. Efficacy of praziquantel against Schistosoma mekongi and *Opisthorchis viverrini*: a randomized, single-blinded dose-comparison trial. PLoS Negl. Trop Dis. 6, e1726.

Lovis, L., Mak, T.K., **Phongluxa, K**., Soukhathammavong, P., Sayasone, S., Akkhavong, K., Odermatt, P., Keiser, J., Felger, I., 2009.PCR Diagnosis of *Opisthorchis viverrini* and Haplorchis taichui Infections in a Lao Community in an area of endemicity and comparison of diagnostic methods for parasitological field surveys.J Clin.Microbiol. 47, 1517-1523.