Mixed Methods Analysis of Pig associated Zoonoses in Lao PDR

Stephanie Burniston

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Declaration

I declare that the research described within this thesis is my own work and that this thesis is my own composition and certify that it has never been submitted for any other degree or professional qualification.

S Burniston

Stephanie Burniston

University of Edinburgh, 2016

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Table of Contents

Abstract i

List of Abbreviations iii

1 Introduction 1

1.1 Literature review 3

1.1.1 Q fever 3

1.1.1.1 Epidemiology and disease burden 3

1.1.1.2 Transmission and risk factors 4

1.1.1.3 Clinical manifestation 5

1.1.1.4 Diagnosis 7

1.1.1.5 Prevention and control 8

1.1.2 Brucellosis 9

1.1.2.1 Epidemiology & disease burden 9

1.1.2.2 Transmission & risk factors 11

1.1.2.3 Clinical Manifestation 12

1.1.2.4 Diagnosis 13

1.1.2.5 Prevention & Control 14

1.1.3 Hepatitis E Virus (HEV) 14

1.1.3.1 Epidemiology and disease burden 14

1.1.3.2 Transmission & Risk factors 16

1.1.3.3 Clinical manifestation 17

1.1.3.4 Diagnosis 18

1.1.3.5 Prevention & Control 19

1.1.4 Japanese encephalitis 19

1.1.4.1 Epidemiology and disease burden 19
1.1.4.2 Transmission and risk factors 21
1.1.4.3 Clinical manifestation 22
1.1.4.4 Diagnosis........ 23
1.1.4.5 Prevention & control........ 23
1.1.5 Syndromes associated with the study diseases 24
1.1.5.1 Acute febrile illness 24
1.1.5.2 Acute Jaundice Syndrome........ 27
1.1.5.3 CNS Infections........ 27
1.2 Thesis structure 28
2 Study Area & Design........ 30
2.1 Lao PDR: Country Profile 30
2.1.1 Area and population........ 30
2.1.2 Climate, flora & fauna 33
2.1.3 The People 33
2.1.3.1 Ethnicity & religion 33
2.1.3.2 Diet........ 35
2.1.4 Administration system 35
2.1.5 Socioeconomic status........ 36
2.1.6 Environmental trends........ 37
2.2 Health Services Delivery Model (health system infrastructure)........ 38
2.2.1 Social health protection........ 40
2.2.2 Public health priorities 41
2.3 Disease surveillance and reporting in Lao PDR 42

2.3.1 Current health information system ... 42

2.3.2 Other surveillance programmes ... 44

2.3.3 Field epidemiology training programme ... 45

2.4 Veterinary services in Lao PDR ... 46

2.5 Diagnostic centres and methods currently available ... 47

2.6 Pig production and management systems ... 49

2.7 Background – 2011 ILRI and ACIAR Serosurveillance Study ... 49

2.7.1 Smallholder Pig Systems Project ... 50

2.8 Rationale for PhD research ... 51

2.8.1 Aims & objectives ... 52

3 Qualitative and Quantitative analysis of pig zoonoses in northern Lao PDR ... 56

3.1 Introduction ... 56

3.2 2011 ILRI/ACIAR Serosurveillance study ... 57

3.2.1 Methodology used ... 57

3.2.1.1 Serological survey and risk factors questionnaire ... 57

3.2.1.2 Study area and sample size ... 58

3.2.1.2.1 Province selection ... 58

3.2.1.2.2 Serological Sampling ... 58

3.2.1.2.3 Serological analysis ... 59

3.2.1.2.4 Further data analysis ... 60

3.2.2 Results ... 61

3.2.2.1 Human characteristics ... 62

3.2.2.2 Human serological results ... 63

3.2.2.2.1 Significant risk factors for human infection ... 66

3.2.2.3 Pig sample characteristics 69
3.2.2.4 Pig serological results 69
3.2.2.4.1 Significant risk factors for pig infection 73
3.2.3 Summary of findings 74
3.3 Comparison with data from the National Centre for Laboratory and Epidemiology 76
3.3.1.1 Data collection methods used for surveillance 76
3.3.1.2 Acute flaccid paralysis (AFP) 78
3.3.1.3 Fever and rash syndrome 79
3.3.1.4 Acute jaundice syndrome (AJS) 81
3.3.1.5 Meningitis 83
3.3.1.6 Acute encephalitis syndrome (AES) 85
3.3.1.7 Overall summary 87
3.4 Discussion - links between survey observations, syndromic surveillance and the 4 study diseases 88
3.5 Conclusion 91
4 Knowledge, attitudes and practices of villagers in northern Lao PDR 92
4.1 Introduction 92
4.1.1 Use of qualitative research 93
4.1.1.1 Knowledge, attitudes, and practices (KAP) survey methodology 94
4.1.2 Study aims and objectives 96
4.2 Materials and methods 97
4.2.1 Study design 97
4.2.1.1 Participant recruitment 98
4.2.1.2 Ethical considerations 98

4.2.1.3 Sample size and data collection 98

4.2.2 Data management and analysis of qualitative data 99

4.3 Results 100

4.3.1 Characteristics of the study villages 100

4.3.1.1 Ethnic groups 100

4.3.2 Main human health problems by province 103

4.3.2.1 Definitions 103

4.3.3 Main swine health problems by province 108

4.3.4 Awareness and perceptions about human and animal health and zoonoses by province 112

4.3.5 Health seeking behaviours by province 118

4.3.5.2 Financial barriers 125

4.3.6 Risk factors and risky behaviours for zoonotic disease transmission 127

4.3.6.1 Animal husbandry and health 127

4.3.6.1.1 Animal husbandry practices 127

4.3.6.1.2 Separation of sick vs. well animals 128

4.3.6.1.3 Handling of sick or dead animals 129

4.3.6.1.4 Animal health reporting and training 132

4.3.6.2 Agricultural practices and flooding 134

4.3.6.3 Food consumption practices by province 136

4.3.6.4 Hygiene and sanitation practices 142

4.3.6.4.1 Access to water 142

4.3.6.4.2 Drinking water practices 143

4.3.6.4.3 Hand washing practices 145

4.3.6.4.4 Household waste ... 146

4.3.6.4.5 Latrine use ... 147

4.3.7 Acceptable measures for vector control ... 149

4.4 Discussion ... 151

4.5 Conclusion ... 158

5 Health-seeking behaviour assessment at the village and hospital/health centre levels 160

5.1 Introduction ... 160

5.2 Methodology ... 162

5.2.1 Aims of the survey ... 162

5.2.2 Study area ... 162

5.2.3 Study design ... 162

5.2.4 Sample size and data collection – at village level ... 163

5.2.4.1 Inclusion criteria ... 164

5.2.4.2 Exclusion criteria ... 164

5.2.5 Sample size and data collection – at health care facility level ... 164

5.2.5.1 Inclusion criteria ... 165

5.2.5.2 Exclusion criteria ... 165

5.2.6 Criteria for Illness ... 165

5.2.7 Ethical Considerations ... 166

5.2.8 Data management and analysis ... 166

5.3 Results ... 166

5.3.1 Characteristics of study participants at village and health care facility levels 166

5.3.2 Impact of illness and health seeking behaviour – village household survey 173

5.3.3 Impact of illness and health seeking behaviour – health care facility survey 176

5.4 Discussion ... 178

5.5 Conclusion ... 185

6 Healthcare provider service delivery assessment ... 186

6.1 Introduction ... 186

6.2 Methodology ... 189

6.2.1 Aims of the survey ... 189

6.2.2 Study area ... 190

6.2.3 Study design – sample size and data collection ... 190

6.2.3.1 Health care worker interviews ... 190

6.2.3.2 Private drug-seller or pharmacist interviews ... 191

6.2.3.3 Traditional/Spiritual healer and village health volunteer interviews ... 191

6.2.4 Ethical considerations ... 191

6.2.5 Data management and analysis ... 192

6.3 Results ... 192

6.3.1 Health care worker (HCW) Interviews ... 192

6.3.2 Pharmacy/drug-seller (PDS) interviews ... 197

6.3.3 Traditional or Spiritual Healer and Village Health Volunteer interviews .. 198

6.4 Discussion ... 202

6.4.1 Healthcare worker interviews ... 203

6.4.2 Pharmacist/drug seller interviews ... 204

6.4.3 Traditional healer, spiritual healer and village health volunteer interviews 205

6.5 Conclusion 208

7 Discussion 209

7.1 Lao PDR human and animal health system – need for improvement........ 209

7.1.1 Alternative health care providers 212

7.1.2 Veterinary services and animal health in Lao PDR 214

7.1.3 Disease surveillance – incorporation of zoonoses in national surveillance 216

7.2 Socio-cultural factors that influence health 217

7.3 Use of a mixed methods approach 218

7.3.1 Movement towards a One Health approach 219

8 Conclusion 222

References 224

9 Appendix I 254

Appendix II 260

Focus Group Discussion – Knowledge, Attitudes and Practices – Interview guide....... 260

Visual aids for FGDs 266

Appendix III Form 1 - Socio-demographic and Animal factors Questionnaire 270

Form 2 - Impact of Illness & Health Seeking Behaviour Questionnaire – Household survey 278

Form 3 - Impact of Illness & Health Seeking Behaviour Questionnaire – Hospital survey 286

Appendix IV 293

Health Care Provider Service Delivery Assessment 293

Pharmacy/Drug Seller Interview 301

Traditional Healer/Spiritual Healer/Health Volunteer Interview 305

Tables

Table 3.1 NCLE case definitions for diseases/syndromes (included in PhD research) under national surveillance (NCLE, 2013). 77

Table 4.1 Summary of Village Characteristics and Focus Group Discussions 101

Table 4.2 Ethnic groups represented in each study village... 102

Table 4.3 Human health problems mentioned by FGD participants, by province 108

Table 4.4 Swine health problems mentioned by FGD participants, by province 112

Table 4.5 Distance to rice fields from the study villages... 135

Table 4.6 Water source for study villages 144

Table 5.1 Income source summary 170

Table 5.2 Summary of animal ownership in participating households.......................... 171

Table 5.3 Summary of items owned by each participating household 172

Table 5.4 Costs associated with illness experienced by participating households (n=21), in USD 175

Table 6.1 Health care facilities visited (H= hospital) 193

Table 6.2 Type and location of health care providers (HCP) interviewed 198

Table 9.1 Characteristics of study villages, 2011 ILRI/ACIAR Survey........................ 255

Table 9.2 Human disease prevalence by village in percent (95% Confidence Interval). 257

Table 9.3 Human disease prevalence by province in percent (95% Confidence interval) 257

Table 9.4 Pig disease prevalence by village in percent (95% Confidence Interval)....... 259

Table 9.5 Pig disease prevalence by province in percent (95% Confidence Interval) ... 259

Figures

Figure 1.1 Host range and cross-species infection of HEV under natural and experimental conditions (Meng, 2010) 15

Figure 2.1: Map of Lao PDR (courtesy of www.emapsworld.com) 31

Figure 2.2 Distribution of ethno-linguistic families in Lao PDR (source: http://www.seasite.niu.edu/lao/lao_maps/language_family_large.htm) 34

Figure 2.3 Flow-chart of EWAR surveillance (IBS and EBS) (NCLE, 2013) 44

Figure 2.4 Project Plan Summary 53

Figure 2.5 Criteria for Illness used to determine participant eligibility 54

Figure 3.1 Prevalence of hepatitis E virus by province, with 95% Confidence Intervals 64

Figure 3.2 Prevalence of hepatitis E virus by village and total, with 95% Confidence Intervals 65

Figure 3.3 Prevalence of Japanese encephalitis virus by province, with 95% Confidence Intervals 66

Figure 3.4 Prevalence of Japanese encephalitis virus by village and total, with 95% Confidence Intervals 66

Figure 3.5 Prevalence of hepatitis E virus by province, with 95% Confidence Intervals 70

Figure 3.6 Prevalence of hepatitis E virus by village and total, with 95% Confidence Intervals 71

Figure 3.7 Prevalence of Japanese encephalitis virus by province, with 95% Confidence Intervals 72

Figure 3.8 Prevalence of Japanese encephalitis virus by village and total, with 95% Confidence Intervals 73

Figure 3.9 Reported cases and deaths of AFP in Lao PDR by province, from 2004-2013 78

Figure 3.10 Reported cases of AFP in 4 provinces by year 79

Figure 3.11 Reported cases and deaths of fever and rash in Lao PDR by province, from 2004-2013 80

Figure 3.12 Reported cases of fever and rash in 4 provinces by year 81

Figure 3.13 Reported cases and deaths of AJS in Lao PDR by province, from 2004-2013 82

Figure.3.14 Reported cases of AJS in 4 provinces by year 83

Figure 3.15 Reported cases and deaths as a result of meningitis in Lao PDR by province, from 2004-2013 84

Figure 3.16 Reported cases of meningitis in 4 provinces by year 85

Figure 3.17 Reported cases and deaths due to AES in Lao PDR by province, from 2004-2013.. 85

Figure 3.18 Reported cases of AES in 4 provinces by year... 87

Figure 4.1 Criteria for Illness used to capture information relevant to study diseases and their associated syndromes 103

Figure 5.1 Village and health care facility questionnaires with number of participants for each 167

Figure 5.2 Age and Gender Composition of Participating Households......................... 168

Figure 5.3 Age and Gender Distribution of Population of Lao PDR, 2014………………183

Abstract

Southeast Asia carries a large burden of endemic zoonotic diseases, in livestock and humans, especially in countries where livestock production is increasing among rural households for income generation and poverty reduction.

This thesis explores the risk factors for transmission of pig-associated zoonoses – particularly Q fever, brucellosis, hepatitis E, and Japanese encephalitis – in northern Lao PDR, with a view to development of recommendations for "catch-all" control measures to impact on multiple diseases, improving biosecurity and preventing disease transmission to the human population.

Research included (i) a qualitative assessment of the knowledge, attitudes, and practices of villagers related to pig-associated zoonoses and their risk factors using focus group methodology; (ii) an assessment of health seeking behaviour at hospital/health centre and village level to examine factors that influence choice of health care provider and determine the impact of health seeking behaviour on illness and treatment costs, and an examination of non-conventional health care sources to understand the complexity of health seeking behaviour and influences on choice of health care provider and, lastly, (iii) health care provider and service delivery assessments to determine healthcare facility routine service delivery procedures and assess capability in diagnosing and treating illness.

In terms of disease, the most common illnesses reportedly seen by all those interviewed were respiratory illness, acute febrile illness and diarrhoea, confirming them as the leading causes of morbidity. Knowledge and awareness of the etiological agent of pig-associated zoonoses among villagers, patients, and health care providers was very poor for brucellosis and Q fever, with limited awareness of hepatitis E. Most were aware of Japanese encephalitis. Clinical diagnosis and symptomatic treatment of illness is the normal practice and identification of causative agents in human illness does not often occur. All three empirical assessments identified poor diagnostic capability as a major concern.

Focus group discussions revealed that knowledge and awareness of disease risk factors, and of zoonoses in general, was low among villagers. Practices related to food consumption, latrine usage, hand hygiene and sanitation, which are known disease risk factors, were found to be a concern in study villages. Attitudes and practices adopted by villagers in relation to human and animal health and health seeking behaviours were strongly influenced by financial circumstances, access to appropriate healthcare facilities, spiritual beliefs, and a lack of knowledge and resources to maintain the health of both animals and humans.

The first point of care when experiencing illness was often the health centre or a local traditional healer or spiritual healer or pharmacist/drug seller, depending on location. This was followed by the district hospital, if nearby. Many villagers described going back and forth between traditional medicine and modern medicine service providers, with 76% (19/25) of participants reportedly seeing more than one type of healthcare provider for a given episode of illness. Self-medication was the most common practice (84% of all participants) irrespective of the care provider consulted. Attendance at a healthcare facility was dependent on available funds and the perceived severity of illness. Overall household costs ranged between no cost, because of the "poor patient" policy that exempts vulnerable groups from paying for care, and $2500 USD for medical treatment, hospital stay, transportation and sometimes food. Healthcare workers at all facility levels (from health centre to provincial hospital) expressed a lack of confidence in making an accurate diagnosis for these pig associated zoonoses due to poor diagnostic capability in their respective facilities.

A One Health approach to zoonotic disease surveillance that incorporates trans-disciplinary methods and partnerships will lead to improved understanding of the underlining social determinants of health and their impact on health-seeking behaviours, disease transmission and ultimately disease reporting.

List of Abbreviations

ACIAR – Australian Centre for International Agricultural Research
AES – Acute encephalitic syndrome
AFP – Acute flaccid paralysis
AFI – Acute febrile illness
ASEAN – Association of Southeast Asian Nations
CFT – Complement fixation test
CSF – Cerebrospinal fluid
DAFO – District Agriculture and Forestry Office
DDC – Department of Communicable Disease Control
DHO – District health office
EBS – Event –based surveillance
EIA – Enzyme immunoassay
ELISA – Enzyme – linked immunosorbent assay
EWAR – Early warning alert and response
FAO – Food and Agricultural Organization
FGD/FG – Focus group discussion/focus group
FMD – Foot and mouth disease
FPA – Fluorescence and polarization assay
GDP – Gross domestic product
HCF – Health care facility
HEV – Hepatitis E virus
HH – Household head
HI – Hemagglutination inhibition assay
IBS – Indicator – based surveillance
IDRC – International Development Research Centre
IFA – Immunofluorescence assay
ILRI – International Livestock Research Institute
JE/JEV – Japanese encephalitis or Japanese encephalitis virus
KAP (survey) – Knowledge, attitudes and practices survey
LECS – Lao Expenditure and Consumption Survey
LFA – Lateral flow assay
LPS – Lipopolysaccharide
MDA – Mass drug administration
MoAF/MAF – Ministry of Agriculture and Forestry
MOH – Ministry of Health
NCLE – National Centre for Laboratory and Epidemiology
NEIDCO – National Emerging Infectious Disease Coordinating Office
NSSNSD - National Surveillance System for Notifiable Selected Diseases
OH – One Health
PAFO – Provincial Agriculture and Forestry Office
PCR/ RT-PCR – Polymerase chain reaction/Reverse Transcriptase polymerase chain reaction
PDR – (Lao) People's Democratic Republic
PHO – Provincial health office

PRNT – Plaque reduction neutralization test
PRRS – Porcine reproductive and respiratory syndrome
RNA – Ribonucleic acid
SE Asia – Southeast Asia
SPFL – Severe pulmonary haemorrhagic form of leptospirosis
VHV/VHW – Village health volunteers/workers
WHO – World Health Organization

1 Introduction

A global challenge exists in controlling the burden of zoonotic diseases in human and animal populations. Many of these diseases are endemic throughout the developing world where conditions for transmission are ever present; such as poor sanitation, intensive farming practices and humans living in close proximity with animals; thus contributing to the spread of infectious disease in both animals and humans (Okello, Gibbs, Vandersmissen, *et al.*, 2011). Southeast (SE) Asia carries a large burden of endemic zoonotic diseases, especially in countries where livestock production is a strong source of growth among rural households for income generation and poverty reduction (Costales, 2007). Pig production is an important source of growth among mainly rural households; therefore a number of diseases associated with their production are endemic throughout the region. Their occurrence in humans is dependent on the interaction of a number of factors, such as socioeconomic status, population density, occupation, association with animals, recreational activities, climate and rainfall – essentially interactions between humans, animal hosts, and the environment (Vke, 2011; Victoriano, Smythe, Gloriani-barzaga, *et al.*, 2009). Not only do pig associated zoonoses directly affect animal and human health, it also impacts the export of livestock and associated products, which in turn affects the country's economy and the well being of its people.

Insufficient diagnostic capacity makes accurate diagnosis of etiological agents of infectious diseases extremely difficult in many developing countries. The diagnostic capability simply does not exist or is significantly lacking, leaving a reliance on using a combination of epidemiological surveillance information and broad-spectrum empirical therapy to treat cases (Manock, Jacobsen, de Bravo, *et al.*, 2009). Therefore, it relies strongly on having a robust surveillance program. However, prevalence and incidence information is largely unknown in many resource-poor nations, with estimates based on limited or unreliable data (Crump, Youssef, Luby, *et al.*, 2003). Indeed, limited information is available on pig-associated zoonotic disease prevalence and risk factors for transmission in the Laotian setting. Many of these diseases have similar presentations and are often clinically diagnosed as syndromes such as 'acute febrile illness' or 'acute undifferentiated fever.' Resemblances of one disease with another can lead to incorrect diagnosis and under-reporting of disease, further emphasizing the need for appropriate surveillance systems, as annual incidences could be considerably higher than what is currently reported (Erlanger, Weiss, Keiser, *et al.*, 2009). In the context of Lao PDR, where rice agriculture and pig production systems often coexist and are important for income generation, risk factors for pig-associated zoonoses are present. Briefly, risk factors include consumption and food preparation practices, swine contact (especially in high-risk occupations), and poor sanitation and slaughter practices (Conlan, Khounsy, Inthavong, *et al.*, 2008; Taybouavone, Hai, Odermatt, *et al.*, 2009; Willingham III, De, Doanh, *et al.*, 2003; Tran, Odermatt, Le, *et al.*, 2006; Phongluxa, Xayaseng, Vonghachack, *et al.*, 2013; Bardosh, Inthavong, Xayaheuang, *et al.*, 2014a; Okello, Ash, Keokhamphet, *et al.*, 2014; Conlan, Vongxay, Khamlome, *et al.*, 2012; Choudhury, Conlan, Racloz, *et al.*, 2013). Occupational exposure to infectious material, for diseases such as brucellosis and hepatitis E, is common in abattoir workers and farmers, who are considered high-risk groups. Coupled with a growing demand for and the consumption of meat in SE Asia there is an increasing demand by consumers for food quality and safety, as described by Costales (2007).

This PhD research study will look at a set of pig associated zoonotic diseases with a relevant impact to human and animal health in northern Lao PDR – specifically, hepatitis E, Q fever, brucellosis, and Japanese encephalitis. While the presence of hepatitis E and Japanese encephalitis has been confirmed in Lao PDR, the presence of brucellosis and Q fever is not yet confirmed. Literature on the potential significance of zoonoses, such as brucellosis and Q fever, in pig-rearing systems in Lao PDR is significantly lacking, while the majority of published data on zoonoses, such as hepatitis E and Japanese encephalitis, come from hospital based surveys mostly from the capital, Vientiane (Okello, Burniston, Conlan, *et al.*, 2015). The overall aim of this study is to explore relationships between these diseases and the factors that influence them using a mixed methods approach, in order to aid in the development of strategies to identify and manage zoonotic disease risks.

1.1 Literature review

1.1.1 Q fever

1.1.1.1 Epidemiology and disease burden

Coxiella burnetti is an obligate intracellular bacterium, with a developmental cycle that consists of a spore-like form that is highly resistant to environmental conditions, thus allowing it to survive in the environment whilst remaining virulent (Roest, Bossers, van Zijderveld, *et al.*, 2013; McCaul & Williams, 1981; Munster, Leenders, van der Hoek, *et al.*, 2010). *C. burnetti* is regarded as a biological threat due to its low infectious dose and high transmissibility (Roest, Bossers, van Zijderveld, *et al.*, 2013). Outbreaks of *C. burnetti* have frequently been reported worldwide, in diverse geographic regions and climate zones, classifying it as a public health problem in many developed countries, including France, the Netherlands, Spain, UK, Canada and Australia (Fenga, Gangemi, De Luca, *et al.*, 2015; Carcopino, Raoult, Bretelle, *et al.*, 2009; Tissot-Dupont, 2007, 2004; Van Woerden, 2004; Marrie, 1988; Van den Brom, Schimmer, Schneeberger, *et al.*, 2013; Schimmer, Schotten, van Engelen, *et al.*, 2014; Whitney, Massung, Candee, *et al.*, 2009). Surveillance for the disease, however, is quite poor, particularly in developing countries and the extent of the disease burden is not fully understood. The disease, often referred to as Q-fever, has a wide host range and is more often found in domestic ruminants, particularly cattle, sheep, and goats. It has also been detected in domestic pets, such as cats and dogs (Roest, Bossers, van Zijderveld, *et al.*, 2013; Roest, Tilburg, van der Hoek, *et al.*, 2011), and in pigs, rodents, ticks, arthropods, and other wildlife (Denman & Woods, 2009; Carcopino, Raoult, Bretelle, *et al.*, 2009; Hirai & To, 1998; Lang, 1990; Marrie, Embil & Yates, 1993; Woldehiwet, 2004; Hartzell, Wood-Morris, Martinez, *et al.*, 2008).

The distribution of Q fever in Asia is not fully understood, though the disease has been reported from Thailand, Japan, China, South Korea, and Malaysia (Suputtamongkol, Rolain, Losuwanaruk, *et al.*, 2003; Maurin & Raoult, 1999; Wu, Li, Gu, *et al.*, 2014; Kwak, Chu, Hwang, *et al.*, 2013; Tay, Ho & Rohani, 1998). The disease was recently recognised as a cause of acute fever in northeast Thailand (Suputtamongkol, Rolain, Losuwanaruk, *et al.*, 2003). Laboratory diagnosis of the disease is reportedly not routinely done in South Korea and Malaysia (Kwak, Chu, Hwang, *et al.*, 2013; Tay, Ho & Rohani, 1998). This is likely the case in Lao PDR, as no publications have been found in the literature demonstrating the presence, or lack thereof, of *C. burnetti* in the country in either pigs or humans. The bacteria have been detected in cattle and buffalo in Lao PDR, with particularly high prevalence in Xayabouri province (northern Lao PDR) (Vongxay, Conlan, Khounsy, *et al.*, 2012a; Douangngeun, Theppangna, Soukvilay, *et al.*, 2016). Diagnosis of the disease is quite challenging in resource-poor settings, and further research is required in order to determine its role in febrile illness as a cause of morbidity and mortality in Lao PDR.

1.1.1.2 Transmission and risk factors

Humans typically become infected via inhalation of the bacteria from contaminated dust and aerosols in the environment, mainly related to domestic animal and sometimes companion animal contact (Benenson & Tigertt, 1956; Pinsky, Fishbein, Greene, *et al.*, 1991; Komiya, Sadamasu, Kang, *et al.*, 2003; Komiya, Sadamasu, Toriniwa, *et al.*, 2003). Contamination of the environment usually occurs as a result of abortions in animals, which are associated with significant excretion of the bacteria in placental tissue and birth products; the bacterium has also been detected in urine, faeces, vaginal mucus and milk of infected host animals (Denman & Woods, 2009; Roest, Bossers, van Zijderveld, *et al.*, 2013; Arricau-Bouvery, Souriau, Lechopier, *et al.*, 2003; Berri, Souriau, Crosby, *et al.*, 2001; Guatteo, Beaudeau, Berri, *et al.*, 2006; Rousset, Berri, Durand, *et al.*, 2009; Rousset, Durand, Champion, *et al.*, 2009). It has been suggested that contaminated aerosols can travel up to 5 km in warm and dry weather conditions and infect humans (through inhalation) (Roest, Bossers, van Zijderveld, *et al.*, 2013; Tissot-Dupont, 2004; van Steenbergen, Morroy, Groot, *et al.*, 2007; Schimmer, Ter Schegget, Wegdam, *et al.*, 2010). Direct contact is not necessary for infection to occur. Its ability to be transmitted over large distances also makes diagnosis and identification of the source of infection extremely challenging.

The most common risk factor is living or working with animals, including visiting animal farms, participating in animal birthing (handling birth products), and consumption of unpasteurized milk products (Carcopino, Raoult, Bretelle, *et al.*, 2009; Kwak, Chu, Hwang, *et al.*, 2013). The role of milk consumption in *C. burnetti* transmission is not fully understood however, as there have been cases of asymptomatic seroconversion without any report of clinical illness (Cerf & Condron, 2006). Contact with animals was found to be specifically associated with meningoencephalitis caused by Q fever in a large case series evaluation in France (Raoult, Tissot-Dupont, Foucault, *et al.*, 2000). Although rare, human-to-human transmission is possible, through sexual contact or contact with infected pregnant women during delivery due to aerosolized particles (Raoult & Stein, 1994; Fournier, Marrie & Raoult, 1998; Mann, Douglas, Inglis, *et al.*, 1986). Little is known about vertical transmission from mother to child, but transmission across the placenta, inhaling infected amniotic fluid or through ingestion of infected milk cannot be excluded (Munster, Leenders, van der Hoek, *et al.*, 2010; Raoult & Stein, 1994; Ludlam, 1997).

The presence of C. *burnetti* in swine has not yet been confirmed in most countries, including Lao PDR, but has been detected in pigs in South Korea and Uruguay (Somma-Moreira, Caffarena, Somma, *et al.*, 1987; Seo, Ouh, Lee, *et al.*, 2016). However, the association between swine contact and *Coxiella* infection in humans has been discussed in surveys that investigated the prevalence of *C. burnetti* antibodies among American and Dutch veterinarians (Whitney, Massung, Candee, *et al.*, 2009; Van den Brom, Schimmer, Schneeberger, *et al.*, 2013) and in Dutch cattle farm residents and workers (Schimmer, Schotten, van Engelen, *et al.*, 2014). The survey in the US found 22.2% of veterinarians tested to be seropositive for *C. burnetti* antibody, and highlighted treatment of cattle, swine, and wildlife as risk factors for exposure (Whitney, Massung, Candee, *et al.*, 2009). Both Dutch studies have also indicated pig contact as a risk factor for infection. Although consumption of milk products is quite low within Lao PDR, animal husbandry is a significant income generation activity in the mostly rural country, making animal contact inevitable. A lack of data on the presence of Q fever in Loa PDR inhibits accurate assessment of its risk to animal and human health.

1.1.1.3 Clinical manifestation

The major clinical demonstration of Q fever in humans is an acute self-limiting fever, headache, chills, followed by atypical pneumonia and/or hepatitis; with even less common manifestations of encephalitis/meningitis (Carcopino, Raoult, Bretelle, *et al.*, 2009; Tay, Ho & Rohani, 1998; Roest, Bossers, van Zijderveld, *et al.*, 2013; Suputtamongkol, Rolain, Losuwanaruk, *et al.*, 2003; Lim, Kim, Lee, *et al.*, 2014). With a non-specific and variable presentation, the likelihood of disease incidence and prevalence being underestimated is quite high (Tissot Dupont, 1992; Maurin & Raoult, 1999).

While often asymptomatic in pregnant women (Tissot-Dupont, 2007), Q fever can sometimes result in an adverse maternal outcome, depending on the trimester of infection, and is a noteworthy cause of foetal morbidity and mortality (Carcopino, Raoult, Bretelle, *et al.*, 2009). Pregnant women are the largest risk group, though most remain asymptomatic when infected (Munster, Leenders, van der Hoek, *et al.*, 2010). They also have an increased risk of developing the chronic form of Q fever or to reactivate a past infection (Maurin & Raoult, 1999; Carcopino, Raoult, Bretelle, *et al.*, 2007).

The chronic form of the disease develops in about 1-5% of acute fever cases (Roest, Bossers, van Zijderveld, *et al.*, 2013) and commonly causes endocarditis and vascular infection that is fatal without appropriate treatment (Kwak, Chu, Hwang, *et al.*, 2013). Q fever is reported to affect all ages, though age may play a role in disease complications and outcome, and tends to affect more men than women (Raoult, Tissot-Dupont, Foucault, *et al.*, 2000). The case fatality rate for acute Q fever is fairly low, at about 1-2% overall (Tissot Dupont, 1992; Raoult & Stein, 1994), while the chronic form of the disease has a fatality rate between 2% - 65% (Maurin & Raoult, 1999; Palmer, McCall, Jarvinen, *et al.*, 2007; Pan American Health Organization, 2003). There is also a high incidence of spontaneous abortion, foetal loss, and low birth weight (Manock, Jacobsen, de Bravo, *et al.*, 2009).

The pathogenesis in domestic animals is not fully understood, but is probably affected by the inoculation route. Infection is likely acquired through inhalation, as well as through ingestion, in a heavily contaminated environment. Though commonly asymptomatic, the most important clinical presentation is abortion and stillbirth in pregnant animals, of which the former tends to occur near the end of gestation without any preceding clinical symptoms (Roest, Bossers, van Zijderveld, *et al.*, 2013; Arricau-Bouvery, Souriau, Bodier, *et al.*, 2005). As with humans, the resulting abortions are accompanied by significant excretion of the bacteria in the placental tissue and birth products, and can also be detected in faeces, vaginal mucus and milk of these infected animals (Roest, Bossers, van Zijderveld, *et al.*, 2013; Arricau-Bouvery, Souriau, Lechopier, *et al.*, 2003; Berri, Souriau, Crosby, *et al.*, 2001; Guatteo, Beaudeau, Berri, *et al.*, 2006; Rousset, Berri, Durand, *et al.*, 2009; Rousset, Durand, Champion, *et al.*, 2009). In non-pregnant animals, infection with *C. burnetti* is virtually asymptomatic but can be associated with metritis and reproduction problems (Roest, Bossers, van Zijderveld, *et al.*, 2013).

1.1.1.4 Diagnosis

Q fever diagnosis in humans is generally based on serological methods, such as indirect immunofluorescence assay (IFA), complement fixation test (CFT), or enzyme-linked immunosorbent assay (ELISA), with PCR molecular assays used for confirmation (Herremans, Hogeman, Naubuurs, *et al.*, 2013; Szymańska-Czerwińska, Galińska, Niemczuk, *et al.*, 2013; Panning, Kilwinski, Greiner-Fischer, *et al.*, 2008; Wielders, Kampschreur, Schneeberger, *et al.*, 2012). Culture methods are challenging, time consuming, and generally avoided as the bacteria are hazardous and require the use of a biosafety Level 3 laboratory (Field, Mitchell, Santiago, *et al.*, 2000; Masala, Porcu, Sanna, *et al.*, 2004). Serological diagnosis allows for differentiation between acute, convalescent and chronic *C. burnetti* infection through analysis of antibody patterns, and IFA is commonly used in patient follow-up and identifying those at risk for chronic Q fever (Szymańska-Czerwińska, Galińska, Niemczuk, *et al.*, 2013; Wielders, Kampschreur, Schneeberger, *et al.*, 2012; Anderson, Boyer, Garvey, *et al.*, 2013; Herremans, Hogeman, Naubuurs, *et al.*, 2013; Wegdam‐Blans, Wielders, Meekelenkamp, *et al.*, 2012).

In animals, similar serological methods are also used, though ELISA and IFA are said to be more sensitive than CFT and commonly preferred (Roest, Bossers, van Zijderveld, *et al.*, 2013; Anderson, Boyer, Garvey, *et al.*, 2013; Field, Mitchell, Santiago, *et al.*, 2000; Porter, Caplicki, Mainil, *et al.*, 2011). There is some concern about the effectiveness of serology in diagnosis of abortions at the individual level, as some animals have been reported to shed the bacteria without a detectable serological response (Roest, Bossers, van Zijderveld, *et al.*, 2013; Berri, Souriau, Crosby, *et al.*, 2001; Guatteo, Beaudeau, Berri, *et al.*, 2006; Rousset, Berri, Durand, *et al.*, 2009; Rousset, Durand, Champion, *et al.*, 2009; Anderson, Boyer, Garvey, *et al.*, 2013; Berri, Rousset, Champion, *et al.*, 2007; Guatteo, Joy & Beaudeau, 2012; Rodolakis, Berri, Héchard, *et al.*, 2006). Therefore, the use of serology at the flock or herd-level is preferred to detect infection or exposure within a population of animals (Anderson, Boyer, Garvey, *et al.*, 2013). The bacteria can also be detected in infected animal placenta using immunohistochemistry, and in a wide range of samples – placental, faeces, vaginal mucus, and milk – using PCR (Roest, Bossers, van Zijderveld, *et al.*, 2013). The ELISA is said to be the most sensitive technique for detecting antibodies specific to *C. burnetti*, while PCR is the most sensitive for detecting *C. burnetti* DNA (Jones, Twomey, Hannon, *et al.*, 2010; Roest, Bossers, van Zijderveld, *et al.*, 2013; Anderson, Boyer, Garvey, *et al.*, 2013).

1.1.1.5 Prevention and control

Given that transmission of *C. burnetti* to humans and animals is mainly through inhalation of aerosols, and those at highest risk of infection are those working or living with animals, suitable personal protective equipment is a necessity when handling animals or animal products known to be carriers or infected with the bacteria (Fenga, Gangemi, De Luca, *et al.*, 2015). Pasteurization of milk and milk products is also highly recommended (Anderson, Boyer, Garvey, *et al.*, 2013). Given the nature of *C. burnetti* to survive in the environment, eradication of the bacteria from the environment is near impossible. However, good farm hygiene and management practices can be carried out to reduce environmental transmission, including immediate removal and disposal of aborted foetuses, dead new-borns, placentas and other birth products, manure sterilization/composting and management, disinfection of pathways to pastures, air filtration systems in housing, and movement controls (Anderson, Boyer, Garvey, *et al.*, 2013; Fenga, Gangemi, De Luca, *et al.*, 2015; Georgiev, Afonso, Neubauer, *et al.*, 2013).

Vaccination of humans and animals is another option available in some countries, particularly for those in high-risk occupations or those living in high-risk areas that are at risk of severe complications (Fenga, Gangemi, De Luca, *et al.*, 2015; Roest, Bossers, van Zijderveld, *et al.*, 2013; Parker, Barralet & Bell, 2006). Pre-exposure vaccination of those in high-risk occupations is also carried out routinely in some countries, where its safety and effectiveness has been demonstrated (Reid & Malone, 2004). Several animal vaccines have been developed, mainly for cattle and domestic ruminants (Roest, Bossers, van Zijderveld, *et al.*, 2013). Vaccination, in combination with other control methods, is likely to be most effective.

1.1.2 Brucellosis

Brucellosis is a bacterial disease, caused by species of the genus *Brucella*. It has a worldwide distribution and affects both humans and animals, representing a significant public health concern. The causative organism is recognized as six main species, with two new ones, based on its pathogenicity and host preference – *Brucella melitensis* (most common in sheep and goats), *Brucella abortus* (most common in cattle), and *Brucella suis* (in pigs), *Brucella. ovis*, *Brucella canis*, *Brucella neotomae*, and *Brucella cetaceae* and *Brucella pinnipediae* (Christopher, Umapathy & Ravikumar, 2010). Five of the six main species cause disease in one or more animal hosts (all except *B. neotomae*) and four of these cause human disease (*B. melitensis*, *B. suis*, *B.abortus* and *B.canis* in descending order of pathogenicity) (Corbel, 2006). A unique characteristic of this bacterium is its ability to evade recognition by the host's immune system and proliferate within phagocytic cells (Franco, Mulder, Gilman, *et al.*, 2007).

1.1.2.1 Epidemiology & disease burden

Over the last decade or so, the global epidemiology of brucellosis has drastically changed. Greater than half a million new cases occur annually and incidence rates in some countries exceed 10 cases per 100,000 population (Mantur & Amarnath, 2008). The disease burden is more profound in developing countries, due to a lack of strong and effective public health systems, domestic animal health programs, and appropriate diagnostic facilities (Mukhtar & Kokab, 2008). As it also closely resembles other diseases, brucellosis is likely considerably under-diagnosed and under-reported even in endemic countries. There is a significant need for high quality surveillance and control on brucellosis in countries of the Asia-Pacific, Eastern Europe, Central & South America, and African regions. This need was highlighted in an Egyptian study, where active population-based surveillance on acute febrile illness showed a brucellosis incidence of

70 cases per 100,000 person years – only 5.7% of these cases were detected and reported through the routine hospital-based surveillance system in the same governorate (province), indicating that a reliance on the routine hospital data would have underestimated disease incidence by about 12 – 18 times (Jennings, Hajjeh, Girgis, *et al.*, 2007; Dean, Crump, Greter, *et al.*, 2012b).

As a considerable proportion of the population in developing countries rely on livestock for survival, brucellosis can greatly impact the economic stability of these countries. Disease burden does not exist only in the clinical disease it causes, but also the cost of treatment and work days lost due to illness, and the loss of productivity in animals, which results in a decreased availability of food and, therefore, adversely affects the health and well being of people (Mukhtar & Kokab, 2008). A 2002 review conducted by ILRI of 76 animal diseases and syndromes found that brucellosis lies in the top 20 with regards to its impact on impoverished people (this ranking was based on a composite index developed using scoring criteria for socio-economic and human health impacts of several diseases, including production losses (disease incidence), control costs, effects on marketing opportunities and public expenditure on animal health, disease risk to human populations, and disease severity) (Perry, Randolph, Mcdermott, *et al.*, 2002).

The distribution of brucellosis in South East Asia is not well known, though it has been highlighted as a concern in Thailand, Malaysia, and China (Sam, Karunakaran, Kamarulzaman, *et al.*, 2012; Jama'ayah, Heu & Norazah, 2011; Ekpanyaskul, Santiwattanakul, Tantisiriwat, *et al.*, 2012; Manosuthi, Thummakul, Vibhagool, *et al.*, 2004; Zhong, Yu, Wang, *et al.*, 2013). However, no data has been published on swine brucellosis prevalence in Lao PDR, though the disease has been detected in bovines (Vongxay, Conlan, Khounsy, *et al.*, 2012a; Douangngeun, Theppangna, Soukvilay, *et al.*, 2016). One hospital-based study in Malaysia found 70% of seropositive cases to be veterinarians and farmers. A reliable estimate of DALY parameters has not yet been made available by the WHO for brucellosis, as very little is known about this disease particularly in the Asia-Pacific context. It has been estimated that by achieving a 52% reduction in brucellosis transmission between animals, 51,856 human brucellosis cases could also be averted and 49,027 human DALYs would be gained (Zinsstag, Schelling, Roth, *et al.*, 2007).

1.1.2.2 Transmission & risk factors

The main animal reservoirs of brucellosis are sheep, goats, cattle and pigs. Transmission to humans usually occurs via consumption of unpasteurized dairy products (foodborne), direct contact with infected animals or animal products (such as placentas or aborted foetuses, or excretions in genital discharges) (Dean, Crump, Greter, *et al.*, 2012b), or through inhalation of infectious aerosols (Christopher, Umapathy & Ravikumar, 2010; Dean, Crump, Greter, *et al.*, 2012a). It has been suggested that aerosol inhalation is particularly common in abattoirs during slaughter of infected animals (Corbel, 2006). Consumption of fresh or raw animal products, including meat, certain organs such as the liver, spleen, or kidneys, or blood, has also been implicated in the occurrence of brucellosis infection (Corbel, 2006). Human to human transmission via close personal contact, sexual contact, or through breastfeeding is possible, but quite rare (Corbel, 2006). Additional research is needed on the specific risk factors for *B. suis* transmission from pigs, as transmission through dairy products has not been implicated in Lao PDR (Guerrier, Daronat, Morisse, *et al.*, 2011).

Although generally not age-specific, the disease in humans is primarily an occupational one, affecting those who work with infected animals or animal tissue, such as farmers, shepherds, butchers, abattoir/slaughterhouse workers, meat inspectors, veterinarians, and laboratory workers. Some studies have indicated that animal keepers and slaughterhouse workers are at a particularly high risk due to the amount of time spent with animals, suggesting an association between the nature of the job and seropositivity for brucellosis (Mukhtar & Kokab, 2008; Ramos, Junior, Sobrinho, *et al.*, 2008; Karimi, Alborzi, Rasooli, *et al.*, 2003; Kumar, Singh & Barbuddhe, 1997; Agasthya, Isloor & Prabhudas, 2007). Because of the involvement of animals, it has also been suggested that the rural population is at a higher risk of infection than urban dwellers (Mukhtar & Kokab, 2008; Smits, Basahi, Diaz, *et al.*, 1999). The risk and severity of disease largely depends on the type of *Brucella* an individual is exposed to, which is influenced by the host animal species acting as the source of infection (Corbel, 2006).

Animal to animal transmission occurs mainly through direct contact and environmental contamination following an abortion, but this can vary depending on the host species.

Sexual transmission and/or artificial insemination have also been identified as a mode for transmission (Corbel, 2006). Infection of *B. suis* in pigs tends to occur via ingestion, coitus and contact with mucous membranes (Van Der Giessen & Priadi, 1988). Once the bacteraemic stage is reached, brucellae can be isolated from most tissues in the animal, particularly lymph nodes, making the handling of infected animals quite dangerous and a risk factor for transmission to humans (Van Der Giessen & Priadi, 1988). Animal to animal transmission occurs particularly in herds, due to close contact and significant shedding of organisms into the environment. Susceptibility to brucellosis tends to be greatest in animals that are sexually mature; although young animals tend to be more resistant to infection, latent infections can occur thus presenting a long-term hazard.

1.1.2.3 Clinical Manifestation

In humans, the bacteria causes an acute febrile illness which can progress to chronic granulomatous disease that is capable of infecting any organ and results in clinical morbidity requiring prolonged antibiotic therapy with a combination of drugs (Mukhtar & Kokab, 2008; Pappas, Papadimitriou, Akritidis, *et al.*, 2006; Corbel, 2006). Although rarely fatal, it can be a severely debilitating and disabling. Cases commonly present with intermittent fevers, severe fatigue, weight loss, headache, and joint pain (Dean, Crump, Greter, *et al.*, 2012b). In the absence of treatment, this can persist for weeks to months. Neurological complications (for example, meningitis or meningo-encephalitis), endocarditis, and testicular or bone abscess formation can also occur (Dean, Crump, Greter, *et al.*, 2012b; Corbel, 2006). Approximately 2% of untreated cases result in death (Madkour, 2001).

In animals, symptoms can vary widely depending on the location of the bacteria and stage of infection within a herd. Severity of illness also depends on various factors such as vaccination status, age, sex, and herd or flock size and density. It can include undulant fevers, abortion, premature births, retained placenta, infertility, lameness due to arthritis, or posterior paralysis due to osteomyelitis (Van Der Giessen & Priadi, 1988; Corbel, 2006). As the infection usually establishes itself in the reproductive tract, it frequently results in abortions (Corbel, 2006). Subclinical infections can also occur. Persistent bacteraemia is common in swine and dogs, but more intermittent and of short duration in other species (Corbel, 2006).

1.1.2.4 Diagnosis

Diagnosis of the disease is challenging as a result of the non-specific nature of clinical presentation, slow growth rate in blood culture and complex sero-diagnosis (Christopher, Umapathy & Ravikumar, 2010; Colmenero, Reguera & Cabrera, 1990).

A review on recent trends in lab diagnosis by Christopher et al (2010) provides a descriptive summary of available diagnostic tests, which is recapped as follows: blood culture is the gold standard but is only successful in 40 – 70% of cases; depending on the duration, localization of infection, and type of *Brucella* species (Alikhani, Hashemi, Naseri, *et al.*, 2013). The Biphasic Ruiz – Castaneda system is the traditional method of isolating *Brucella* species in clinical samples (Ruiz, 1954), but has largely been replaced by the centrifugation technique, which provides a higher positivity rate (Gotuzzo, Carrillo, Guerra, *et al.*, 1986). Bone marrow cultures have proven useful when investigating patients with prior antibiotic use. Cultures can also be done from pus, tissue, cerebrospinal fluid (CSF), and pleural/joint/ascetic fluid in order to detect Brucella (Mantur, Biradar, Bidri, *et al.*, 2006).

In the absence of culture, serological diagnosis can be made using agglutination tests, such as the popular Rose Bengal test – used for screening – with confirmation by the serum agglutination test or standard tube agglutination test (SAT). The antiglobulin or Coombs test is complex, but most suitable for confirmation in relapsing and persistent cases. Complement fixation or immunocapture tests can also be used, including the ELISA, fluorescence polarization assay (FPA), immunochromatographic *Brucella* IgM/IgG lateral flow assay (LFA), and the recent *Brucella* Capt BCAP. Corbel (2006) has stated that for animals, serological procedures may be less satisfactory and/or may require some modifications depending on the species being tested. For instance, the ELISA or intradermal skin test is most reliable for brucellosis diagnosis in swine, whereas other tests may prove more useful for diagnosis in cattle, sheep and goats.

1.1.2.5 Prevention & Control

As human exposure and infection is related to contact with infected animals, it would be prudent and more effective to prevent and/or control the disease in animals, as well as a more efficient use of resources. The goal is to reduce exposure and increase the resistance of animals in the population to infection (Corbel, 2006). Careful herd management and hygiene practices, including vaccination use, would aid in the prevention and control of animal brucellosis, however at present there is no effective vaccination for use in swine. Elimination of infected animals is also commonly practiced, but with consideration first given to several factors, including vaccination status of the herd, as immediate slaughter can be expensive and result in significant economic loss to animal keepers. Without due consideration, this could have a potentially negative impact on continued reporting of brucellosis by animal keepers and potentially exacerbate the problem.

Most sources of human infection are related to occupational exposure or consumption of contaminated food products. Therefore, recommended measures for prevention and control of human brucellosis would be the use of protective equipment and clothing while handling infected animal products, such as stillbirths or products of conception. Appropriate disinfection and hygiene practices, and avoidance of the consumption of unpasteurized dairy products and/or raw or undercooked infected meat to prevent or reduce exposure are also recommended.

1.1.3 Hepatitis E Virus (HEV)

Hepatitis E virus is an RNA virus of the family Hepeviridae, genus Hepevirus, and is classified phylogenetically into four genotypes (1-4). The global epidemiology and distribution of the virus has changed significantly over the last few years as a result of its re-evaluation, and is now understood to be far more diverse and widespread than previously thought. It was named ‘Hepatitis E Virus’ due to its enteric route of transmission and tendency to cause epidemics (Aggarwal & Naik, 2009).

1.1.3.1 Epidemiology and disease burden

Large-scale sporadic outbreaks have occurred worldwide – either waterborne epidemics or large foodborne outbreaks of acute hepatitis. HEV is endemic in regions with poor sanitation and hygiene, including parts of Asia, Africa, the Mediterranean and Central and South America (Aggarwal & Naik, 2009; Emerson & Purcell, 2003). However, surprisingly high seropositivity levels exist in some industrialized countries for which the cause is unknown, but zoonotic transmission through contact with or consumption of infected animals/animal products is strongly suspected (Meng, 2010).

Genotype 1 HEV has resulted in human cases of epidemic and sporadic hepatitis E in parts of Asia and Africa, where the disease is known to be endemic, and has also caused disease in travellers to those endemic areas (Aggarwal & Naik, 2009). Genotype 2 was first reported in an outbreak in Mexico and has since been found in Western Africa (Nigeria and Chad) (Aggarwal & Naik, 2009). Both genotypes 1 and 2 are known to be exclusively human pathogens. Genotype 3 was first identified in human cases (locally acquired) in the USA and has since been reported in industrialized countries of Europe, Japan, Australia and New Zealand with some cases in Korea and Argentina (Aggarwal & Naik, 2009). Genotype 4 has been reported to cause sporadic cases in Central Europe and East Asia (China, Taiwan, Japan and Vietnam) (Aggarwal & Naik, 2009; Mirazo, Ramos, Mainardi, *et al.*, 2014), and more recently in Lao PDR (Conlan, Jarman, Vongxay, *et al.*, 2011). A zoonotic reservoir for genotypes 3 and 4 has been implicated through the detection of anti-HEV antibodies in domestic and wild pigs and other animal species (Figure 1-1).

HEV strains	Natural hosts	Experimental hosts
Genotype 1	Humans	Non-human primates, rats, lambs
Genotype 2	Humans	Non-human primates
Genotype 3	Humans, pigs, deer, mongoose, horse (?)	Non-human primates, pigs
Genotype 4	Humans, pigs	Non-human primates, pigs
Avian HEV	Chickens	Turkeys, chickens

Figure 1-1 Host range and cross-species infection of HEV under natural and experimental conditions (Meng, 2010)

The highest attack rate appears to be in young adults, though seropositivity is age-dependent and seems to increase with age (Meng, 2010). Young males are more often affected than females, suggesting an association between profession and social activities with greater exposure (Balayan, 1997), particularly with genotypes 1 and 2 (Aggarwal &

Naik, 2009). Middle-aged or elderly persons are more commonly affected by genotypes 3 and 4 (Aggarwal & Naik, 2009). In SE Asia, the disease is generally reported in rural rather than urban areas.

Evidence of naturally occurring antibodies to HEV has also been found in several animals – such as pigs, cattle, sheep, goats, horses, macaques, cats, dogs, rats and mice (Aggarwal & Naik, 2009; Emerson & Purcell, 2003; Meng, 2010) – but appears to be more common in pigs. Often referred to as 'swine HEV,' it is spread worldwide in both developing and developed countries regardless of whether HEV is endemic in the respective human population (Meng, 2010). Genotypes 3 and 4 strains of swine HEV have been found to be genetically similar, and in some cases identical, to human HEV genotypes 3 and 4 providing evidence for zoonotic HEV transmission (Cooper, Huang, Batista, *et al.*, 2005; Meng, 2010). Infection typically occurs around 2-3 months of age and causes a short-lived viraemia for 1-2 weeks with virus shedding in faeces for approximately 3-7 weeks (Meng, 2010), and generates antibodies that cross-react with human HEV strains (Aggarwal & Naik, 2009).

In Lao PDR, the disease was reported in humans in a hospital based seroprevalence survey in the capital city, Vientiane (Syhavong, Rasachack, Smythe, *et al.*, 2010). While in pigs, high prevalence has been reported in northern Laos (Conlan, Jarman, Vongxay, *et al.*, 2011; Blacksell, Myint, Khounsy, *et al.*, 2007; Conlan, Vongxay, Jarman, *et al.*, 2012). The latest Global Burden of Disease study has also demonstrated that 3,715,000 DALYs are lost globally due to acute hepatitis E (Murray, Vos, Lozano, *et al.*, 2012).

1.1.3.2 Transmission & Risk factors

Genotypes 1 and 2 generally cause large waterborne outbreaks in humans, while genotypes 3 and 4 are primarily zoonotic with occasional human infection from multiple routes of transmission (Hinjoy, Nelson, Gibbons, *et al.*, 2012; Drobeniuc, Favorov, Shapiro, *et al.*, 2001). These genotypes can independently co-circulate and cause infection exclusively in humans or animals.

Swine-related occupations incur a greater risk of human HEV infection (Hinjoy, Nelson, Gibbons, *et al.*, 2012; Meng, Wiseman, Elvinger, *et al.*, 2002). A high prevalence of antibodies has been reported in domestic and wild pigs, suggesting that they may be enzootic reservoirs (Drobeniuc, Favorov, Shapiro, *et al.*, 2001). An additional important risk factor, and a practice that occurs in Lao PDR, is the consumption of raw or undercooked pig organ meat. It has been suggested that infection of farmers can also occur from direct contact with HEV infected pigs (Hinjoy, Nelson, Gibbons, *et al.*, 2012), but this may be out-weighed by the practice of eating raw meat.

Waterborne transmission is well recognized and is the most common route of infection, particularly for genotypes 1 and 2. Villages or areas located along rivers and streams generally depend on them for water related hygiene and sanitation activities and drinking water. Therefore they are at high risk for infection as a result of continuous contamination of water resources. This has been associated with recurrent epidemics of hepatitis E in South East Asia (Corwin, Tien, Bounlu, *et al.*, 1999; Corwin, Putri, Winarno, *et al.*, 1997; Labrique, Thomas, Stoszek, *et al.*, 1999). Periodic flooding also plays an important role in the occurrence of epidemics as it contributes to the contamination of water resources with sewage. Boiling of drinking water has, therefore, been shown to be a protective factor. On the other hand, sporadic cases that occur less frequently tend to result from food-borne outbreaks, while endemic cases occur throughout the year usually as a result of large waterborne outbreaks in the rainy season (Balayan, 1997). In a study of people living in northern Thailand, poor hand washing practices and flooding during the rainy season was associated with HEV infection (Hinjoy, Nelson, Gibbons, *et al.*, 2012).

Transmission of swine HEV is presumed to occur by the faecal-oral route. Direct contact with infected pigs or ingestion of faeces contaminated feed or water have been suggested as sources of infection (Bouwknegt, Frankena, Rutjes, *et al.*, 2008), however other routes have not been ruled out. The use of pig manure can lead to contamination of water resources (either river or coastal or irrigation sources) and, therefore, of vegetable/produce or shellfish.

1.1.3.3 Clinical manifestation

Clinical presentation and severity of illness varies in different species. A Japanese study found that genotypes 3 and 4 seem to be less pathogenic in humans compared with genotypes 1 and 2; with genotype 4 being associated with more severe disease than genotype 3 (Mizuo, Yazaki, Sugawara, *et al.*, 2005). The incubation period in humans typically ranges between 2-10 weeks (Aggarwal & Naik, 2009; Meng, 2010), and clinical illness is generally dose-dependent. The virus commonly causes a self-limiting acute viral hepatitis but can develop into severe disease with fulminant hepatitis or acute liver failure and result in death (Conlan, Jarman, Vongxay, *et al.*, 2011; Balayan, 1997; Aggarwal & Naik, 2009). The incidence of fulminant hepatitis for all jaundiced cases in SE Asia has been reported as high as 12% (Tandon, Joshi, Jain, *et al.*, 1982; Balayan, 1997). Epidemic cases can also present with jaundice, anorexia, hepatomegaly, abdominal pain or tenderness, nausea, vomiting, and fever. Severity of disease tends to depend on age and presence of pre-existing conditions. Pregnant women are prone to more severe disease, having the highest rate of fulminant hepatitis and a case fatality rate of 20-30%, sometimes as high as 40% particularly in advanced stages of pregnancy (Balayan, 1997; Labrique, Sikder, Krain, *et al.*, 2012). In the general population, the case fatality rate can range between 0.5 to 4% (Aggarwal & Naik, 2009). Although illness usually lasts for a few weeks it can be prolonged in some cases. Asymptomatic or sub-clinical infections have also been detected and do commonly occur. However, chronic infections have only been documented in transplant recipients who receive immunosuppressive drugs (Aggarwal & Naik, 2009), and have not been shown in other populations.

Naturally infected pigs are generally asymptomatic with no signs of disease – but exhibit microscopic evidence of mild hepatitis (Aggarwal & Naik, 2009; Halbur, Kasorndorkbua, Gilbert, *et al.*, 2001).

1.1.3.4 Diagnosis

HEV diagnosis in humans is primarily based on serological tests using ELISA to detect anti-HEV IgM or rising IgG titres to determine acute infection, and reverse transcriptase polymerase chain reaction (RT-PCR) to detect virus RNA (Meng, 2010; Syhavong, Rasachack, Smythe, *et al.*, 2010). Since swine infection is subclnical, serology as well as RT-PCR (on faeces) is performed for diagnosis in pigs (Meng, 2010). Swine HEV and human HEV genotypes 3 and 4 are genetically indistinguishable, therefore, a specific diagnostic assay to differentiate between them is not necessary (Cooper, Huang, Batista, *et al.*, 2005; Meng, 2010).

1.1.3.5 Prevention & Control

Key measures for the prevention of HEV infection consist of proper treatment and safe disposal of excreta, the provision of safe drinking water supply or boiling/chlorination of water, and the improvement of personal hygiene practices. In addition, sanitary food practices and avoidance of the consumption of uncooked or undercooked meat are also important in preventing HEV infection. Vaccination is another potentially key prevention method now that the State Food and Drug Administration of China has approved the HEV 239 vaccine for production and sale (Labrique, Sikder, Krain, *et al.*, 2012). Vaccine efficacy has been reported at >99% in persons who completed a 3-dose series (Zhu, Zhang, Zhang, *et al.*, 2010), but this has yet to be tested on pregnant women. The vaccine has been tested where genotypes 3 and 4 are prevalent and has yet to be tested in areas where genotype 1 prevails. However, the vaccine contains a capsid protein that was derived from the genotype 1 Burma reference strain (Labrique, Sikder, Krain, *et al.*, 2012), so it is possible that its effectiveness will overlap both genotypes.

1.1.4 Japanese encephalitis

Japanese encephalitis (JE/JEV) is a vector-borne viral disease that is endemic in many tropical and temperate parts of Asia and the Pacific (Erlanger, Weiss, Keiser, *et al.*, 2009). The disease has been classified as an emerging disease because of the failure to halt the spread of JEV in Asia and the Pacific despite the availability of an effective and inexpensive vaccine (Erlanger, Weiss, Keiser, *et al.*, 2009). Only recently has its importance been brought to general attention with the occurrence of large outbreaks in parts of India and Nepal (Wong, Ooi, Abdullah, *et al.*, 2008).

1.1.4.1 Epidemiology and disease burden

JE has an estimated global annual incidence of approximately 35-50,000 human cases, and annual mortality of 10-15,000 deaths (Vallée, Dubot-Pérès, Ounaphom, *et al.*, 2009; Erlanger, Weiss, Keiser, *et al.*, 2009). Under reporting is substantial in many JE endemic countries, given a reliance on clinical diagnosis in the absence of laboratory testing and varied levels and quality of disease surveillance, suggesting that these numbers are likely to be significantly higher (Campbell, Hills, Fischer, *et al.*, 2011).

Campbell et al (2011) have estimated that approximately 67,900 cases of JE occur annually in 24 JE endemic countries (including Lao PDR, Cambodia, China, Japan, Nepal, etc.), with an overall incidence of 1.8 per 100,000. Furthermore, approximately 75% (51,000) of these cases occur in children aged 0-14 years, with an estimated overall annual incidence of 5.4 per 100,000 (Campbell, Hills, Fischer, *et al.*, 2011). JE is the leading cause of viral encephalitis in Asia with particular impact on children aged 1-15 years (Impoinvil, Baylis & Solomon, 2012). Nearly half the global human population lives in countries where JE occurs (Erlanger, Weiss, Keiser, *et al.*, 2009), putting an estimated 3 billion people at risk. There is concern regarding the future of JE, which could consist of increasingly frequent and/or more severe outbreaks.

The prevalence of JE is relatively high in South East Asia where the virus has been detected in humans and animals in Malaysia, Indonesia, Cambodia, Philippines, Singapore, Thailand and Vietnam[1]. In Lao PDR, the disease has been reported in humans in a hospital-based survey in Vientiane capital, and in 2 community-based surveys in Vientiane and the Nakai Plateau. Meanwhile, animal infection has been reported in 4 northern provinces of the country (Conlan, Vongxay, Jarman, *et al.*, 2012; Hiscox, Winter, Vongphrachanh, *et al.*, 2010; Moore, Blacksell, Taojaikong, *et al.*, 2012; Vallée, Dubot-Pérès, Ounaphom, *et al.*, 2009). Although a DALY estimate has not been reported specifically for JE, the 2010 Global Burden of Disease study has demonstrated 9, 563 000 and 7, 141 000 DALYs are lost globally due to meningitis (other than pneumococcal meningitis, *Haemophilus influenzae* type B meningitis and meningococcal infection) and encephalitis of an infectious cause, respectively (Murray, Vos, Lozano, *et al.*, 2012).

[1] (Chhour, Ruble, Hong, *et al.*, 2002; Duong, Sorn, Holl, *et al.*, 2011; Srey, Sadones, Ong, *et al.*, 2002; Touch, Hills, Sokhal, *et al.*, 2009; Touch, 2009; Kari, Liu, Gautama, *et al.*, 2006; Konishi, Sakai, Kitai, *et al.*, 2009; Liu, Gibbons, Kari, *et al.*, 2010a; Ompusunggu, Hills, Maha, *et al.*, 2008; Conlan, Vongxay, Jarman, *et al.*, 2012; Hiscox, Winter, Vongphrachanh, *et al.*, 2010; Moore, Blacksell, Taojaikong, *et al.*, 2012; Vallée, Dubot-Pérès, Ounaphom, *et al.*, 2009; Kilbourn, Karesh, Wolfe, *et al.*, 2003; Ooi, Lewthwaite, Lai, *et al.*, 2008; Wong, Ooi, Abdullah, *et al.*, 2008; Inoue, Morita, Matias, *et al.*, 2003; See, Tan, Wang, *et al.*, 2002; Ting, Tan, Wong, *et al.*, 2004; Olsen, Supawat, Campbell, *et al.*, 2010; Tiawsirisup & Nuchprayoon, 2010; Watt & Jongsakul, 2003; Solomon, 2008; Dung, Turtle, Chong, *et al.*, 2009; Solomon, Dung, Wills, *et al.*, 2003; Lindahl, Boqvist, Ståhl, *et al.*, 2012; Solomon, Dung, Kneen, *et al.*, 2002; Yen, Duffy, Hong, *et al.*, 2010; Le, Phan, Do, *et al.*, 2010)

1.1.4.2 Transmission and risk factors

Transmission of JE involves the interaction of multiple factors – the environment, domestic and wild birds, and humans (Impoinvil, Baylis & Solomon, 2012). More of a problem in rural settings, the disease is associated with rice agriculture and pig farming. The vector responsible for transmitting the virus is from the *Culex vishnui* subgroup, particularly *Culex tritaeniorhynchus* (van den Hurk, Ritchie & Mackenzie, 2009; Vallée, Dubot-Pérès, Ounaphom, *et al.*, 2009), considered as the primary vector. However, the main species responsible for JE infections can vary in different countries (Hassan et al, 2010). This rice-field-breeding mosquito is abundant and important in maintaining a zoonotic cycle of transmission between its species and ardeid wading birds and/or pigs (van den Hurk, Ritchie & Mackenzie, 2009). The occurrence and abundance of virus-competent mosquito populations, which is influenced by temperature and rainfall, is the principal risk factor for transmission of mosquito-borne diseases (Impoinvil, Baylis & Solomon, 2012). Humans typically become infected following the onset of the monsoon rain season in summer, due to prolific growth in the mosquito population with high JE infection rates as well as high infection rates in pigs (Impoinvil, Baylis & Solomon, 2012).

Wading waterfowl, such as wild ducks, herons, and egrets, have been implicated in the transmission of JE. It has been suggested that these birds act as natural maintenance and dissemination hosts, whose migration patterns seem to coincide with seasonal JE epidemics in temperate environments such as Japan, China, and Korea (Impoinvil, Baylis & Solomon, 2012). Therefore, they are considered primary enzootic hosts of JEV, and play a role in epizootic viral amplification in some areas (van den Hurk, Ritchie & Mackenzie, 2009). They may also introduce new strains of the virus into an area, but likely play more of a maintenance role with circulating strains as a means of overwintering (Chen, Tesh & Rico-hesse, 1990).

A feature of the physical environment that contributes to the JEV transmission cycle is the practice of rice agriculture. Studies have shown a link between the proximity to irrigated rice fields and JE transmission (Impoinvil, Baylis & Solomon, 2012; Liu, Gibbons, Kari, *et al.*, 2010a). As mosquitoes lay their eggs and undergo larval development in rice fields, where waterfowl also forage, these sites become an important environmental avenue for pathogen transmission to occur.

Pigs are the primary amplifying hosts because they have a high natural infection rate, high viremia, a high birth rate (acting as a source of susceptible pigs), and a propensity for vector mosquitoes to feed on them (Scherer, Kitaoka, Okuno, *et al.*, 1959). They can also act as maintenance hosts in endemic areas (van den Hurk, Ritchie & Mackenzie, 2009). Although pigs are required for pre-epizootic amplification of the JE virus, some epidemics do occur in the absence of high pig populations (Soman, Rodrigues, Guttikar, *et al.*, 1977). During times of peak transmission, virus amplification in susceptible pigs kept in close proximity to human inhabitants usually precedes epidemic transmission to humans – a phenomenon sometimes referred to as the spill over effect. Therefore, where pig husbandry and rice production systems co-exist, there is a significant impact on transmission of JE. A recent study in Japan has also identified the occurrence of vector-free transmission, via the oro-nasal route, and persistence of JE in pigs in an experimental setting, though the process does not seem to be as efficacious as vector transmission of the virus (Ricklin, García-Nicolás, Brechbühl, *et al.*, 2016).

1.1.4.3 Clinical manifestation

The first confirmed human case of JE in Lao, PDR was reported in 1989 (Vongxay, 1995), but no systematic surveillance has been conducted to date (Hiscox, Winter, Vongphrachanh, *et al.*, 2010). Humans are considered ‘dead-end’ hosts from which transmission does not occur. Clinical presentation can vary from non-specific flu-like symptoms (fever, malaise, nausea, vomiting, etc.) to febrile seizures, severe encephalitis, meningitis, and acute flaccid paralysis. (Liu, Ding, Yen, *et al.*, 2010; Solomon, Kneen, Dung, *et al.*, 1998). While many cases of JE are asymptomatic, of those who do present with encephalitis 25-30% of cases are fatal, and half of the survivors are left with severe neurological sequelae (Solomon, Dung, Kneen, *et al.*, 2000; Mackenzie, Gubler & Petersen, 2004).

There is no evidence of adverse effects or clinical disease in mosquito vectors or water birds involved in transmission of JE. Although rare, it is characterized by reproductive disease in pigs and is most commonly associated with foetal abortion and birth of stillborn or mummified foetuses (usually at term) in sows and aspermia in boars (Impoinvil, Baylis & Solomon, 2012; van den Hurk, Ritchie & Mackenzie, 2009). Piglets that are born alive typically do not survive (Impoinvil, Baylis & Solomon, 2012). Non-pregnant animals are usually asymptomatic, but can experience febrile illness and symptoms of encephalitis (occasionally seen up to 6 months of age) (Impoinvil, Baylis & Solomon, 2012).

1.1.4.4 Diagnosis

The most common methods used to diagnose JE in humans are IgM MAC ELISA, usually in conjunction with an IgG ELISA, to test for Dengue virus and JE at the same time due to cross-reactivity (Vallée, Dubot-Pérès, Ounaphom, *et al.*, 2009; Wong, Ooi, Abdullah, *et al.*, 2008; Liu, Ding, Yen, *et al.*, 2010; Kari, Liu, Gautama, *et al.*, 2006). This is the reference method, while other commercial ELISAs have also been used to diagnose JE in Asia. In addition, IgM & IgG enzyme immunoassays (EIA), virus isolation, RT-PCR, hemagglutination inhibition (HI) assay, and plaque reduction neutralization test (PRNT) have also been used. Similar serological methods have been used to determine disease prevalence in animals and vectors.

1.1.4.5 Prevention & control

Measures currently available are human and swine vaccination, changes in animal husbandry practices, and/or vector control programs. Issues with adopting solitary control measures suggest that an interdisciplinary approach is necessary in order to decrease transmission of this devastating disease.

The vaccine currently available (inactivated cell-culture based vaccine) for humans is relatively safe and effective but requires more than one dose. Therefore, issues with compliance and delivery costs can be a problem in poor, rural communities. A live attenuated vaccine is also available in several Asian countries and has been stated to require only one dose (PATH, 2010). Two other new vaccines are also being developed and it is believed they will help improve immunization compliance (Erlanger, Weiss, Keiser, *et al.*, 2009). Mayxay et al (2013a) report that vaccination against JE is not only likely to reduce the incidence of encephalitis, death and disability, but also of undifferentiated fever and, thereby, the key economic issues of health care expenditure and resultant loss of work. A live attenuated vaccine for pigs is currently available, but has not proved to be useful in preventing transmission to humans. Given that most pigs are slaughtered at 6-8 months of age, vaccination of new-borns would be necessary. Maternal antibodies in new-born pigs last approximately two to six months, rendering the vaccine ineffective in pigs less than six months of age (Conlan, Vongxay, Jarman, *et al.*, 2012; van den Hurk, Ritchie & Mackenzie, 2009).

A variety of vector control methods have also been tested in an attempt to decrease the transmission of JE, including pesticide use and insecticide spraying of rice fields, and the use of pyrethroid impregnated bed nets. Previous studies have shown insecticide treated bed nets to be successful in reducing the incidence of JE in humans and decreased the risk of infection in children <10 years of age (Dutta, Khan, Khan, *et al.*, 2011; Dapeng, Renguo, Jinduo, *et al.*, 1994; Dapeng, Konghua, Jinduo, *et al.*, 1994). Research has shown that an integrated vector control approach with alternating wet and dry irrigation, to reduce mosquito populations, is necessary if vaccination coverage is low in endemic rural settings (van den Hurk, Ritchie & Mackenzie, 2009). Environmental management using alternative pig husbandry practices have also been shown to decrease transmission (Gresser, Hardy, Diseases, *et al.*, 1958). This can include penning or stabling animals in screened barns, using barn fans, rearing pigs away from hosts (human and/or horse), and intermittent irrigation (Impoinvil, Baylis & Solomon, 2012). While these methods can be quite effective, they are not practical in all settings.

The most promising strategy would likely be a combination of human vaccination, vector control, and environmental management (i.e. alternative pig husbandry practices) to interrupt contact with the mosquito vector and prevent disease in humans and animals. Since JE is more of a rural disease associated with rice and pig farming, modernization of agricultural practices and land development is also likely to be potent in eliminating transmission of JEV (Impoinvil, Baylis & Solomon, 2012).

1.1.5 Syndromes associated with the study diseases

1.1.5.1 Acute febrile illness

Acute febrile illness (AFI) comprises many different symptoms, though is typically defined as patients experiencing acute fever (38 degrees Celsius or higher) of specific duration (8-15 days or less/ > 48 hours) with no obvious cause and who are eligible for malaria diagnostic testing by national standards. A sudden onset of high fever, chills, and headache is a common feature of several diseases endemic to SE Asia, and most often these diseases are neither easily distinguished from each other nor from malaria (Suttinont, Losuwanaluk, Niwatayakul, *et al.*, 2006).

It has previously been suggested that febrile illnesses caused by infections other than malaria are major, uncounted and neglected causes of morbidity and mortality (Acestor, Cooksey, Newton, *et al.*, 2012; Black, Cousens, Johnson, *et al.*, 2010). Despite causing a higher mortality globally, even in malaria endemic countries, the allocation of resources to understanding and managing these pathogens is limited (Acestor, Cooksey, Newton, *et al.*, 2012; Black, Cousens, Johnson, *et al.*, 2010; WHO, 2011a). The resultant lack of data on these causative agents restricts the ability of health care services to provide adequate care for affected patients. In much of Southeast Asia, malaria is a relatively minor and reducing contributor to mortality (Acestor, Cooksey, Newton, *et al.*, 2012), although it still remains a public health concern due to the risk of resurgence and emergence of resistance. This is due, in part, to negative malaria results in patients presenting with undifferentiated fever requiring malaria rapid diagnostic tests or microscopy; therefore, suggesting that other pathogens are responsible (Acestor, Cooksey, Newton, *et al.*, 2012). Similarly in Lao PDR, malaria incidence is falling and transmission is heterogeneous between regions with northern areas having a lower incidence than southern Lao PDR (Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013a; White, Newton, Maude, *et al.*, 2012b). With the increased use of rapid diagnostic tests for malaria it is becoming clear that suspected cases of malaria are indeed negative for the disease.

Evidence in the literature has shown a significant lack of information regarding other potential causative agents of febrile illnesses in Lao PDR (including non-zoonotic agents), with at least 50% of published data on disease incidence coming out of Thailand, followed by Vietnam (~ 27%) (Acestor, Cooksey, Newton, *et al.*, 2012). Information that does exist on fever epidemiology and management in the country appears to come mainly from the capital city, Vientiane (Acestor, Cooksey, Newton, *et al.*, 2012; White, Newton, Maude, *et al.*, 2012b). Given the ethnic and geographical diversity in the country, aetiologies of fever are likely to be different outside of the capital. This is evident in two published studies looking at non-malarial fever in Lao PDR where notable differences in the cause of disease between regions was evident, requiring a more spatially explicit treatment protocol in order to facilitate appropriate treatment of cases (White, Newton, Maude, *et al.*, 2012b; Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013a). Mayxay et al (2013a) found that leptospirosis and JE to be common in the north, while dengue and malaria are more common in the south. A wide range of other non-malarial causes of febrile illness have also been described, such as scrub typhus, murine typhus, typhoid, etc., which are often indistinguishable from malaria as well.

Co-infections have also been reported, such as JE/dengue and scrub typhus, JE and influenza, dengue and leptospirosis etc. (Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013a; Mayxay, Sengvilaipaseuth, Chanthongthip, *et al.*, 2015), however, the frequency or extent of this occurrence is not fully understood. It is likely to be high as the environment is such that exposure to multiple pathogens is quite common. Conversely, diagnostics for some of these diseases is not possible outside of the capital, Vientiane. At all levels of health care in the country, diagnostic capacity is limited leaving most diagnoses to be made clinically. This leaves health care providers in predominantly rural areas to diagnose and treat patients based on clinical knowledge and experience. Thus, knowledge of local pathogens and disease patterns is critical for accurate decision-making. This presents a challenge even for health services in developed countries that struggle to find the specific aetiology for acute febrile illnesses that have been acquired in the tropics (Doherty, Grant & Bryceson, 1995; Freedman, Weld, Kozarsky, *et al.*, 2006).

Targeted research is needed in Lao PDR to understand the aetiologies of fever, define their degree of heterogeneity and the environmental and human determinants in order to inform health policy (Acestor, Cooksey, Newton, *et al.*, 2012; White, Newton, Maude, *et al.*, 2012b). Research is also needed on the impact of these diseases on households, particularly in rural areas where it is likely to be substantial. A study in Cambodia, a country with twice the population as Lao PDR but also with a predominantly rural population, found the financial impact of dengue and other febrile illnesses to have a substantial impact on households in rural areas (Huy, Wichmann, Beatty, *et al.*, 2009).

1.1.5.2 Acute Jaundice Syndrome

Acute jaundice is often described as the acute onset of jaundice accompanied by severe illness and, like AFI, has multiple and varied potential aetiologies. There is little information on the diverse infectious causes of jaundice in Southeast Asia. In the case of Lao PDR, indeed very few studies have been published on the aetiology of jaundice and/or liver impairment with those that do exist emerging mainly out of the capital city, Vientiane (Lozano, Naghavi, Foreman, *et al.*, 2012; Murray, Vos, Lozano, *et al.*, 2012). The absence of supportive laboratory diagnosis, in most parts of Lao PDR, makes distinctions between viral and bacterial aetiologies of acute jaundice and hepatitis alone extremely unlikely. Hence, the true burden of the causative agents of acute jaundice syndrome is unknown. The Global burden of disease (GBD) study estimates that in the case of hepatitis as a cause for acute jaundice, mortality caused by hepatitis was 307,700 (ranging between 268,200–356,500) worldwide in 2010 (Pozio & Murrell, 2006). Of these, approximately 56, 600 deaths (range 23,300 – 113,300) were caused by acute hepatitis E (Pozio & Murrell, 2006). Meanwhile estimated DALYs lost due to hepatitis was approximately 13,258,000 (11,364,000–15,855,000) or 192 (165–230) per 100,000 (Macpherson, 2005).

1.1.5.3 CNS Infections

Similarly, causes of central nervous system (CNS) infections are numerous and can vary over time, by geographic region, with age, co-morbidities, vaccination programs, and routes of pathogen transmission (Lu, Huang, Chang, *et al.*, 2002; Peltola, 2000; Solomon, 2004). They have a high morbidity and mortality and often result in long-term neurological and psychiatric sequelae. According to the WHO, there were approximately 700,000 episodes of meningitis in 2004 and 70% of these lived in Africa and SE Asia (WHO, 2008). In a hospital-based survey on the aetiology of CNS infections in Vietnam, the case fatality rate (CFR) was 12% in adults and 7% in children, but varied widely depending on the underlying pathogen (Trung, Le Thi Phuong, Wolbers, *et al.*, 2012). Trung, NHD et al (2012) also found that viral encephalitis affected 70% of paediatric patients with CNS infections, compared to 34% in adult infections. In the same study, in patients with clinical encephalitis, JEV was the most common pathogen encountered, and was responsible for 33% of paediatric viral encephalitis/meningitis cases (24% of all viral encephalitis/meningitis cases). Other studies have suggested that in developing countries, such as Lao PDR, the combined mortality rates of all causes of bacterial meningitis are likely to be greater than 20% (Durand, Calderwood & Weber, 1993) . The 2010 Global Burden of Disease study has estimated that 9,563,000 and 7,141,000 DALYs are lost globally due to meningitis (other than pneumococcal meningitis, *H. influenzae* type B meningitis and meningococcal infection) and encephalitis of an infectious cause, respectively (Murray, Vos, Lozano, *et al.*, 2012).

Knowledge of the aetiological agents of CNS infections is critical in order to guide empirical therapy of cases. Rapid and early diagnosis is key to patient outcome. Again, however, identification of these causal agents is limited in many developing countries. The widespread use of antibiotics prior to presentation to a health care facility is common practice and another key problem. As mentioned previously, conventional bacteriological and molecular microbiological diagnostic facilities are generally confined to the capital, Vientiane, and the use of antibiotics prior to presentation or testing is common practice (Khennavong, Davone, Vongsouvath, *et al.*, 2011). Effective surveillance is extremely challenging in resource-poor settings, such as rural Lao PDR, due to the lack of appropriate laboratory diagnostic capability (Elliott, Dittrich, Paris, *et al.*, 2013). This is evident by the lack of published literature on the aetiology of CNS infections in the country, apart from a diagnostic evaluation study using PCR for diagnosis of bacterial meningitis (Elliott, Dittrich, Paris, *et al.*, 2013).

1.2 Thesis structure

Chapter 2 – provides country profile information on Lao PDR, including people and population characteristics, socio-demographic and socio-economic details. Information on health system infrastructure, surveillance and reporting, veterinary services, and diagnostic capacity for both human and animal health within the country will also be discussed. Pig production and management currently employed in the country will also be described; in addition to a brief overview of the 2011 ILRI/ACIAR collaborative survey that has influenced this PhD research, followed by a rationale for conducting this research, and outline of study aims and objectives.

Chapter 3 – primarily using secondary data sources, this chapter provides a qualitative and quantitative analysis and summary of the 2011 ILRI/ACIAR Serosurveillance study in humans and pigs, supplemented by Lao PDR national surveillance data, and reported data from other organizations (where available).

Chapter 4 – is a qualitative assessment and analysis of the level of knowledge and awareness, and practices of villagers in northern Lao PDR with regards to the pig-associated zoonotic diseases and their risk factors. Using focus group methodology, this study specifically looks at the socio-cultural factors that influence behaviour and thereby impact disease transmission and burden.

Chapter 5 – is an assessment of health seeking behaviour, at the hospital/health centre and village level, using semi-structured interviews to look at factors that influence people's choice of health care provider. It also attempts to determine the impact of health seeking behaviour on duration of illness and cost for treatment.

Chapter 6 – is a health care provider and service delivery assessment using semi-structured interviews to determine health centre/hospital routine service delivery procedures and assess preparedness in dealing with patients presenting with the study diseases and/or syndromes. It will also explore other, non-conventional, sources of health care to further understand health seeking behaviour and influences on the choice of health care provider.

Chapter 7 – Discussion

Chapter 8 – Conclusion

2 Study Area & Design

2.1 Lao PDR: Country Profile

2.1.1 Area and population

The Lao People's Democratic Republic (PDR), also referred to as Laos, is a landlocked country situated in the Mekong Region. Lao PDR is surrounded by 5 countries; China, Thailand, Vietnam, Cambodia, and Myanmar. The country's main river, the Mekong, forms a large part of the border between Lao PDR and Thailand (Kaufmann, Marchesich & Dop, 2003). Lao PDR is divided into 17 provinces and one prefecture, Vientiane City, the capital (Figure 2-1). Northern Lao PDR is made up of steep mountain ranges that are mostly covered by forests, while the central region is known for its extensive caves and limestone landscapes, and the south is dominated by the Mekong delta and includes most of the country's population and agriculture (Japan International Cooperation Agency, 2013).

Figure 2-1: Map of Lao PDR (courtesy of www.emapsworld.com); study provinces in red circles

In 2014, the population of Lao PDR was estimated at 6.7 million in 2014, with annual population growth estimated at about 1.6% (The World Bank, 2016b). The average life expectancy at birth was 68 years in 2013, an increase from 65 years in 2010 (Lao PDR National Statistics Bureau, n.d.; WHO, 2011b; The World Bank, 2016b). The population is characterised as quite young, with 50% being under 20 years of age according to the 2005 population census (MoPI - Dept. of Statistics, 2005). In 2013, approximately 36.5% of the Lao population lived in urban areas (UNICEF, 2014), and the annual urban population growth was about 5% in 2014 (The World Bank, 2016b). Most of Lao PDR is still rural, with people inhabiting mountainous, hard-to-reach areas with little access to basic infrastructure and services (WHO, 2011b). As demonstrated by the 2010/2011 Lao agricultural census, access to safe drinking water, electricity, power and year-round road access was found to be inferior in the northern region of the country compared with the central and southern regions, with only 19.3%, 64%, 38%, and 56%, respectively having access (MAF & FAO, 2014). Rural villages in upland areas lacked the most services.

As part of the Millennium Development Goals (MDGs), the Lao government committed to providing access to improved drinking water sources to 80%, and improved sanitation facilities to 60%, of the total population (The World Bank, 2010a). Sources of drinking water at the village level include rivers, streams, dams, protected and unprotected wells/boreholes, rainwater tanks, or piped water (MAF & FAO, 2014). Piped water was more common in urban areas, with villages located in uplands northern provinces, largely lacking in year-round road access, being less likely to have it (The World Bank, 2010a). Increases in coverage of both improved drinking water sources and sanitation have been observed, as the 2011-12 Lao Social Indicator Survey (LSIS) survey suggests that 70% of the total population in Lao PDR have access to improved drinking water sources, although it is primarily in urban areas, with 57% at improved sanitation (MoH & LSB, 2012). Challenges faced include cultural acceptability of open defecation in rural areas, where over half the population is reported to partake in this practice (The World Bank, 2010a).

Education is provided to children up to 15 years of age, by law, however gender and ethnic disparities remain a problem as well as discrepancies between urban and rural populations (WHO, 2011b). According to the 2011-2012 Lao Social Indicator survey, the primary school net attendance ratio (adjusted) was 84.9%, with 65.3% of children reaching the last grade of primary, and secondary school net attendance ratio (adjusted) was 44.6% (MoH & LSB, 2012). National literacy rates in 2005 were on average 73% in those greater than 15 years of age (MoPI - Dept. of Statistics, 2005); in 2011-12 the rates were 68.7% and 77.4% in women and men aged 15-24 years, respectively (MoH & LSB, 2012). The 2010/2011 Lao agricultural census demonstrated a greater lack of access to primary education in villages located in upland areas and rural villages without road access (MAF & FAO, 2014). The Lao expenditure and consumption survey in 2012/2013 also found that although 92.2% of villages had a primary school located within the village, only 16.7% had a secondary school (MoPI - Dept. of Statistics, 2012). Furthermore, in those aged 6 years and over, the survey showed that 55.62% had completed primary school, with only 20.48% and 12.45% completing lower and upper secondary school, respectively (MoPI - Dept. of Statistics, 2012). Completion rates were lower in females compared to males.

2.1.2 Climate, flora & fauna

Lao PDR has a mainly tropical climate, with micro-climatic variations depending on elevation (Van Gansberghe, 2005). The monsoon rain season generally occurs from about May to October and a dry/hot season from November to about April (Kaufmann, Marchesich & Dop, 2003). Rice is the major upland crop, though other perennial crops are grown, such as coffee, rubber and tree fruits. Wherever possible, floodplains and valley bottoms are used for lowland rice production, which tend to be quite fertile due to continuous addition of nutrients contained in topsoil lost from the surrounding slopes (Roder, 2001). There is usually one rice harvest season each year, though some areas have 2 (personal observation).

Flora and fauna vary in different parts of the country, due to varying temperature, altitude, soil, water, and human activity (Van Gansberghe, 2005). Likewise, insect pest populations and their associated diseases also vary depending on the region. The Mekong River and its tributaries provide rich water resources and ecosystems (MoNRE, 2012).

2.1.3 The People

2.1.3.1 Ethnicity & religion

There are officially 49 ethnic groups, with over 100 subgroups within Lao PDR. These are classified into four main ethno-linguistic categories – the Lao-Tai or “Lao Loum”/Lowland Lao (around 65% of the population), Mone-Khmer or “Lao Theung”/Slope Dwellers (representing about 25% of the population), and the Sino-Tibetan and Hmong- Yu Mien groups or “Lao Seung”/Highland Lao (about 10% of the population) (M-IWRMP, 2010; Libman, Bouamanivong, Southavong, *et al.*, 2006). The distribution of each ethno-linguistic category is illustrated in the map shown in Figure 2-2. They have distinctly different languages, customs, and lifestyles and exhibit different health seeking behaviours (WHO & Lao PDR Ministry of Health, 2012).

The predominant religion in Lao PDR is Buddhism, followed mainly by the Lao Loum, representing about 67% of the population; while about 2% of the population is Christian (MoPI - Dept. of Statistics, 2005; Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). Although not regarded as a religion, a significant proportion of the population possesses animistic beliefs (about 31% according to the 2005 census), often referred to locally as '*Sadsana Phi*' or 'Spirit religion' (MoPI - Dept. of Statistics, 2005; Shirayama, Phompida & Kuroiwa, 2006).

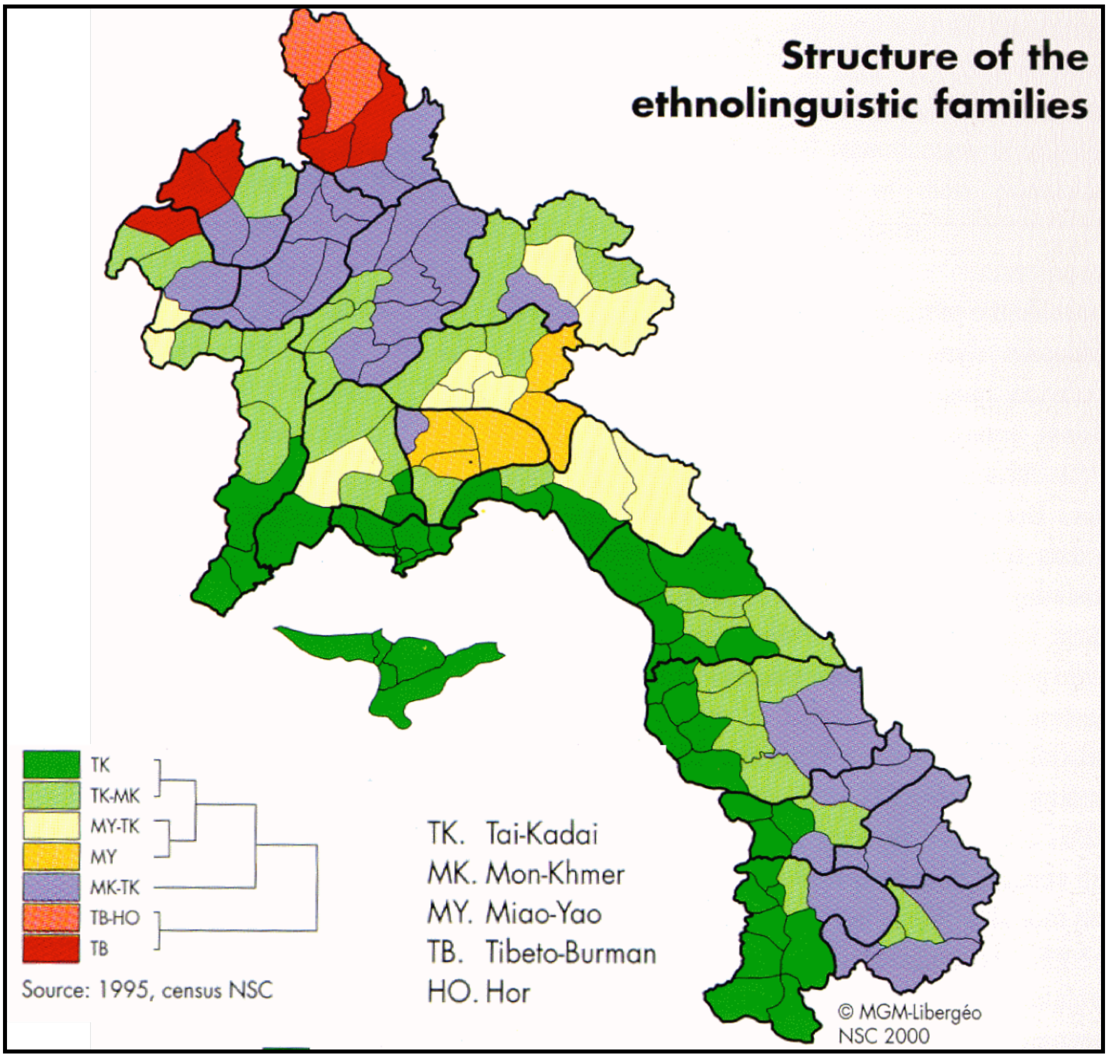

Figure 2-2 Distribution of ethno-linguistic families in Lao PDR (source: http://www.seasite.niu.edu/lao/lao_maps/language_family_large.htm)

2.1.3.2 Diet

The typical diet in Lao PDR consists of rice, especially glutinous rice, with vegetables (mainly dark green leafy vegetables), some fruit, root crops, eggs, meat, fish and poultry (Kaufmann, Marchesich & Dop, 2003). Rice is the staple food for most households and accounts for about 67% of average total dietary energy consumption (FAO & MAF, 2013). Some variations exist in the proportion and frequency of consumption of the other food groups in different regions of the country, particularly in urban versus rural areas. Protein and fat consumption is higher in urban areas where a higher variety of foods are available (Kaufmann, Marchesich & Dop, 2003). A common cultural dietary practice is the consumption of raw meat and meat products, such as blood and offal, particularly at weddings or special occasions and traditional ceremonies (Blacksell, Myint, Khounsy, *et al.*, 2007; Tran, Odermatt, Le, *et al.*, 2006; Conlan, Vongxay, Khamlome, *et al.*, 2012).

2.1.4 Administration system

Lap PDR is divided into regions – northern, central, and southern Lao PDR. It is a unitary state governed by the Lao People's Revolutionary Party (LPRP), headed by the President who is elected by the National Assembly (United Nations, 2005). The central/national level of government consists of the Prime Minister, appointed by the President with approval from the National Assembly, and relevant ministries (United Nations, 2005). The LPRP and central party committee members determine all government policies. The lack of opposition parties and, therefore, policies can impact systems and services at the district level, particularly if certain ethnic groups are not represented in the central party. The country is divided into 17 provinces and one prefecture (Vientiane capital), with each province further divided into districts. Districts are made up of constituent villages at the local level. The Lao government appoints provincial governors, the prefect and district chiefs, while village heads are elected by the villagers themselves (United Nations, 2005).

2.1.5 Socioeconomic status

Considered a low-middle-income country, the economy in Lao PDR has been undergoing significant change over the years, steadily growing with its Gross Domestic Production (GDP) increasing on average about 7% annually in the last decade (The World Bank, 2016b). This growth is substantially driven by foreign investment in natural resource extraction industries, such as mining, timber products, and hydroelectric power (WHO & Lao PDR Ministry of Health, 2012). Natural resources comprise a significant portion of the country's wealth, which adds to the challenge of sustainable management of these resources and suitable investment into public infrastructure (The World Bank, 2016a). Management of these resources to achieve long-term development and sustainability is a key focus of the Government's 7th National Socio-Economic Development Plan (NSEDP) (The World Bank, 2016a; MoPI, 2011).

Growth and development within the country has contributed to a reduction in the percentage of the population living in poverty, from 33.5% a decade ago to 23.2% in 2012/2013, however at a slower pace compared with other countries in the region (The World Bank, 2016a, 2016b). Poverty levels are higher in rural areas compared with urban, particularly in areas without road access compared to those with roads (MAF & FAO, 2014). Lao PDR also became a member of the Association of Southeast Asian Nations (ASEAN) in 1997 (FAO, 2005), which aims to accelerate economic development in member nations, as well as promote peace and stability. In 2013, Lao PDR also officially became a member of the World Trade Organization, with a goal to graduate from 'Least Developed Country' status by 2020 (The World Bank, 2016a).

A healthy agricultural economy is important in lesser-developed economies in the Southeast (SE) Asia region such as Lao PDR, Myanmar and Cambodia, where 30-40% of the country's GDP tends to come from agriculture (Costales, 2007; MAF & FAO, 2014), 9% of which is contributed by livestock (FAO, 2005). Although the contribution of agriculture to Lao PDR's GDP has been steadily declining over time, in 2014 agriculture still made up 28% of the country's GDP (The World Bank, 2016b).

Livestock production is an important source of household income in Lao PDR, financially and non-monetarily, particularly in smallholder pig farms that use traditional farming methods. In general, the Asian region is a major producer of pig meat worldwide, with SE Asia and Southern China comprising the majority of production (Costales, 2007). Rising demand and consumption of meat/meat products over the last three decades has fuelled this increase in production in Asia, leading to what is now termed as the 'Livestock Revolution' (Millar & Photakoun, 2008; Delgado, Rosegrant, Steinfeld, *et al.*, 2001; Werner, Gray & Bastin, 2002). Millar & Photakoun (2008) demonstrate how this increase in demand has led to a dependence on agriculture and forestry by most of the population as a source of income. In 2011, 74.7% of the labour force in Lao PDR was employed in the agricultural sector (MAF & FAO, 2014), a decrease from 82% in 2003 (ADB, 2006). However, still making up the highest proportion of the country's labour force. The 2010/2011 Lao Agricultural Census found an increase of 20% and 24% in the numbers of farm households and livestock holdings, respectively, from the previous census in 1998/1999 (MAF & FAO, 2014).

At the national level, livestock production operates on a smallholder scale as most households keep a few animals, such as cattle, pigs, and poultry, for domestic consumption and sale at local markets. Most livestock production in Lao PDR is traditional, extensive, and low input/investment; with livestock often used as cash reserves and for ceremonial needs (Millar & Photakoun, 2008; Wilson, 2007). Improving productivity is recognized as an important means for fostering sustainable economic growth, reducing poverty and food insecurity (MAF & FAO, 2014; Nampanya, Rast, Khounsy, *et al.*, 2010). Meat production and meat consumption has been increasing in Lao PDR and in the neighbouring region, providing market opportunities for livestock farmers (MAF & FAO, 2014).

2.1.6 Environmental trends

With a growing population, expanding agriculture, climate change, illegal logging and hunting, and exploitation of natural resources, there is growing concern about the impact to biodiversity and environmental quality within the country (Phaengsuwan, 2012). Along with urbanisation and issues with poor sanitation and lack of sewerage facilities in some areas, water quality is subsequently becoming an important issue (Japan

International Cooperation Agency, 2013; The World Bank, 2005). Infectious water-borne diseases are a particular concern in rural areas (Japan International Cooperation Agency, 2013; The World Bank, 2005). Increasing industrial pollution and highway construction also pose a threat to the urban environment (Japan International Cooperation Agency, 2013). Together, these factors all contribute to surface and groundwater quality issues becoming increasingly important in the near future. Air quality issues stem from poor vehicle and road maintenance, and a growing number of vehicles particularly in urban areas (Japan International Cooperation Agency, 2013; The World Bank, 2005).

Deforestation is also becoming an issue, with the conversion of forests to plantations and cash crops by commercial companies, hydropower, mining, infrastructure development, illegal logging and some shifting cultivation practices (slash and burn) (Japan International Cooperation Agency, 2013). Extensive forest areas and biodiversity are also under threat from upland erosion and resulting watershed deterioration (Phetsomphou, 2007). Forest cover in the country has decreased significantly from 70% to 43% over the last fifty years (The World Bank, 2013; FAO, 2010). As a result, more than 20% of the country's land has been designated as protected areas to conserve the rich biodiversity and beautiful landscapes (Japan International Cooperation Agency, 2013). However, increased population growth in traditional communities, migration and settlement are increasing human use of these areas, which are among the most remote in the country (The World Bank, 2005). In addition, availability of suitable land for agriculture is a growing concern as logging, slash and burn cultivation, use of chemicals in agriculture, soil erosion, poor soil quality and unexploded ordinance puts pressure on available land (Phetsomphou, 2007).

2.2 Health Services Delivery Model (health system infrastructure)

The health sector in Lao PDR is governed by a series of laws, decrees, regulations and policies (WHO & Lao PDR Ministry of Health, 2012). The Law on Health Care (2005) states that all citizens have the right to receive health care services, and requires the delivery of health care in an equitable manner (WHO & Lao PDR Ministry of Health, 2012). However, few safety nets exist for the poor and out-of-pocket payments make up majority of the health expenditure in the country, about 62.6% (WHO, 2011b). Aside from development partner funding, government health expenditure has been limited over the years, with total health expenditure as a percentage of GDP between 2005 and 2013 ranging between 1.9% and 4.3% (2.0% of GDP in 2013), and is significantly lower in comparison to other countries in the region (The World Bank, 2016b). In 1996, a user fee at most private and public health facilities was established, with exemptions in place for specific vulnerable groups at public facilities (WHO, 2011b). With a strong vertical approach to health service delivery and a heavy reliance on funding from development partners, Lao PDR has a government run public system that is unfortunately poorly utilised. The lack of adequately trained staff effectively distributed around the country, along with inadequate infrastructure and affordable drug supply, further exacerbate this problem.

The health care system is organized into four administrative levels – central, provincial, district and village; with one government-funded provincial and district hospital in each province and most districts, respectively (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012). Village level health centres in turn assist district hospitals. Private facilities, on the other hand, are increasing, particularly in urban areas. This sector expanded in the 1980s as part of a major health financing reform, when Lao PDR moved towards a market-based economy and because of a compromised drug supply in the public sector (Patcharanarumol, Mills & Tangcharoensathien, 2009). The public sector delivers most services through health centres and district, provincial, and central hospitals, while the private sector consists mostly of clinics with a growing number of private clinics and wards being set up in some major hospitals (WHO & Lao PDR Ministry of Health, 2012).

Traditional medicine remains key to the treatment and prevention of a large number of conditions and disease throughout the country, even among the well educated and financially able, and receives strong support from the country's government. It operates at the local community level, provincial and national level. The Ministry of Health (MOH) established a Traditional Medicine Research Centre in 1976, now called the Institute of Traditional Medicine (since 2010), and practitioners/healers play an important role in primary health care especially in rural areas (WHO & Lao PDR Ministry of

Health, 2012). Reasons for its popularity include perceived efficacy, accessibility, and affordability (WHO & Lao PDR Ministry of Health, 2012).

2.2.1 Social health protection

Social health protection was introduced in 2002, presenting four different schemes[2]. Coverage spans about 14% of the country's population (Alkenbrack, Jacobs & Lindelow, 2013). The Lao Expenditure and Consumption survey (LECS), conducted countrywide every 5 years, showed a decline in the utilization of health services (from a "modern provider," which includes government or private health institutions and providers) from 2.1% to 1.8% of individuals in the time period between the 2002/2003 and 2007/2008 surveys (The World Bank, 2010b). The exception to this decline was the rich quintile, which saw a small increase, thus widening the inequalities gap in accessing health care between the rich and the poor. The LECS survey demonstrated that utilization of outpatient health services was connected to access to services (i.e. distance to the nearest health centre or hospital). The 2007/08 survey showed that 70% of households lived within 10km of the nearest health centre, but 50% lived within 10km of the nearest hospital, although even those with easy access to health services showed low level of utilization (The World Bank, 2010b). Despite official figures implying otherwise, accessibility remains an important challenge, particularly for the rural poor, as ability to pay and distance to a health care provider are major barriers. About 54% of villages face challenges accessing health care facilities because pharmacies/dispensaries and hospitals tend to be located greater than 2 hours walk away, and this problem is further exacerbated in rural compared to urban areas particularly in villages with poor or without road access (MAF & FAO, 2014; WHO & Lao PDR Ministry of Health, 2012). Inpatient services, which reflects the serious nature of illness requiring hospitalization of patients, also had a decrease in utilization with services mainly being accessed by more financially sound individuals (The World Bank, 2010b).

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[2] (i) State Authority Social Security (SASS) for civil servants; (ii) Social Security Organization (SSO) for private sector employees; (iii) voluntary Community-based Health Insurance (CBHI); and (iv) Health equity fund supported by external donors focusing on the poorest of the population (WHO CCS, 2011).

The discrepancy between the rich and the poor in Lao PDR, in terms of access to health care is significant. The 2012/13 Lao expenditure and consumption survey (LECS) similarly found access to various services in villages to be considerably poor, with only 34.8%, 29.6%, 48.8%, and 57.6% of the population having access to a pharmacist, licensed pharmacist, health volunteer, and midwife, respectively (MoPI - Dept. of Statistics, 2012). Access barriers and poor service quality, therefore, result in generally poor utilization of the health care system (WHO, 2012).

2.2.2 Public health priorities

Apart from further developing and strengthening the country's health system, areas of importance in the current national health strategy include primary health care, maternal child health, and aid effectiveness and coordination (WHO, 2012). Although some progress has been made in expanding health coverage for the Laotian people, health related outcomes in Lao PDR remain among the poorest in Southeast Asia (WHO & Lao PDR Ministry of Health, 2012). Maternal and child health is of particular concern due to relatively high maternal, child and infant mortality rates in the country (WHO, 2012). Current available health indicator data for Lao PDR show that the mortality rate for children under 5 years of age was 69 per 1000 live births in 2014 (and 67 per 1000 live births in 2015 thus far) (The World Bank, 2016b), while the infant mortality (< 1 year) rate was 54 per 1000 live births in 2013 (UNICEF, 2014). The 2011/12 Lao social indicator survey (LSIS) found the maternal mortality ratio in the previous seven-year period (2005-2011) to be 357 deaths per 100,000 live births (95% CI 269, 446) (MoH & LSB, 2012).

It has been claimed that the main cause for morbidity and mortality in Lao PDR are communicable diseases – in particular acute diarrhoea, dengue, acute respiratory infections, parasitic diseases, and vaccine-preventable diseases (WHO, 2011b). Lack of access to adequate clean water supply, sanitation facilities, appropriate nutrition sources and limited access to health care facilities in remote rural areas with trained staff are the major risk factors for these issues (WHO, 2011b). The financial barriers to accessing health care also put many households at risk of falling further into poverty. The Lao PDR government has expressed a commitment to the need for expansion and strengthening of its health system to meet the needs of its people, particularly the rural poor; as stated in the goals for the Ministry of health's 7th Five year National Health Sector Development Plan (2011-2015).

The Expanded Programme on Immunization (EPI) in Lao PDR was launched in 1982 (WHO-WPRO, 2016). While routine vaccination coverage has improved over the years, with notable achievements in the control of poliomyelitis, maternal and neonatal tetanus, vaccine accessibility and coverage is still a problem in hard to reach communities (WHO-WPRO, 2016; WHO, 2013). Reliance on donor funding for 90% of vaccine and operational costs is said to be the most important challenge to overcome, raising questions about the government's commitment to the programme (WHO, 2013). A JE vaccination campaign was carried out in northern Lao PDR in 2013 and in southern and central regions of the country in 2015, for children aged 1 to 15 years, with support from Gavi, the Vaccine Alliance (GAVI, 2015; WHO, 2015). Study participants in Luang Prabang province confirmed that the campaign was held in February to April 2013 (personal communication with district health care workers). The vaccine is to be rolled out through the country's routine immunization schedule in 2016 using national funding, and will be administered to infants up to 9 months old (WHO, 2015).

2.3 Disease surveillance and reporting in Lao PDR

2.3.1 Current health information system

The national health information system in Lao PDR was developed in 1983, however, health system data collection has been significantly lacking or has been of inadequate quality (WHO, 2011b) due to lack of appropriate training, sufficient time and resources. While comprehensive data collection is still limited, improvements have been made through the development and implementation of the Lao Early Warning Alert and Response (EWAR) Surveillance system at the National Centre for Laboratory and Epidemiology (NCLE). The system requires nation-wide reporting of information from all level and types of health care facilities on 17 notifiable diseases/syndromes. These include acute flaccid paralysis, fever and rash, meningitis, acute encephalitis syndrome (AES) amongst other syndromes.

The EWAR surveillance system provides an early warning system by monitoring disease trends and detecting outbreaks allowing timely action and minimization or prevention of morbidity and mortality (NCLE, 2013). The system functions at the health centre, district, provincial and national levels and is set up to perform on-going systematic indicator-based surveillance (IBS) and ad hoc event-based surveillance (EBS). The IBS system is also called the National Surveillance System for Notifiable Selected Diseases (NSSNSD) and includes health care facilities nationwide (NCLE, 2013). Data is collected at health care facilities and reported to the public health authorities on a weekly basis (see Figure 2-3 below for diagram on information flow). Each level reports information on cases and deaths to the next higher level – health centre and district hospital to the district health office (DHO); the DHO, provincial and private hospitals to the provincial health office (PHO); and the PHO to the NCLE, and on to the Department of Communicable Disease Control (DDC) at the Ministry of Health (MOH). Information from village health workers (VHWs), ports and immigration checkpoints also flow upward to the DHO and onward (Ancheta, Mendoza, Pachuen, *et al.*, 2010). At the grassroots level, VHWs typically have early knowledge of illness at the village level and provide monthly reports to local health centres, except in the case of unusual events that require more frequent reporting at the district level (Ancheta, Mendoza, Pachuen, *et al.*, 2010). Laboratory confirmation is required from every case for some of the diseases/syndromes reported to NCLE, such as acute flaccid paralysis (AFP) and fever and rash, making liaison between national and local laboratories essential for sample collection and referral (NCLE, 2013).

Since 2009, the Lao EWAR network has expanded from 33 to 144 Districts in all 17 Lao Provinces, and the system has greatly enhanced early outbreak recognition since 2008 (Phommasack, Moen, Vongphrachanh, *et al.*, 2012).

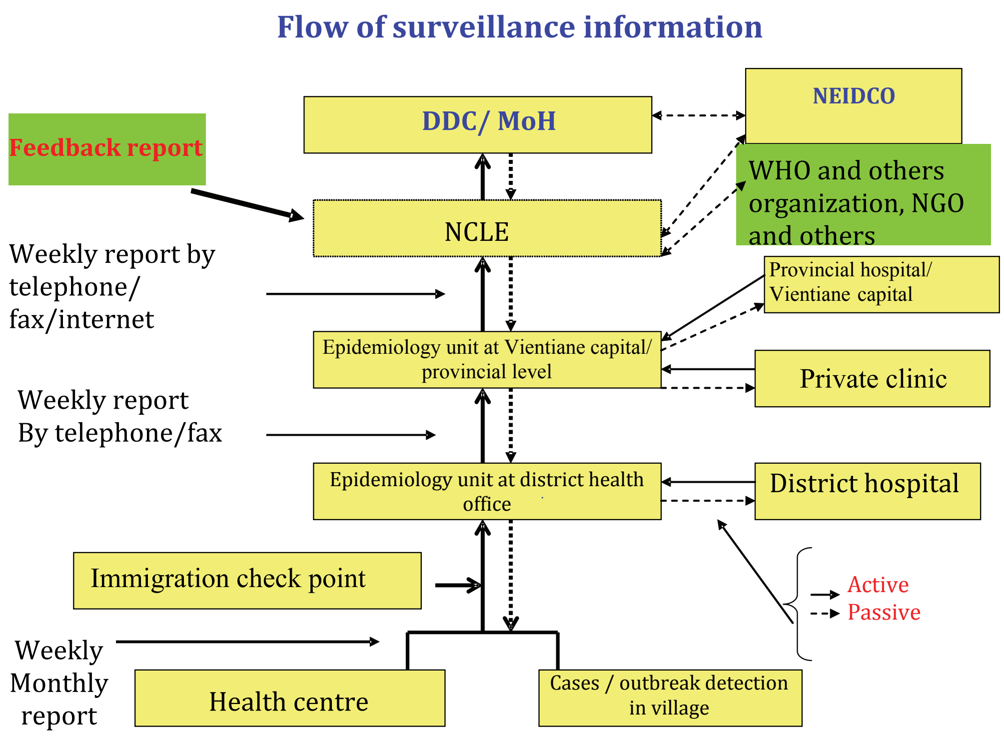

Figure 2-3 Flow-chart of EWAR surveillance (IBS and EBS) (NCLE, 2013)

As part of disease surveillance on zoonoses and cross-border activity, respectively, the Lao MOH has engaged in memorandums of understanding (MOUs) with the Ministry of Agriculture and Forestry (MOAF) at the national and provincial level, and with the MOH of bordering countries indicating areas of and mechanisms for collaboration (Ancheta, Mendoza, Pachuen, *et al.*, 2010). In the case of emerging diseases with epidemic or pandemic potential in animals closely associated with human habitation, the MOH is alerted to the possibility of human transmission while the MOAF is responsible for disease surveillance and control (Ancheta, Mendoza, Pachuen, *et al.*, 2010). Information sharing and joint response activities are emphasized in the MOUs.

2.3.2 Other surveillance programmes

The Mekong Basin Disease Surveillance (MBDS) network was formally established in 2001, following the 1997 MOU between the World Health Organization (WHO) and the Association of South East Asian Nations (ASEAN) that identified disease prevention and control as a priority for inter-country collaboration (Phommasack, Jiraphongsa, Ko Oo, *et* *al.*, 2013). The main areas of focus of the network included improving cross-border infectious disease outbreak investigation and response through shared disease surveillance and outbreak response, developing epidemiological surveillance expertise and enhancing communication between member countries (Phommasack, Jiraphongsa, Ko Oo, *et al.*, 2013). Included in its core strategies is the integration of the human-animal sector interface, strengthening of community surveillance and laboratory capacity (Phommasack, Jiraphongsa, Ko Oo, *et al.*, 2013). Their primary role has been disease control in the region, enhancing government and international organization efforts to build national and regional capacity in dealing with new and emerging disease outbreaks (Phommasack, Jiraphongsa, Ko Oo, *et al.*, 2013). The MBDS network was registered as a foundation in 2012, solidifying the network's sustainability by allowing it to mobilize funding and resources from different funding agencies and governments (Phommasack, Jiraphongsa, Ko Oo, *et al.*, 2013).

In 2006, the National Avian and Human Influenza Coordinating Office (NAHICO) was formed, but later evolved into the National Emerging Infectious Disease Coordinating Office (NEIDCO) in 2009, as a result of changing pandemic threats from H5N1 to H1N1 and possible future unknown threats (Phommasack, Moen, Vongphrachanh, *et al.*, 2012).

2.3.3 Field epidemiology training programme

Initially offered only in Thailand, the Field Epidemiology Training program (FETP/FET) was developed to address critical shortages in public health practitioners (Phommasack, Moen, Vongphrachanh, *et al.*, 2012). The FET program in Lao PDR was started in 2009, operationally supported by the US CDC, to build a core group of epidemiology-trained personnel and promote One Health principles through training of individuals from human and animal sectors (Phommasack, Moen, Vongphrachanh, *et al.*, 2012; CDC, 2015). The programme consists of in-class instruction as well as project field placements that contribute to strengthening the national surveillance system while providing invaluable experience in outbreak investigations (Phommasack, Moen, Vongphrachanh, *et al.*, 2012).

2.4 Veterinary services in Lao PDR

The Lao PDR Ministry of Agriculture and Forestry (MAF) consists of several departments, including the Department of Livestock and Fisheries (DLF), as well as the National Agriculture and Forestry Research Institute (NAFRI). At the provincial and district levels, the MAF consists of Provincial Agriculture and Forestry Offices (PAFOs) and District Agriculture and Forestry extension offices (DAFOs) (MAF, 2012). Under the DLF, the Animal Health Division (AHD) is responsible for diagnosis and control of disease, quarantine measures, the veterinary extension network, as well as vaccine production, distribution and use (FAO, 2005). The Division also supports training of village veterinary workers (VVWs), who are smallholders that assist with animal health concerns at the village level, usually without any official compensation (FAO, 2005).

The Lao Decree on the prevention and control of animal diseases established in 2012 aims to prevent, control and eradicate epidemic animal diseases in the country in order to ensure healthy and productive livestock, consumer safety, and to avoid negative socioeconomic and environmental impacts (MAF, 2012). The system is faced with numerous challenges that affect the quality and quantity of veterinary services provided and, thereby, impacts animal health. For instance, having a very basic information system for collecting animal health data makes prioritizing scarce resources for dealing with animal disease extremely difficult (FAO, 2005).

A shortage of veterinarians or animal health technicians is another problem, as limited training schools have previously been offered within the country (FAO & MAF, 2013). The National University of Laos (NUOL) at Nabong campus, near Vientiane capital, has been providing 5 year veterinary training (Bachelor of Veterinary Science) since 2008, but limited staff and facilities make clinical teaching difficult (Mekong Livestock Research, 2015; FAO & MAF, 2013). Access to a veterinary clinic is poor particularly in rural areas, as revealed by the 2010/2011 Lao agricultural census, which found that of all rural villages surveyed only 1.7% had a veterinary clinic (85% of villages included in the census were classified as rural; 8662 of 11640 total villages were included in the census) (MAF & FAO, 2014). This amounted to 1.3% of rural villages located in northern Lao PDR and 1.9% of rural villages that had road access (MAF & FAO, 2014). On the other hand, the number of private veterinary clinics in the capital, Vientiane, run mainly by international groups from countries such as Thailand, United Kingdom, and Italy, seem to be on the rise (personal communication with ACIAR project coordinator).

The census also found that greater than 50% of rural villages in the country had involvement of development projects related to crops, livestock, fisheries, forestry, control of shifting cultivation and environmental protection (funded by various sources including government agencies, domestic and international private funds and NGOs). However, it is unclear as to the specific nature and type of projects undertaken within each sector and whether they include an animal health component. The result of limited access to veterinary expertise has been low vaccination rates of livestock, high animal mortality rates, and husbandry practices that need improvement (FAO & MAF, 2013; Werner, Gray & Bastin, 2002). The 2010/2011 agricultural census found the lack of livestock vaccination to be a major problem faced by farmers in approximately 40% of rural villages surveyed (MAF & FAO, 2014). Vaccination rates in pigs, in particular, were quite low although they had increased from 8% to 18% between 1999 and 2011 at the national level; with rates ranging between 18% and 20% across different regions (MAF & FAO, 2014). Inadequate knowledge and awareness on the risk of animal diseases by farmers, as well as financial constraints, provide additional barriers to seeking appropriate help and/or implementing appropriate disease prevention and control measures (Werner, Gray & Bastin, 2002; FAO & MAF, 2013).

Successful control of zoonoses will require strengthening the capacity of veterinary services on surveillance, diagnosis, management of animal movement, vaccination and public awareness (FAO & MAF, 2013).

2.5 Diagnostic centres and methods currently available

Diagnostic capacity is focused mainly at the central and provincial level, with some basic diagnostic methods available at the district level. At the national level, under the DLF, the Lao National Animal Health Laboratory (NAHL) is a government laboratory and leading research centre for emerging and zoonotic diseases in the animal health sector (One Health Network Southeast Asia, n.d.). Participating in a number of collaborative projects with other agencies and institutions, such as the USAID PREDICT project, the

Mahidol-Oxford Tropical Medicine Research Unit (MORU), ACIAR, the European Union (EU), and the Lao-Oxford Mahosot Hospital Wellcome Trust Research Unit (LOMWRU), NAHL is also working towards enhancing laboratory capability and capacity within the country (UC Davis, n.d.).

LOMWRU is also involved in human disease surveillance and laboratory training activities in Lao PDR, working within the Mahosot hospital in Vientiane capital (One Health Network Southeast Asia, n.d.). Though no collaborative zoonoses projects exist with NAHL. Recently equipped with a new infectious disease centre (opened in 2009), Mahosot hospital has a Biosafety level 3 laboratory, a molecular diagnostics laboratory, and a general and serology laboratory, in addition to the original microbiology lab (LOMWRU, 2008). The new laboratory will support diagnostic services in the hospital and elsewhere, clinical and laboratory research on common infectious diseases in Lao PDR, and act as a training centre (LOMWRU, 2008). As a result, microbiology tests currently available at the hospital include blood culture; bacterial identification using various specimens (ex. Urine, pus, stool, throat swabs, vaginal/urethral swabs, etc.); microscopy; bacterial culture (for CSF infections, TB, leptospiral); dengue/JEV serology; scrub and murine typhus rapid tests (also perform rickettsial IFA and culture); bacterial PCR (s. pneumonia, H. influenza b, and N. meningitides); viral PCR (CMV, enterovirus, HSV, VZ, JEV, dengue, mumps, measles, influenza, West Nile, tick-borne encephalitis, and Nipah viruses); viral culture; and Dengue/JEV IgM/IgG/NS1 ELISAs (LOMWRU, 2013).

Some rapid diagnostic tests are also used in the smaller local hospitals for serological diagnosis of common infectious diseases, such as leptospirosis, dengue, scrub and murine typhus (LOMWRU, 2008). A gap exists in the diagnostic capacity between Vientiane capital and other areas of the country in both the human and animal health sectors, with poorly resourced district level human laboratories and non-existent animal laboratories. Addressing the challenges faced in laboratory diagnostic enhancement in Lao PDR will require innovative approaches and multi-sectoral cooperation (Phommasack, Moen, Vongphrachanh, *et al*., 2012).

2.6 Pig production and management systems

Significant differences in practice exist between the lowland areas of the Mekong Corridor and the upland areas of the Sloping Lands zone (highlands) (FAO, 2005). Pig production is an important income source particularly for highland people, with commercial operations typically found close to population centres such as Vientiane that are relatively small scale in comparison to operations in neighbouring Vietnam and Thailand. Differences in production systems and practices are also said to exist between different ethnic groups; for example, households of Hmong (73%) and Khmu (64%) ethnicity were more likely to rear piglets compared with Lao (38%) ethnic groups (Werner, Gray & Bastin, 2002). Many households raise native breed pigs, as they are hardy and able to forage for food (Werner, Gray & Bastin, 2002). Pig management tends to be extensive and low input with pigs raised in mainly free-range conditions, with some penning animals in certain areas or at specific times of the year.

In addition to increasing social and market pressures and significant infrastructure limitations, the main constraints faced by producers are lack of appropriate nutrition or feed, and therefore low productivity, and animal diseases that cause high morbidity and mortality as well as low reproductive rates and weight gain in the animals (FAO, 2005). Pig diseases often occur as epidemics or large outbreaks where most or all of the pigs in a village may succumb to the disease, which is a devastating financial loss (Werner, Gray & Bastin, 2002). Piglet mortality rates in smallholder farms have been reported to be quite high, between 20% and 40%, because of poor hygiene practices and feed management (Chittavong, Lindberg & Jansson, 2012; Phengsavanh, Ogle, Stur, *et al.*, 2011). This presents a true challenge for the rural poor, therefore, in alleviating their financial burdens and bringing themselves out of poverty.

2.7 Background – 2011 ILRI and ACIAR Serosurveillance Study[3]

In collaboration with the International Livestock Research Institute (ILRI), as part of the EcoZEID project funded by the International Development Research Centre (IDRC) to carry out joint research and capacity development on eco-health approaches to zoonotic

[3] Information on the ILRI/ACIAR surveys has been taken from the ILRI/ACIAR work (Hanoi paper), SPSP 2012 annual report (Allen, Tiemann, Blaszak, *et al.*, 2012; Blaszak, 2012), and (Okello & et al., n.d.).

emerging diseases, the Australian Centre for International Agricultural Research (ACIAR) conducted provincial level baseline prevalence surveys in Lao PDR. These were designed to obtain and demonstrate an epidemiological context for 5 pig related zoonotic diseases – hepatitis E virus (HEV), Japanese encephalitis virus (JEV), Trichinella, taenia/cysticercosis, and erysipelas – in humans and pigs, as well as important pig production diseases – classical swine fever (CSF), porcine reproductive and respiratory syndrome virus (PRRS), and foot and mouth disease (FMD). The motivation behind this survey was the lack of knowledge regarding estimated prevalence of the 8 infections in the Lao context. Therefore, it aimed to provide relevant background information from an eco-health perspective and to identify possible recommendations for intervention.

2.7.1 Smallholder Pig Systems Project

The Smallholder Pig Systems Project (SPSP) is a large inter-disciplinary One Health, one systems project funded by the Australian Centre for International Agricultural Research (ACIAR). Implementation in Lao PDR aimed to improve livestock productivity while also decreasing the risks of animal and human diseases in smallholder pig market chains through identification of critical control points in the production and market systems. Through integrating two components – animal and human health and pig production and marketing – it endeavoured to incorporate Lao PDR counterparts and agencies as part of a multi-disciplinary approach. Some key project objectives involved the development of better strategies to manage risks to farmers and traders from diseases in pigs – including testing strategies to identify and manage zoonotic disease risks at critical control points (Allen, Tiemann, Blaszak, *et al.*, 2012). This work aligns well with the Lao Government's 2020 Strategy for Agricultural Development, which aims to promote local pig farming for food security and poverty alleviation through smallholder livelihood development and market orientation (Lao PDR Ministry of Agriculture and Forestry, 2010).

2.8 Rationale for PhD research

Further research on the burden of pig-associated zoonoses is necessary and significantly lacking in the Laotian context. Two of the study diseases – HEV and JEV – are known to be endemic in the country, whereas no information is available on the presence or prevalence of brucellosis or Q fever in swine. The former disease, however, has been reported from neighbouring countries, Vietnam and Malaysia, while the latter has been reported from Thailand and Malaysia, and other Asian countries mainly in cattle and buffalo. The disease burden that these four diseases contribute to globally can be quite significant and more so in developing countries. The clinical impact and long term effects on health (in terms of chronic infections and/or disability) alone can be quite substantial. Coupled with the economic impacts, in terms of cost of seeking health-care, loss of workdays and income, effects on animal health and associated monetary losses, this can force already struggling people even further into poverty. A large proportion of the Lao population depends heavily on livestock production, on which these diseases have a major effect. The need for further research on specific practices that may be associated with increased risk of transmission of these diseases has previously been identified (Conlan, Vongxay, Jarman, *et al.*, 2012). An understanding of the health seeking behaviours of its people is also essential in contributing to the further development and enhancement of the country’s health care system.

The 2011-2015 One Health work plan of the Lao National Emerging Infectious Diseases Coordinating Office (NEIDCO) has zoonotic disease surveillance as a high-level policy requirement with aims to expand surveillance to explore other emerging/re-emerging threats in addition to the 5 priority diseases (Avian influenza, Anthrax, Rabies, Leptosiporsis, Trichinellosis) (personal communication). The research conducted through this PhD will, therefore, contribute to policy and legislation development needed to apply to multiple sectors for effective zoonotic disease control. Another outcome of this research is to provide evidence from Asia to contribute to the development of a neglected zoonoses disease (NZD) list for Asia. While they are of great concern, the current NZD list is centred on diseases occurring mainly in Africa. Livestock production systems in Asia are different from those in Africa, such that pigs are the major production system presenting a more significant zoonoses risk. Therefore, an assessment of the potential risk and importance of pig zoonoses in Asia is necessary for pig zoonoses input under the NZD list.

2.8.1 Aims & objectives

The main aims of the study were to:

1. Explore the risk factors for transmission of pig-associated zoonoses – particularly Q fever, brucellosis, hepatitis E, and Japanese encephalitis - in the study areas and determine the disease impact on households through the use of secondary and empirical field data.
2. Evaluate knowledge, attitudes and practices with regards to the study diseases and their risk factors, other zoonoses and general health.
3. Evaluate health-seeking behaviour of villagers and hospital/health centre patients and the role of different types of health care providers.
4. Describe routine health service delivery and assess capability in diagnosing and treating the study diseases.

The overall project aims are to develop recommendations for "catch-all" control measures that will impact multiple diseases, and thereby improve biosecurity and prevent disease transmission to the human population.

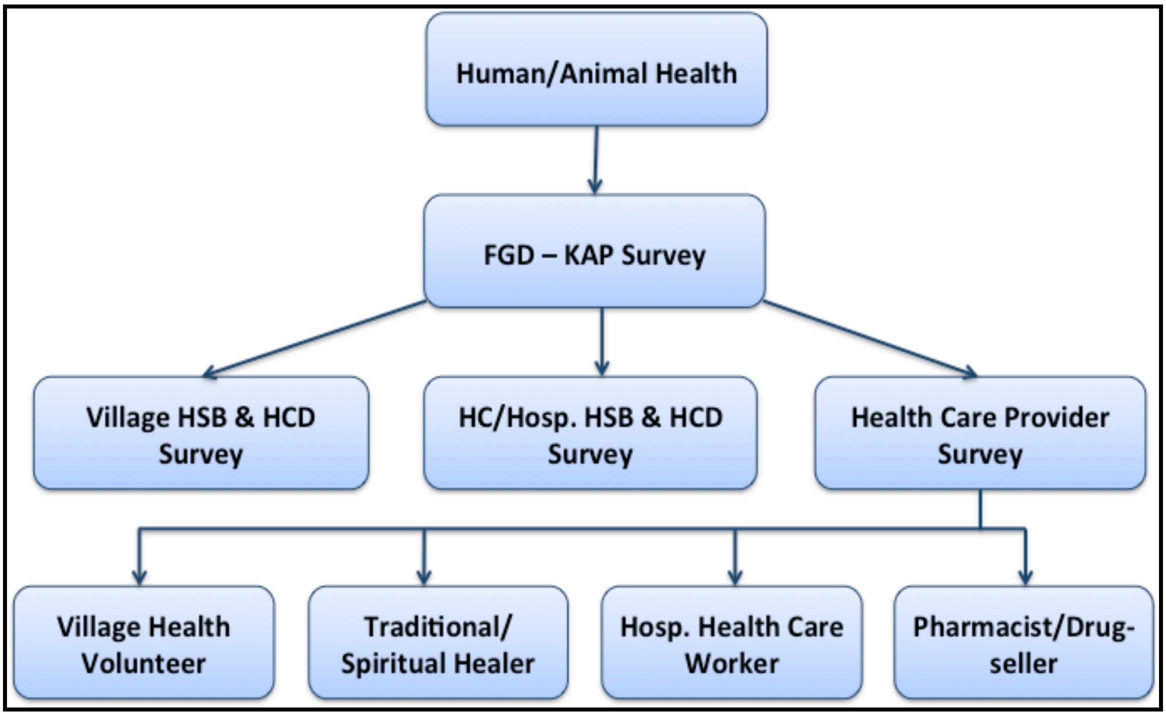

Figure 2-4 Project Plan Summary; FGD=focus group discussion; KAP=knowledge, attitudes and practices; HSB=health seeking behaviour; HC=health centre; HCD=household cost of disease; Hosp.=hospital

The project plan is summarized in **Figure 2-4** above, and the specific objectives that the project has set out to achieve are to

1. Access and analyse secondary serological data collected on patients presenting to a health care facility with commonly diagnosed syndromes or diagnosed with the study diseases/syndromes (NCLE data) and humans and pigs diagnosed with the study diseases in the 2011 ILRI/ACIAR survey.

2. Interview of patient or parent/guardians in hospitals/health centres regarding risks for exposure, health-seeking behaviours, and household cost of disease.

    a. Identify patients admitted with commonly diagnosed diseases or undiagnosed syndromes as per 'Criteria for Illness' (see Figure 2-5 below for details).

3. Determine health-seeking behaviours and household cost of disease for those who do not present to a health care facility (at village level), as well as knowledge,

attitudes and practices towards general health, pig farming, zoonoses and risks for exposure.

4. Interview health care providers to assess their capability in diagnosing and treating illness and explore other, non-conventional, sources of health care to further understand health seeking behaviour and influences on the choice of health care provider.

Criteria for Illness

- Patients admitted/presented to hospital/health centre in last 30 days with study diseases, if diagnosis is made
- Alternatively (more likely) patients with diagnosed syndromes = acute febrile illness, acute jaundice, CNS infections (meningitis, encephalitis, or acute flaccid paralysis)
- OR with following combinations of symptoms:

Fever, headaches, sweats, joint or muscle pain
OR
Nausea, vomiting, loss of appetite (anorexia)
AND
Enlarged tender liver (hepatomegaly) or acute liver failure
OR
Seizures (fits), change in mental state (confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis

Figure 2-5 Criteria for Illness used to determine participant eligibility

The full description and application of the methods employed in this study can be found in the relevant chapters. These include a quantitative analysis of secondary data on pig zoonoses (in humans and pigs) in northern Lao PDR (chapter 3), a qualitative knowledge, attitudes and practices (KAP) survey at the village level using focus group discussions (chapter 4), a qualitative health-seeking behaviour assessment at the village and hospital/health centre level using semi-structured interviews (chapter 5), as well as a qualitative health care provider assessment that includes semi-structured interviews of hospital health care workers, traditional and spiritual healers, village health volunteers, and pharmacist or drug sellers (chapter 6).

3 Qualitative and Quantitative analysis of pig zoonoses in northern Lao PDR

3.1 Introduction

Communicable diseases are believed to be a significant cause of morbidity and mortality in Lao PDR. A number of factors promote their transmission, especially the lack of appropriate sanitation and water supply, malnutrition, poor knowledge and awareness of health, a need for improvement in hygiene behaviour, and inadequate access to quality health care (WHO, 2012). Disease specific data, in terms of incidence and/or prevalence, is limited throughout the country and almost non-existent with regards to the diseases of interest in this study namely, hepatitis E, Japanese encephalitis, brucellosis and Q fever (Burniston, Okello, Khamlome, *et al.*, 2015; Okello, Burniston, Conlan, *et al.*, 2015). Limited diagnostic capacity within Lao PDR poses significant challenges, not only for treatment of ill patients but in understanding the depth of the problem and finding suitable solutions. Also lacking is country-specific information regarding factors that influence the transmission and endemicity of pig-associated zoonoses.

Health indicator data for Lao PDR shows that the mortality rate for children under 5 years of age was 67 per 1000 live births in 2015, with the country ranking at 33 out of 197 countries (The World Bank, 2016b; UNICEF, 2014). The infant mortality rate was 54 per 1000 live births in 2013 (UNICEF, 2014). World Bank data shows that the percent of the population with access to an improved water source was 76% in 2014 (up from 59% in 2006), while access to improved sanitation facilities has increased from 47% in 2006 to 71% in 2014 (The World Bank, 2016b). Although great strides have been made to improve access to water and sanitation in Lao PDR, that are crucial for prevention of disease transmission, access to both was much higher in urban areas compared with rural areas (UNICEF, 2014). In addition, cultural influences on attitudes to open defecation often mean that ownership of a latrine does not always denote usage (Tran, Odermatt, Le, *et al.*, 2006; Bardosh, Inthavong, Xayaheuang, *et al.*, 2014b; Phongluxa, Xayaseng, Vonghachack, *et al.*, 2013).

This exploratory analysis of pig-associated zoonoses and the risk factors that influence their transmission, applies a mixed methods approach. In this chapter secondary data was accessed and analysed from a recent human and swine serosurveillance study conducted in northern Lao PDR as well as data from the national surveillance programme.

3.2 2011 ILRI/ACIAR Serosurveillance study[4]

As described in Chapter 2, a collaborative cross-sectional baseline serological survey was carried out in 2011 by ILRI and ACIAR, in collaboration with the National Animal Health Laboratory [Ministry of Agriculture and Forestry (MoAF)] and the National Centre for Laboratory and Epidemiology [Ministry of Health (MoH)]. The survey aimed to provide an epidemiological context for pig zoonoses and pig production diseases in Lao PDR and to identify possible recommendations for intervention.

3.2.1 Methodology used

3.2.1.1 Serological survey and risk factors questionnaire

A human and swine serological survey was carried out to determine the point prevalences of a suite of pig-associated zoonoses considered a priority for Lao PDR; Japanese encephalitis virus (JEV), hepatitis E virus (HEV), *taenia solium* cysticercosis-taeniasis, *trichinella*, erysipelas, *coxiella burnetti*, and *brucella suis*. This analysis is related to JEV, HEV, *coxiella burnetti*, and *brucella suis*.

A questionnaire was administered to each household that was selected for human or pig serological sampling to obtain information on household demographics and determine behavioural and environmental factors that would potentially influence transmission of pig-associated zoonoses in the study areas. Questionnaire development involved district staff feedback, local piloting and back translation.

[4] Information on the ILRI/ACIAR surveys has been taken from the ILRI/ACIAR work (Hanoi paper), SPSP 2012 annual report (Allen, Tiemann, Blaszak, *et al.*, 2012; Blaszak, 2012), and (Okello *et al.*, n.d.).

3.2.1.2 Study area and sample size

3.2.1.2.1 Province selection

One district in each of Xayabouri and Phongsaly provinces (Figure 2-1), in northern Lao PDR, was selected based on various criteria, including interest and initiative of provincial and district government staff, increasing pig production corresponding to provincial and district plans, potential market access, low project density in the area, and an important socioeconomic role of pig production for small holder farmers. Matching of criteria was done through visits and consultation with farmers, district and provincial government staff and expert advice from other projects. Four villages in each district were selected for an intense baseline survey and further research and intervention.

The government selected Luang Prabang (northern Lao PDR) and Savannakhet (southern Lao PDR) provinces for the survey as each represents upland and lowland areas, respectively, with different geography and development as well as high pig densities. Thirty villages were selected from each province for the survey. The focus of this thesis is on northern Lao PDR and, therefore, Savannakhet province was excluded from the analysis.

3.2.1.2.2 Serological Sampling

Sample and data collection was conducted in Luang Prabang province in July 2011 and in October 2011 in Xayabouri and Phongsaly provinces. Modifications were made as required due to challenges with flooding and access to villages during the rainy season, generally from May to October.

a) Human sampling

For the 2011 survey, a human centric sampling protocol was developed, selecting villages as per the most recent National census (2005), using a probability proportional to human population (PPP) method. This was done as a result of design challenges related to simultaneous collection of human and pig serological data and because of unknown or varying estimated prevalences among the surveyed diseases. Thirty villages each (denoted ILRI villages) were randomly selected from Luang Prabang and Savannakhet provinces (60 in total). Data was however only received and analysed from 59 villages, weighted by the human population. This was in addition to the 8 pre-selected ACIAR villages, 4 each in Xayabouri and Phongsaly provinces, selected based on accessibility, high district pig numbers, areas of high poverty and broad ethnic diversity.

Fifteen households were randomly selected from each village, with one consenting individual over 6 years of age randomly selected from each household for human sampling and interview.

Sample size calculation was obtained using the EpiTool statistical software (AusVet Animal Health Services, 2011) using an estimated prevalence of 50% in order to maximize sample size and to estimate human prevalence with 80% power and 5% precision (Okello *et al.*, n.d.). Village chiefs were also interviewed to attain general village data.

b) Pig sampling

Exact estimation of village pig populations was not possible prior to field visits due to the lack of census data. The number of pigs randomly sampled per village was matched to the number of people sampled, based on the assumption that villages with larger human populations would likewise have larger pig populations, given baseline surveys had revealed almost 100% of households had at least one pig (unpublished data, SPSP project 2011). As households were first randomly selected, pigs owned by these households were then randomly selected for blood sampling based on eligibility criteria (> 4 weeks old, not near full-term pregnancy). One pig from each household was sampled, 15 pigs per village for ACIAR villages. Pigs sampled from ILRI villages were not necessarily from the same household as the humans sampled. Since a PPP sampling method was not adopted here, seroprevalence estimates would have lower precision compared with the human serological survey. However, results should still reveal low, moderate, or high seroprevalences for the study diseases (Okello *et al.*, n.d.).

3.2.1.2.3 Serological analysis

The majority of laboratory testing was carried out in Lao PDR, at the National Animal Health Laboratory (MoAF) for pig samples and the National Centre for Laboratory and

Epidemiology (MoH) for human samples, assisted by in-country training from the Australian Animal Health Laboratory (AAHL). Human and pig sera samples were tested for the prevalence of antibodies to JEV, HEV, *coxiella burnetti*, and *brucella suis,* using a range of diagnostic tests, used for previous epidemiological investigations of zoonotic diseases of porcine origin in Lao PDR (Inthavong, Blaszak, Durr, *et al.*, 2012).

Human serum samples were tested for the presence of antibodies against Hepatitis E (HEV ELISA 4.0, MP Diagnostics Singapore), Japanese Encephalitis (JE) and JE: Dengue antibody ratio (JE-Dengue IgM Combo ELISA Test E-JED01C, Panbio Australia), brucellosis (non-commercial ELISA, Australian Animal Health Laboratory (AAHL), Australia) and *Coxiella burnetii* (FQS-MS-2P-664 IDVET, France). Pig serum samples were likewise tested for presence of antibodies against Hepatitis E (HEV ELISA 4.0v kit, MP Diagnostics Singapore), Japanese Encephalitis IgM and IgG (non-commercial kits, AAHL, Australia), brucellosis (non-commercial kits, AAHL, Australia), *coxiella burnetii* (FQS-MS-2P-664 IDVET, France).

Given the potential for the JEV ELISA to cross react with dengue fever antibodies, JEV testing was also provided for all JEV ELISA positive samples at the Armed Forces Research Institute of Medical Sciences (AFRIMS) in Thailand. Questionnaire and serological data was entered and stored in a secure database (SurVET[5]).

3.2.1.2.4 Further data analysis

A separate analysis was carried out on data from 3 of the 59 ILRI villages and 7 of the 8 ACIAR villages sampled (see chapter 4). Exploratory data analysis was carried out using Microsoft Excel and Winpepi (http://www.brixtonhealth.com/pepi4windows.html). Human and pig serological and questionnaire data were analysed separately. Questionnaire data from the ACIAR and ILRI villages were analysed separately, as a few modifications were made to the questionnaires during implementation in the ACIAR villages. Risk factor analysis results will be presented separately for the ACIAR and ILRI villages.

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[5] SurVET is a freeware in Indonesian, Lao and English. www.quest.survet.net

Disease prevalence was computed for each village, with confidence intervals calculated using Wilson's method (Winpepi Describe manual, 2015). Overall prevalences were estimated using a cluster sample methodology, with respective confidence intervals calculated using Cochran's procedure (Winpepi Describe manual, 2015). To look for significant relationships/differences between serological results and variables such as gender, ethnicity, and specific pork rearing and consumption habits, the overlap between confidence intervals for individual proportions were examined and compared. Where no overlap is observed between two confidence intervals, the difference (between two proportions) is deemed significant, whereas if there is an overlap the difference is not considered to be significant (Schenker & Gentleman, 2001). However, in the latter case, this is not necessarily true (that a lack of significant difference exists). This simple method has been shown to be less complicated than determining appropriate significance tests (with associated corrections, caveats, etc.) and is useful for quick exploratory data analysis (Payton, Greenstone & Schenker, 2003; Schenker & Gentleman, 2001). It is not regarded as an optimal method for nor does it replace precise significance testing, as it is more conservative and low power relative to the standard methods employed (Schenker & Gentleman, 2001). For variables exhibiting significance, prevalence ratios were used to estimate risk within a 95% confidence interval. Prevalence ratios are used in cross-sectional studies used for descriptive purposes, when prevalence is the appropriate measure of disease frequency (Thompson, Myers & Kriebel, 1998). It is more interpretable and consistent with estimating the true effect, and does not exaggerate positive risk factor effects as odds ratios tend to do (Thrusfield, 2005; Thompson, Myers & Kriebel, 1998).

3.2.2 Results

Prevalences for Brucella and coxiella were found to be negligible and no subsequent analysis was performed for significant disease risk factors. Only results for hepatitis E and Japanese encephalitis will be discussed here.

3.2.2.1 Human characteristics

A total of 160 individuals were interviewed and sampled in the 3 study provinces – 70 from Xayabouri (4 villages), 43 from Phongsaly (3 villages), and 47 from Luang Prabang (3 villages) provinces. Village characteristics were obtained by discussion with village heads or village committee members (Appendix Table 9.1). Overall, there were 54.38% female and 45.63% male respondents, with 73.75% aged between 15 and 64 years. 20% of respondents did not have their age recorded (ILRI villages only). Almost half of respondents were Khmou (48.75%), and other ethnicities included Hmong (23.13%), Lao Loum (11.88%), Thai Deng (8.13%), Thai Dam (6.25%) and Lao Tsam (1.88%). There were, on average, 4.96 (range 1-9) and 5.27 (range 1-13) members within the households in the ILRI and ACIAR villages, respectively. In terms of education level, over half of all respondents had completed some or all of primary school (59.38%), with 18.13% having some secondary education, 6.25% completing secondary school, 1.88% attending college or university, and 14.38% not having attended school. Completion of primary and, especially, secondary school and higher is fairly low nationally (MoH & LSB, 2012).

When asked about toilet ownership and daily use, it was revealed that 65.63% of all participant households had a toilet, which 64.38% of all respondents claimed to use daily. Respondents were asked to show their latrines to be assessed for their usage by the interviewer and 62.5% of toilets were observed as being frequently used, with 10.63% never being used (24.38% did not own toilets, 0.63% were used sometimes).

The household source of drinking water was predominantly piped water (88.13%) with 9.38% of respondents actually using bottled water (in Tha pene village, Luang Prabang province only).

Almost all respondents claimed that bed nets were used when sleeping (98.75%). Use of mosquito coils and repellent sprays were low at 14.38% and 6.25%, respectively, with almost half of study respondents claiming to not use any repellents (45.63%).

Pork consumption is common practice, with 95.63% of respondents claiming to consume well cooked pork, only 3.13% claiming to have it medium-cooked, and 1.25% stating to never eat pork. Most respondents claimed to have never consumed raw pig blood (85%), while 12.5% consume it 1 to 3 times per month and 2.5% consume it 5 times or more per month. There was no ethnic variation to this, except in Luang Prabang province, where the most respondents who claimed to consume pig blood one or more times per month were of Khmou ethnicity (9 of 10 respondents consuming pig blood, representing 19.15% of respondents from this province).

With regard to slaughter of pigs, 40.63% of respondents claimed to partake in slaughter, while most claimed to have handled raw pig meat/offal within the last 1 year (86.88%). The most common types of contact involved feeding pigs (66.25%), cleaning pigpens or enclosures (37.5%), caring for sick pigs (33.13%), and moving or handling pigs (32.5%). Approximately 20.62% of respondents (equal proportions of females and males) claimed to not have any contact with pigs.

With regards to respondents' perception of health in the last 4 weeks, just over half (51.88%) claimed that their health was 'okay', with 26.25% stating it was 'not good', 19.38% stating it was 'good', and only 2.5% stating their health was 'very good.'

3.2.2.2 Human serological results

The disease of highest prevalence in the three study provinces was HEV at 63.52% (95% CI 46.18-80.86). The highest prevalence of HEV (72.46%, 95% CI 60.95-81.61) was observed in Xayabouri province (Figure 3-1). Human disease prevalence by village and by province along with their 95% confidence intervals are shown in Table 9.2 and Table 9.3 in the Appendix.

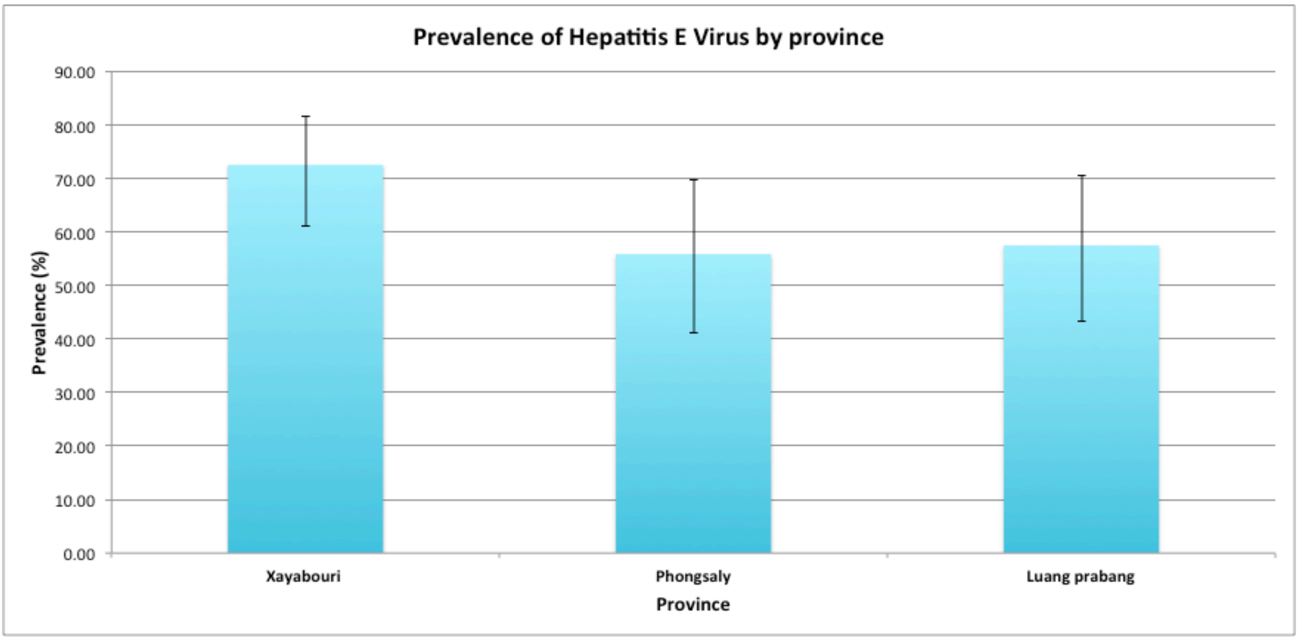


Figure 3-1 Prevalence of hepatitis E virus by province, with 95% Confidence Intervals

Village prevalences ranged from 13.33% - 93.75%, with the 3 highest recorded in Ang (93.75%, 95% CI 71.67-98.89), Poungkao (83.33%, 95% CI 43.65-96.99), and Pha Xang (95% CI 62.69-90.49) and Huay Keng (95% CI 49.02-94.33) villages tied at 80 percent. A comparison of hepatitis E prevalences among the ten study villages is shown in Figure 3-2.

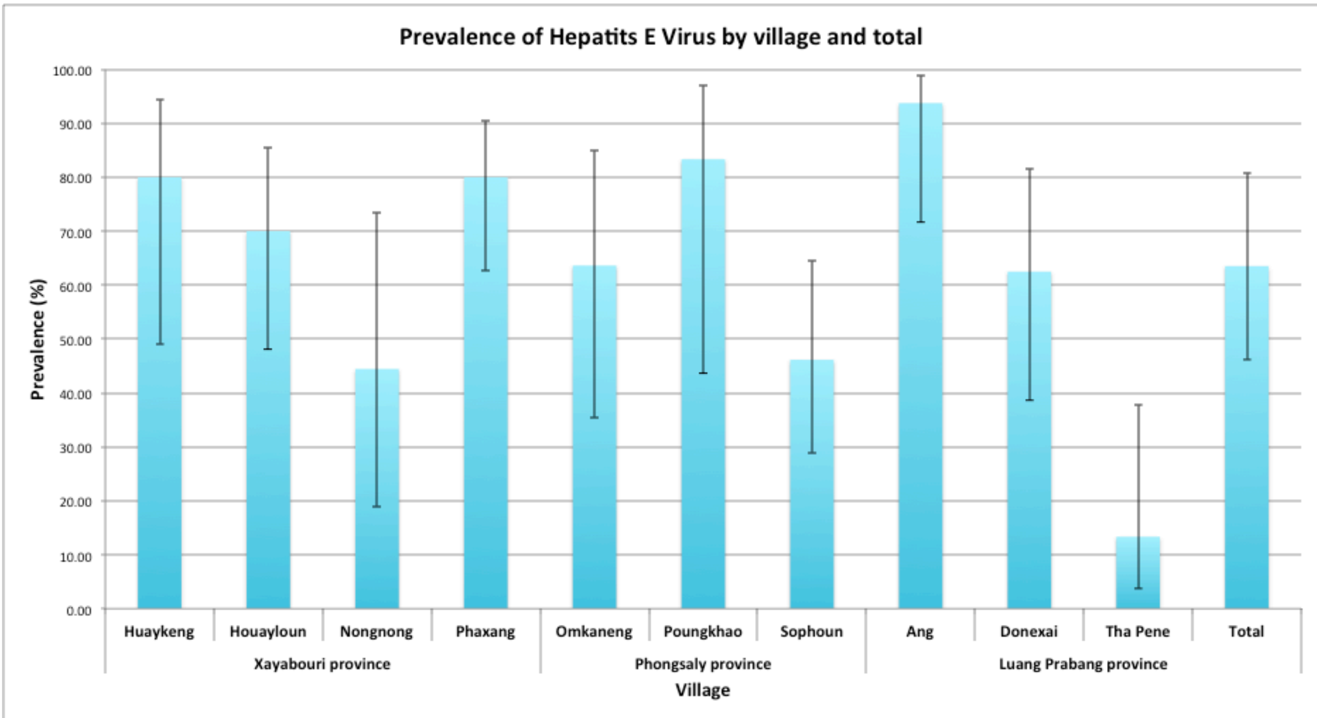


Figure 3-2 Prevalence of hepatitis E virus by village and total, with 95% Confidence Intervals

The overall prevalence of JEV was low at 2.52% (95% CI 0-5.96) with none detected in 7 of 10 study villages and none in Phongsaly province (Figure 3-3). Of the three villages where JEV was detected, Nong Nong village in Xayabouri province showed the highest prevalence of 22.22% (95% CI 6.32-54.74) as shown in Figure 3-4.

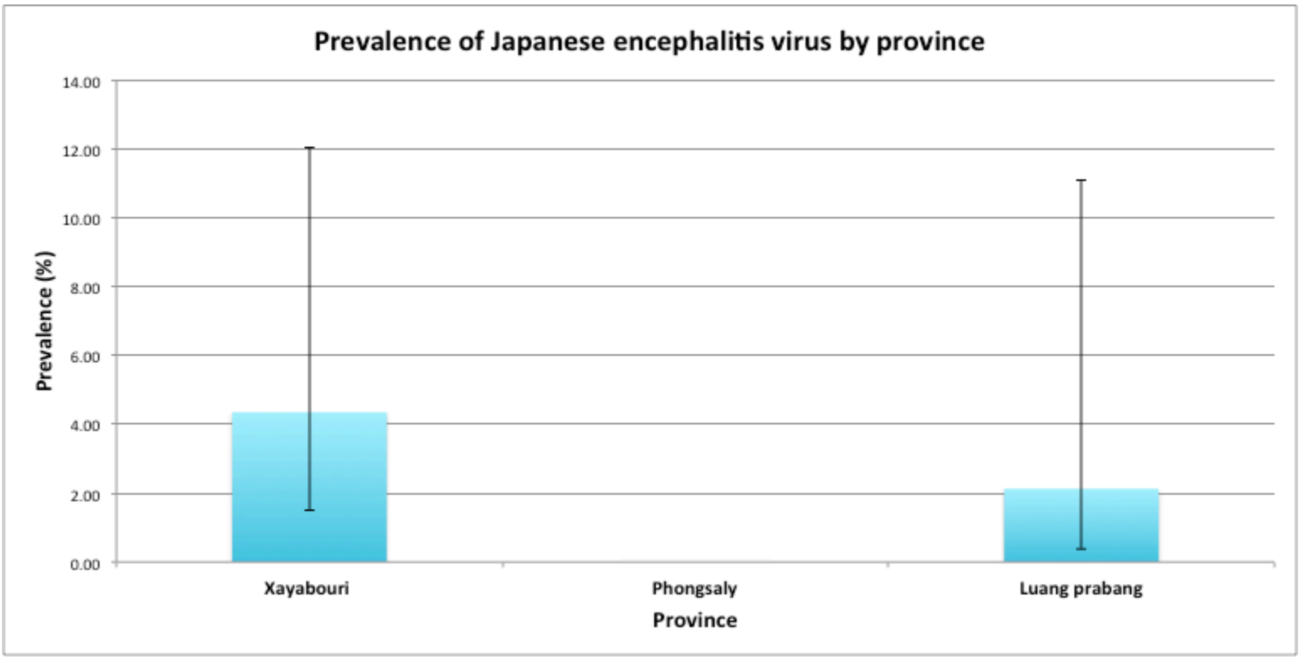


Figure 3-3 Prevalence of Japanese encephalitis virus by province, with 95% Confidence Intervals

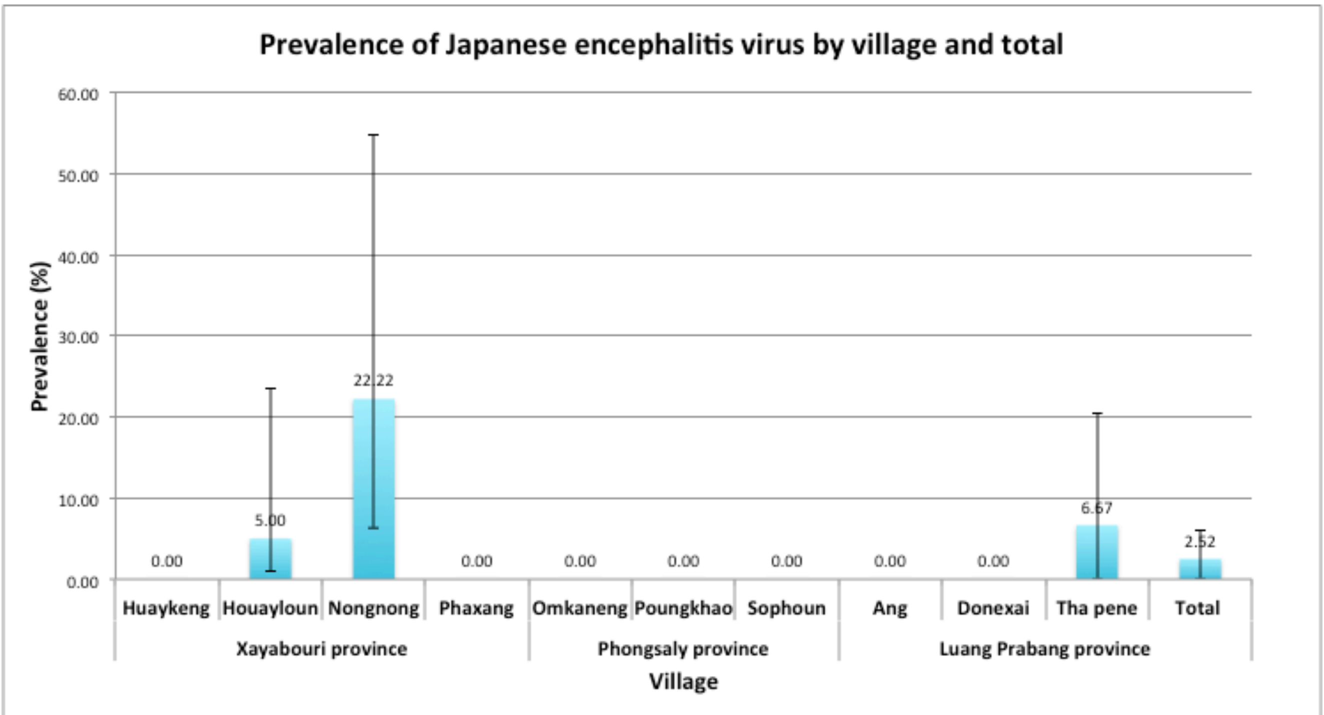


Figure 3-4 Prevalence of Japanese encephalitis virus by village and total, with 95% Confidence Intervals

3.2.2.2.1 Significant risk factors for human infection

Since JE prevalence was considerably low in all study villages, no factors were significant in the analysis of disease risk factors. Using the method of overlapping confidence intervals, factors found to be significant for HEV infection in Xayabouri and Phongsaly provinces (ACIAR villages) included gender, village of residence, ethnicity, contact with pigs (moving or handling pigs), and pig slaughter. Females were at a slightly higher risk of infection than males (PR 1.44, 95% CI 1.05-1.96) in these villages which could also be due to differing gender roles with regards to hygiene and sanitation practices or pig rearing activities.

Living in Pha Xang village, Xayabouri province, was associated with slightly higher risk of infection (compared with living in Sophoun village, Phongsaly province) (PR 1.73, 95% CI 1.10-2.72). This may be due to differences in pig rearing practices between the two villages as a higher proportion of respondents in Pha Xang village (73.33%) claimed to engage in moving or handling pigs compared with Sophoun village (19.23%).

Belonging to a particular ethnic group was also found to be an important risk factor, with Hmong (PR 2.41, 95% CI 1.04-5.58) and Khmou (PR 2.54, 95% CI 1.10-5.83) ethnicities being at higher risk of infection (compared with ethnic Thai Deng). Respondents who engaged in moving or handling pigs were at slightly higher risk of infection for HEV (PR 1.34, 95% CI 1.01-1.78).

Other types of pig contact considered included feeding pigs, cleaning pigpens, caring for sick pigs, building/repairing pigpens, playing with pigs, and having no contact at all. Engaging in these practices was not found to have significant differences in HEV prevalence. Of those claiming to have no pig contact at all (20.63%; 33 of 160 respondents), over half of these respondents were positive for HEV (54.55%; 18 of 33). However, the HEV serotype is unknown and disease positivity may be attributed to human-to-human transmitted serotypes. Slaughtering pigs was a risk factor for HEV infection (PR 1.42, 95% CI 1.07-1.87) and appears to be a common activity with 50.89% of respondents claiming to partake in this practice.

In Luang Prabang province (ILRI villages), significant risk factors included gender, village of residence, toilet ownership and usage, household source of drinking water, distance of household from a pigpen, and pig slaughter. Contrary to findings in the aforementioned two study provinces, females in Luang Prabang province appeared to be at a lower risk of infection with HEV compared with males (PR 0.26, 95% CI 0.11-0.62). This may be due to differing gender roles in these villages or perhaps an effect of the relatively small sample size.

Living in Donexai and Ang villages was also associated with a higher prevalence of HEV, compared with Tha pene village. Tha pene village is the most developed of the study villages in Luang Prabang province, with most respondents having a toilet in/within their household at the time of this survey and poor levels of ownership at Ang (6.25%) and Donexai (31.25%) villages. This is a possible explanation for the lower risk of HEV infection in those owning and using toilets (PR 0.39, 95% CI 0.19-0.78). While toilet ownership is not directly associated with zoonotic transmission of HEV, perhaps this is related to the fact that some households without latrines tend to practice open defecation in the forest or surrounding areas. Latrines are also not used while working in the fields, often due to the large distances between them and the village. Since pigs are often allowed to roam free in villages, open defecation may result in contact with contaminated pig urine or faeces. Coupled with poor hand hygiene practices, this could explain the higher risk of infection in those without toilets. Toilet ownership does not guarantee compliance with hand hygiene practices, and latrine ownership does not always denote usage (Tran, Odermatt, Le, *et al.*, 2006; Bardosh, Inthavong, Xayaheuang, *et al.*, 2014b; Phongluxa, Xayaseng, Vonghachack, *et al.*, 2013). Tha pene village has an improved sanitation system (see Chapter 4). Poor sanitation is also a known risk factor for infection with HEV (Aggarwal & Naik, 2009; Emerson & Purcell, 2003). Bottled water as a source of drinking water was found to be protective against HEV infection (PR 0.17, 95% CI 0.05-0.63). This was the primary household source of drinking water in Tha pene village only, whereas piped water was the predominant source in the other two villages.

Distance of households from the nearest pigpen was a risk factor for HEV, and not JEV, with those located > 150 metres away presenting a lower risk compared with those located within 0 to 10 metres (PR 0.17, 95% CI 0.04-0.63) and 11 to 30 (PR 0.16, 95% CI 0.05-0.51) metres from the household. Pig slaughter was also shown to increase risk of HEV infection (PR 2.00, 95% CI 1.47-2.73) even though only 14.89% of respondents from these three villages claimed to perform this practice.

3.2.2.3 Pig sample characteristics

A total of 153 pigs were sampled in this study – 40 pigs from Luang Prabang, 71 from Xayabouri, and 42 from Phongsaly provinces. Sampled pigs were all of local breed, with majority being bred by the owners themselves (57.62%) or by another farmer in the village (33.77%). A small proportion (8.61%) were purchased from another village.

With regards to quarantine practises of newly purchased pigs, 75.82% of respondents claimed to never perform this, while 5.88% claimed to carry it out sometimes and 1.96% always.

Reasons for keeping/rearing pigs were also explored in the participant questionnaire interviews, but only in Xayabouri and Phongsaly provinces (ACIAR villages). The three principal reasons for rearing pigs included having the ability to sell when money was needed (50.44% of 113 respondents), selling piglets for fattening (46.9%), and to sell fattened pigs (32.74%), with local consumption being less common at 16.81%. Village heads in Luang Prabang province (ILRI villages) indicated that the main purpose for pig raising in the village was to sell fattened pigs.

With regards to pig health, the majority of respondents (60.78%) stated that they experienced no problems in the pigs that were sampled in the previous 2 months (before this survey was carried out). This was followed by diarrhoea (5.23%) and coughing (3.27%), which was considerably less common [followed by not eating/well (2.61%), skin problems (1.96%), and weight loss/ill-thrift (1.31%)]. Questions regarding practices employed when pigs get sick revealed that over half the respondents (54.25%) purchased medications to treat the animals themselves; 16.99% did nothing, followed by calling the volunteer veterinary worker (VVW) for treatment (11.76%). When discussing sudden (adult) pig deaths in the last 1 year, 17.65% of all respondents reported experiencing pig deaths, and a total of 67 deaths were reported in all the study villages.

3.2.2.4 Pig serological results

Overall, the disease of highest prevalence in pigs in the three study provinces was found to be HEV with a prevalence of 75.82% (95% CI 64.18-87.46). The province with the highest prevalence of HEV was Phongsaly (90.48%, 95% CI 77.93-96.23), see Figure

3-5. The prevalences of swine disease with their 95% confidence intervals by village and by province are included in Appendix, Table 9.4 and Table 9.5.

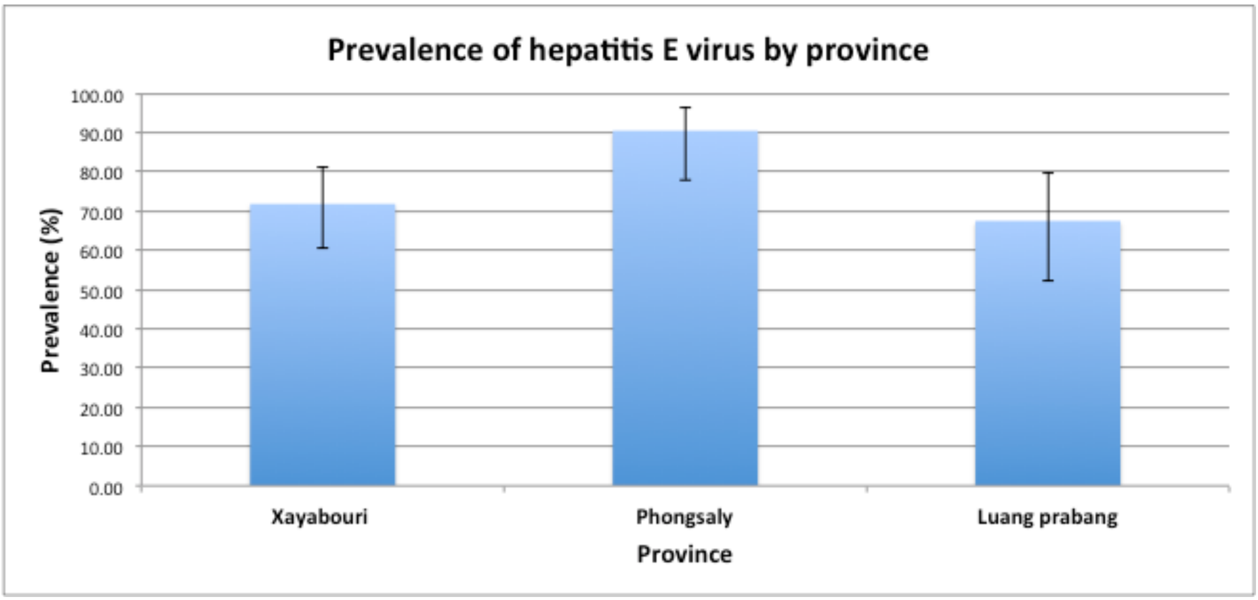


Figure 3-5 Prevalence of hepatitis E virus by province, with 95% Confidence Intervals

Village prevalences ranged from 50% - 100%, with the highest 3 occurring in Poungkao (100%, 95% CI 60.97-100), Ang (93.33%, 95% CI 70.18-98.81), and Omkaneng (90.91%, 95% CI 62.26-98.38) villages. A comparison of hepatitis E prevalence between the 10 study villages is shown in Figure 3-6.

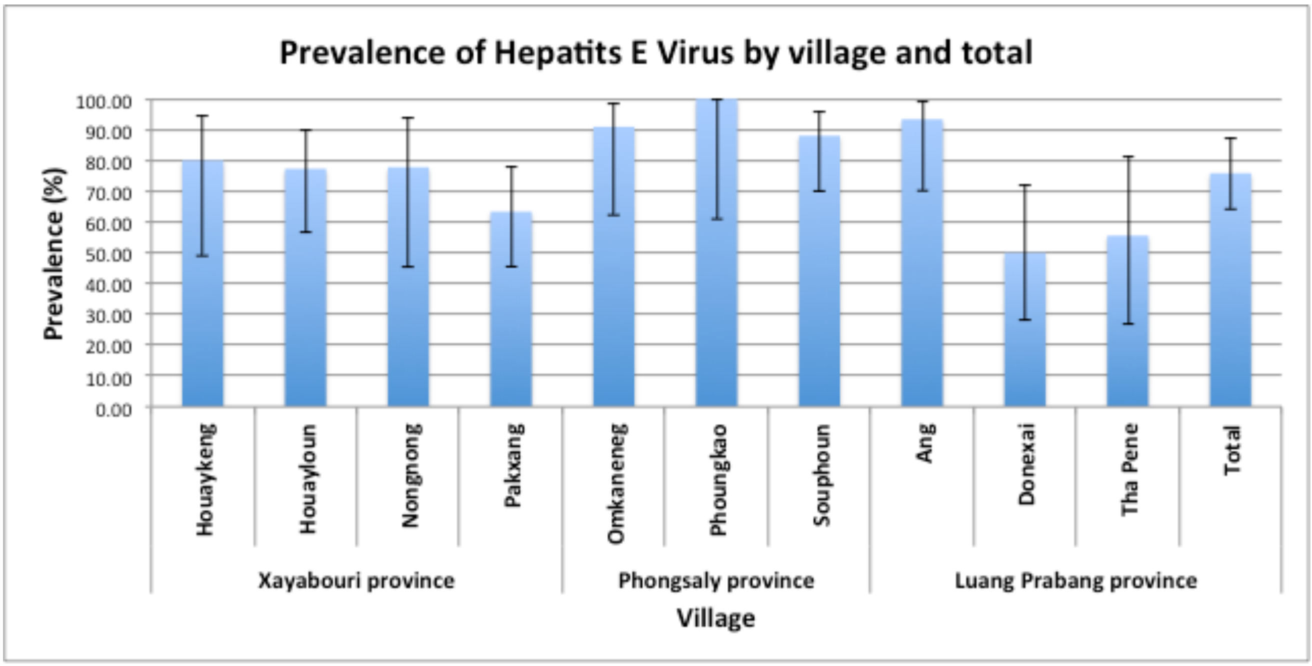


Figure 3-6 Prevalence of hepatitis E virus by village and total, with 95% Confidence Intervals

The occurrence of JE in pigs was low, with prevalence ranging between 0% and 31.25% and an overall prevalence of 9.15% (95% CI 1.19-17.11). No JEV was detected in Phongsaly province (Figure 3-7). It is important to note, however, that there were a number of intermediate results, particularly for Xayabouri province where 45% of samples (32/71) had intermediate results. Of these, 60% (18/32) were from Pha Xang village. Phongsaly province only had 4.76% (2/42) of samples with intermediate results, while Luang Prabang province had none. This may have had an impact on the true JEV prevalence for Xayabouri province.

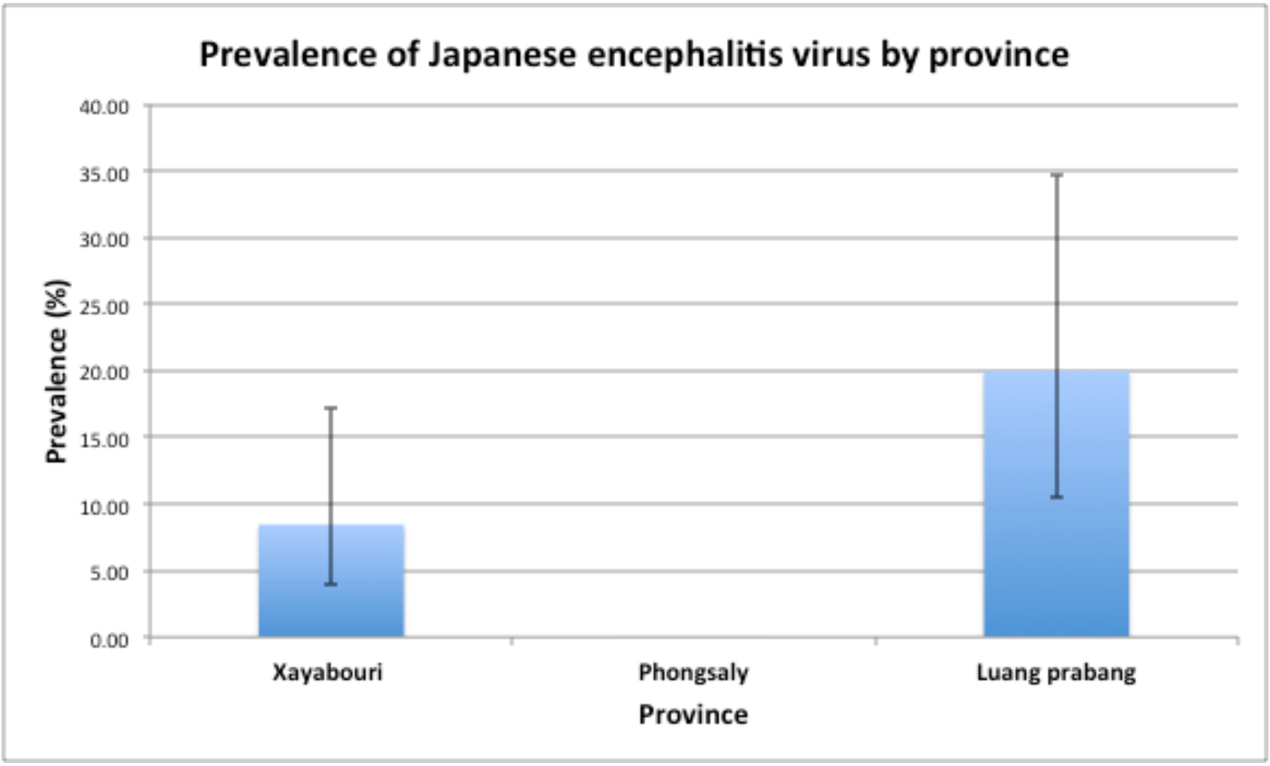


Figure 3-7 Prevalence of Japanese encephalitis virus by province, with 95% Confidence Intervals

At village level, the three highest prevalences were found in Donexai (31.25%, 95% CI 14.16-55.60), with Tha pene and Nong Nong villages at 22.22% (95% CI 6.32-54.74). No JEV was detected in 4 of the ten study villages. A visual comparison of JEV prevalence in the study villages (See Figure 3-8).

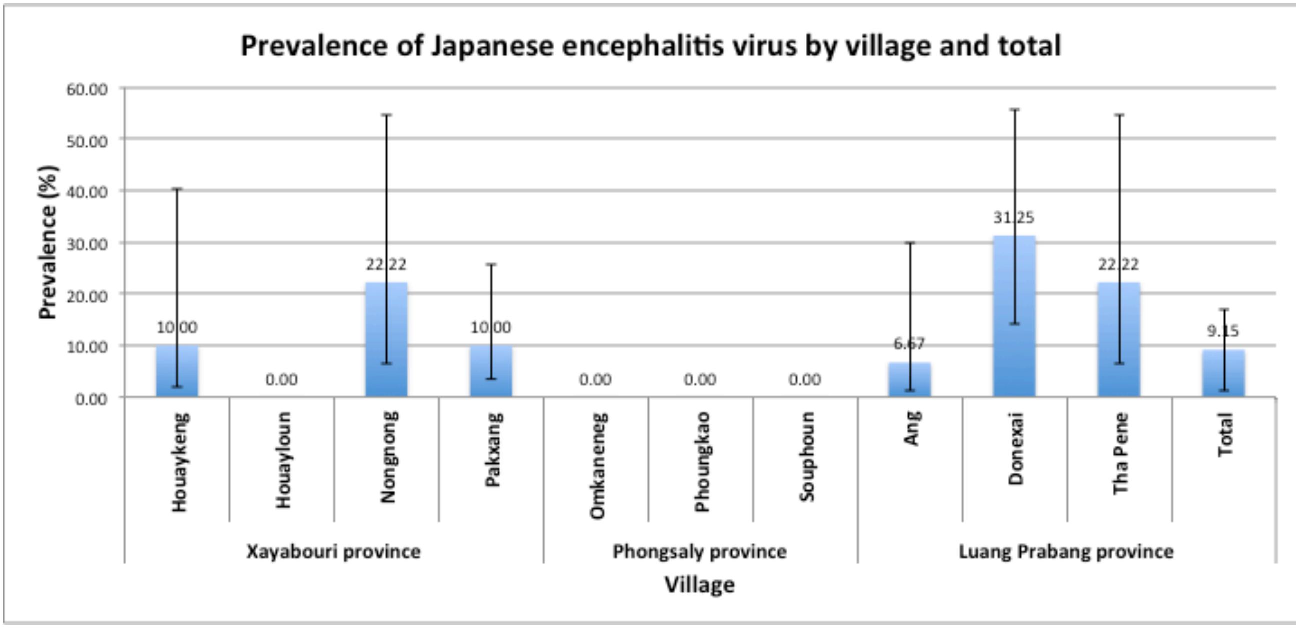


Figure 3-8 Prevalence of Japanese encephalitis virus by village and total, with 95% Confidence Intervals

3.2.2.4.1 Significant risk factors for pig infection

Using the overlapping confidence intervals method, no factors were found to be significantly different for hepatitis E infection among pigs. For Japanese encephalitis, although there was a slight overlap in the confidence intervals for the location where pigs are kept during the wet season, the prevalence ratio interval shows a significant difference at the 5% level, between those predominantly kept in an enclosure compared with those in penned housing. The risk of infection in Xayabouri and Phongsaly provinces (ACIAR villages) was higher in pigs kept in an enclosure (PR 7.5, 95% CI 1.48-38.06), when intermediate results were excluded from the analysis but no significant difference was found when they were included. However, only 2.53% (2/79) of sampled pigs were kept in an enclosure, whereas 94.94% (75/79) of pigs were in penned housing.

In Luang Prabang province (ILRI villages), the confidence intervals did not overlap, thus showing a significant difference in JEV infection between pigs kept in a fenced enclosure and those in penned housing during the wet season (PR 9.667, 95% CI 3.31-28.22). The same was also found during the dry season. Again, however, only 5% (2/40) of sampled pigs were kept in a fenced enclosure, while 72.5% (29/40) were in penned housing. Penned housing was the most common type of housing employed for pigs overall, in all 3 study provinces, with 7.19% (11/153) and 20.91% (32/153) of sampled pigs being allowed to free range some or all of the time during the wet and dry seasons, respectively.

3.2.3 Summary of findings

With the aim of determining point prevalences of a set of pig-associated zoonoses, a cross-sectional human and swine serological survey and risk factor analysis was carried out in selected villages in 3 provinces of northern Lao PDR. The methods used in the current analysis were adopted due to the small sample size and the subsequent challenges of finding significant associations as a result.

The prevalences of *Brucella suis* and *Coxiella burnetti* were found to be negligible and, therefore, not included in the analysis. Hepatitis E virus (HEV) was found to have the highest prevalence in humans and pigs, overall in the 2011 survey, at 63.52% and 75.82%, respectively. Human females were found to be at higher risk of infection in two of the study provinces, while having a lower risk of infection in the Luang Prabang province. This could also be due to varying pig-rearing practices in the different provinces. The influence of gender roles in pig production, particularly women who tend to be primary caretakers of household pigs, has been recognized as significant (Chittavong, Lindberg & Jansson, 2012; Phengsavanh, Ogle, Stur, *et al.*, 2011), and could, partly explain the higher risk of infection in females in this study in participating villages in two of the provinces surveyed. Certain types of contact with pigs (e.g. moving or handling of pigs, or engaging in pig slaughter) were also found to be a risk factor and varied among the study villages. Those of Hmong and Khmou ethnicity were found to have a higher risk of infection and the majority of the study respondents represented these two ethnic groups. No risk factors were found to be significant for HEV infection in pigs, although the prevalence across all survey areas was considerably high.

Meanwhile, pork consumption was not found to increase the risk of human infection with HEV in this survey and most respondents claimed to consume pork "well cooked." "Well cooked" was not defined in the questionnaires administered to respondents. Bardosh et al (2014b), in a rapid ethnographic study, found that "well cooked" means roasting the meat for 2-3 minutes. This would not kill pathogens and would not decrease the risk for parasitic zoonoses, nor other pig-associated zoonoses for which pork consumption is a risk factor. Structured questionnaires can sometimes fail to capture subtle differences that qualitative research is better able to encapsulate.

Japanese encephalitis virus (JEV) prevalence was low, at 2.52% and 9.15% in humans and pigs, respectively. It is unknown if this was related to the time of year that the sample collection was carried out; in July (Luang Prabang province) and October (Xayabouri and Phongsaly province), which are both during the rainy season. Laboratory diagnosis of JEV was undertaken using antibody testing, which indicates previous exposure and not necessarily active infection. No follow-up sampling was conducted immediately following the rainy season or in the dry season for comparison. The wet rain season is typically associated with high human and pig infections due to prolific growth in the mosquito population (Impoinvil, Baylis & Solomon, 2012). Further investigation using appropriate antigen testing would be needed to determine if a seasonality effect does exist in Lao PDR. No risk factors were found to be significant for human infection with JEV, but the type of pig housing was found to be significant for swine infection. The majority practice seems to be housing pigs in pens or enclosures, with some free ranging allowed depending on the time of year. Housing design and the quality of materials used has been found to determine the risk of potential JE vectors entering households, and therefore, the risk of human exposure to potentially infective bites in Lao PDR (Hiscox, Khammanithong, Kaul, *et al.*, 2013). This study found that houses made of poorer quality were at higher risk of mosquito entry and, therefore, exposure to potential JE vectors. Perhaps a similar relationship exists between pig housing and swine infection, although further research is required to elucidate this. While the majority of respondents (98.75%) reported using bed nets at night, it is important to note that this is mainly effective in protecting against malaria and not dengue, for which transmitting mosquitoes bite all day. A distinction was not made between usages of the bed nets in the household versus while staying near the rice fields, as some villagers do during harvest season (see chapter 4). So although bed net usage in households was found to be successful in reducing JE transmission in India (Dutta, Khan, Khan, *et al.*, 2011), transmission can still occur in the rice fields, which are the primary mosquito breeding grounds.

3.3 Comparison with data from the National Centre for Laboratory and Epidemiology

The Lao Early Warning Alert and Response (EWAR) Surveillance system, established at the National Centre for Laboratory and Epidemiology (NCLE), requires nation-wide reporting from all levels and types of health care facilities on 17 notifiable diseases/syndromes. Data is reported from 16 provinces, with Vientiane province split into municipality (capital city) and province. The indicator-based surveillance (IBS) system, also called the National Surveillance System for Notifiable Selected Diseases (NSSNSD), includes nationwide health care facilities where cases are identified and data is collected and reported to the public health authorities on a weekly basis (NCLE, 2013). Since 2009, the Lao EWAR network has expanded from 33 to 144 Districts in all 17 Lao Provinces, and the system has greatly enhanced early outbreak recognition (Phommasack, Moen, Vongphrachanh, *et al.*, 2012). Included in the seventeen notifiable diseases/syndromes are acute flaccid paralysis (AFP), fever and rash, acute jaundice, meningitis and acute encephalitis syndrome (AES). Information on reported cases and deaths for these syndromes spanning a 10-year period (2004 to 2013) is summarized and described below. Laboratory confirmation is not possible for the majority of cases, mainly outside the capital city and the syndromes investigated through this surveillance programme likely represent some of the diseases under study in the 2011 survey and those that are of interest here.

3.3.1.1 Data collection methods used for surveillance

The Lao EWAR system has developed pre-determined clinical or syndromic case definitions that are used by all facilities (see Table 3.1) (NCLE, 2013)

Syndrome/Disease	**Case Definition**
Acute Flaccid Paralysis (AFP)	Any child < 15 years of age with AFP – defined by sudden onset of paralysis, may occur in all parts of the body & characterised by: • Dropping of affected joint(s) • Decrease or absence of resistance to affected muscles when pushing

Fever & Rash	Any person presenting with fever and rash
Meningitis	A person presenting with acute onset of fever (usually >38° C) AND headache AND at least one of the following signs: neck stiffness, projectile vomiting, altered consciousness (lethargy, delirium, coma). *For children under 1 - fever & bulging fontanelle.*
Acute Encephalitis Syndrome (AES)	Acute onset of fever & a change in mental status (including symptoms such as confusion, disorientation, coma, or inability to talk) AND/OR new onset of seizures (excluding simple febrile seizures). May also include: increased irritability, somnolence or abnormal behaviour greater than that seen with usual febrile illness
Acute Jaundice Syndrome (AJS)	Any person with acute onset of jaundice with or without fever & absence of any known precipitating factors or suspected for leptospirosis

Table 3.1 NCLE case definitions for diseases/syndromes (included in PhD research) under national surveillance (NCLE, 2013)**.**

3.3.1.2 Acute flaccid paralysis (AFP)

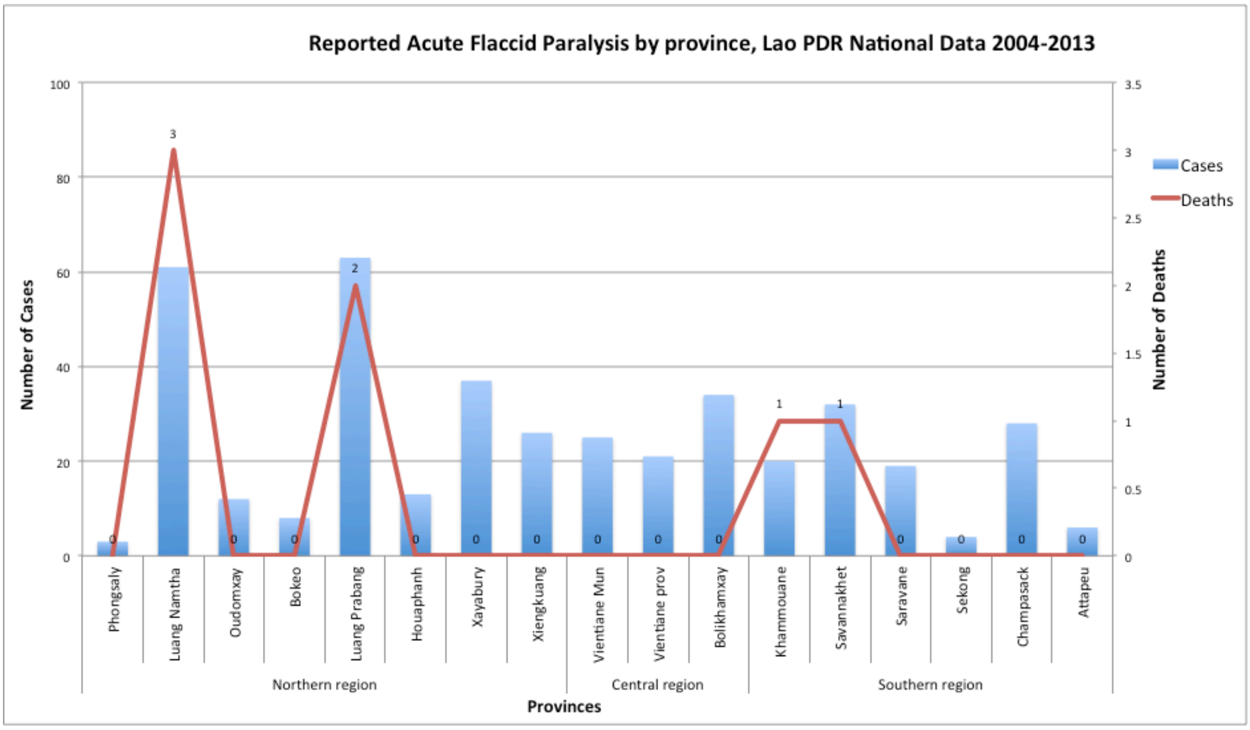
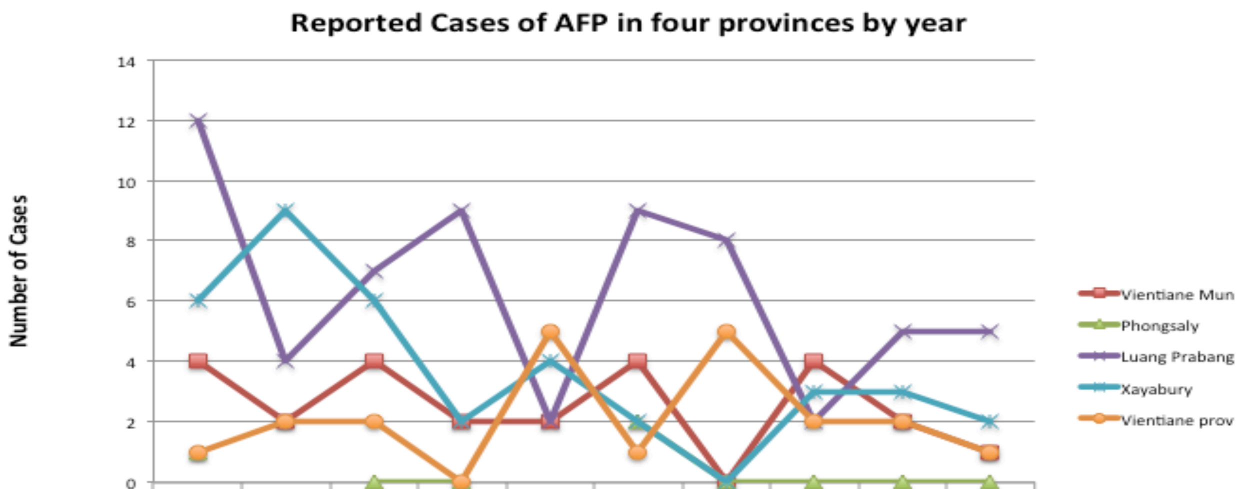


Figure 3-9 Reported cases and deaths of AFP in Lao PDR by province, from 2004-2013

Over a 10-year period there were a total of 412 cases and 7 deaths caused by acute flaccid paralysis in Lao PDR (Figure 3-9). The provinces reporting the most cases were Luang Prabang (63 cases, 2 deaths) and Luang Namtha (61 cases, 3 deaths) provinces, which also account for most number of deaths (71.4%) reported. The 5 provinces with the greatest number of cases were – Luang Prabang, Luang Namtha, Xayaburi (37 cases, 0 deaths), Bolikhamxay (34 cases, 0 deaths) and Savannakhet (32 cases, 1 death) provinces – of which the former 3 are situated in northern Lao PDR, with Bolikhamxay in central and Savannakhet in southern Lao PDR. These provinces account for 55.1% of total cases reported during the 10-year period. The 3 provinces with the lowest number of reported cases were Phongsaly (3 cases, 0 deaths), Sekong (4 cases, 0 deaths), and Attapeu (6 cases, 0 deaths) provinces.

Looking specifically at 4 provinces - the 3 study provinces Luang Prabang, Xayabouri, and Phongsaly and Vientiane municipality and province for comparison – over the 10 year period there were 128 cases of AFP and 2 deaths reported (see Figure 3-10). Luang

Prabang province appears to have had the highest number of reported cases of AFP in 7 out of 10 years (all years except 2005, 2008, and 2011). Meanwhile, the lowest number of reported cases, with gaps in reporting for some years, occurred in Phongsaly province. The difference between these two provinces is likely due to lack of reporting from Phongsaly province. As acute flaccid paralysis is one of the clinical symptoms of Japanese encephalitis, this data could be a proxy indicator for the disease in Lao PDR and a prompt for further diagnostic follow-up. With polio immunization available, other aetiologies for acute flaccid paralysis should also be considered, as it remains a common illness in children in some countries (Solomon, Kneen, Dung, *et al.*, 1998).



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Vientiane Mun	4	2	4	2	2	4	0	4	2	1
Phongsaly	1		0	0		2	0	0	0	0
Luang Prabang	12	4	7	9	2	9	8	2	5	5
Xayabury	6	9	6	2	4	2	0	3	3	2
Vientiane prov	1	2	2	0	5	1	5	2	2	1

Year

Figure 3-10 Reported cases of AFP in 4 provinces by year; blanks represent missing data (not reported)

3.3.1.3 Fever and rash syndrome

With a very broad definition (Table 3.1), overall there were 5369 cases and 27 deaths reported over a 10-year period in Lao PDR. The 5 provinces reporting the highest number of cases include Luang Namtha (376 cases, 0 deaths), Bokeo (720 cases, 3 deaths), Phongsaly (741 cases, 9 deaths), Luang Prabang (671 cases, 7 deaths), and Savannakhet (909 cases, 4 deaths) provinces, of which the latter 3 account for the most number of reported deaths (74.1% of total deaths). The first 4 provinces are located in northern Lao

PDR, while the last is located in the south, and together they account for 63.6% of total cases reported from 2004-2013. The 3 provinces reporting the lowest number of cases were Vientiane municipality (37 cases, 0 deaths), Sekong (86 cases, 0 deaths) and Attapeu (13 cases, 0 deaths) provinces.

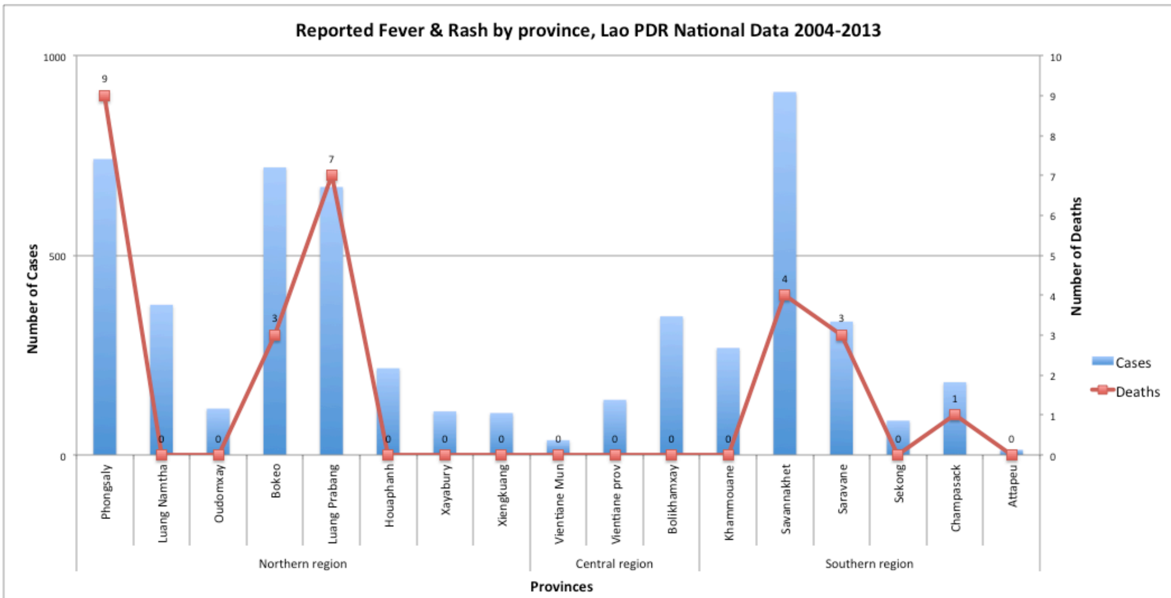
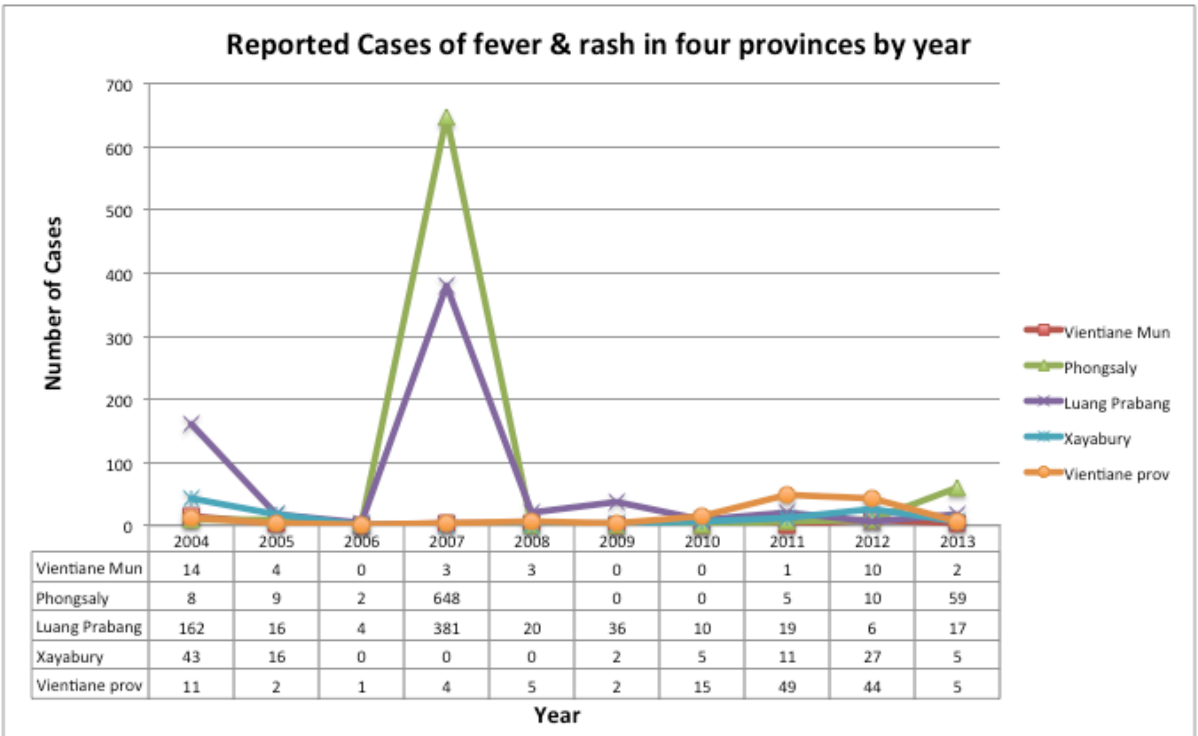


Figure 3-11 Reported cases and deaths of fever and rash in Lao PDR by province, from 2004-2013

Comparing the 3 study provinces and Vientiane municipality and province, over the 10-year period there were a total of 1696 cases and 16 deaths due to fever and rash reported (Figure 3-12). Of these provinces, Phongsaly and Luang Prabang appear to have the highest number of reported cases in 2007, accounting for 60.7% of total cases during the same ten-year period. It is unknown if this increase is due to an epidemic or low reporting in other areas. Meanwhile, the lowest number of reported cases was from Vientiane Municipality. Febrile illness is a feature of several diseases, including the diseases of interest in this study and many are not easily distinguished from each other without laboratory diagnosis. Although *brucella suis* and *coxiella burnetti* were not detected in the 2011 ILRI/ACIAR survey, their presence in Lao PDR is not excluded. Japanese encephalitis and hepatitis E are two other possible diagnoses and should also be considered due to their known endemicity in the country. While dengue is characterized by febrile illness, and indeed there were outbreaks occurring in 2007 in Lao PDR (Khampapongpane et al, 2014), cases are reported and investigated separately from other febrile illnesses through the national surveillance system and not included in this analysis.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Vientiane Mun	14	4	0	3	3	0	0	1	10	2
Phongsaly	8	9	2	648		0	0	5	10	59
Luang Prabang	162	16	4	381	20	36	10	19	6	17
Xayabury	43	16	0	0	0	2	5	11	27	5
Vientiane prov	11	2	1	4	5	2	15	49	44	5

Figure 3-12 Reported cases of fever and rash in 4 provinces by year; blanks represent missing data (not reported)

3.3.1.4 Acute jaundice syndrome (AJS)

Over a ten-year period, a total of 6464 cases and 5 deaths were reported in Lao PDR. The 5 provinces reporting the highest number of cases included Vientiane municipality (866 cases, 0 deaths), Oudomxay (660 cases, 1 death), Xiengkhuang (815 cases, 0 deaths), Savannakhet (873 cases, 0 deaths) and Champassack (1002 cases, 0 deaths) provinces, which account for 65.2% of total cases reported from 2004-2013 (Figure 3-13). Vientiane municipality is part of central Lao PDR, 2 provinces are located in northern Lao PDR and 2 are located in the south. The 3 provinces reporting the lowest number of cases included Phongsaly (6 cases, 0 deaths), Sekong (4 cases, 0 deaths), and Attapeu (8 cases, 0 deaths) provinces.

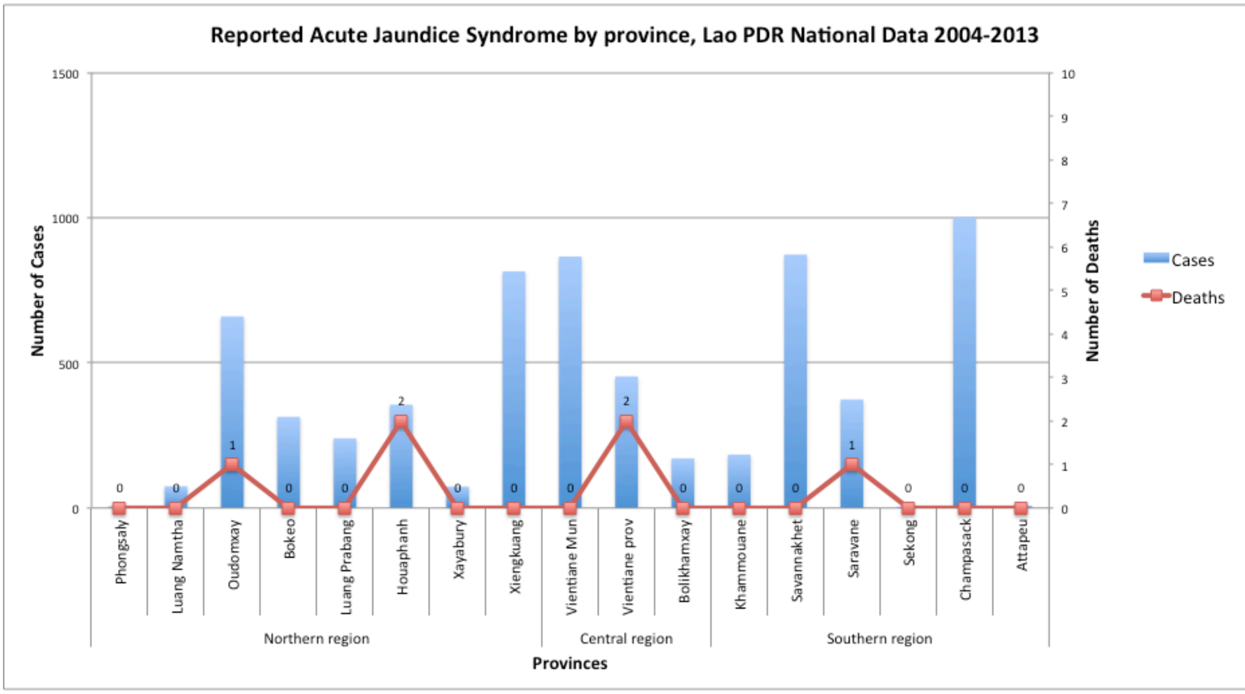
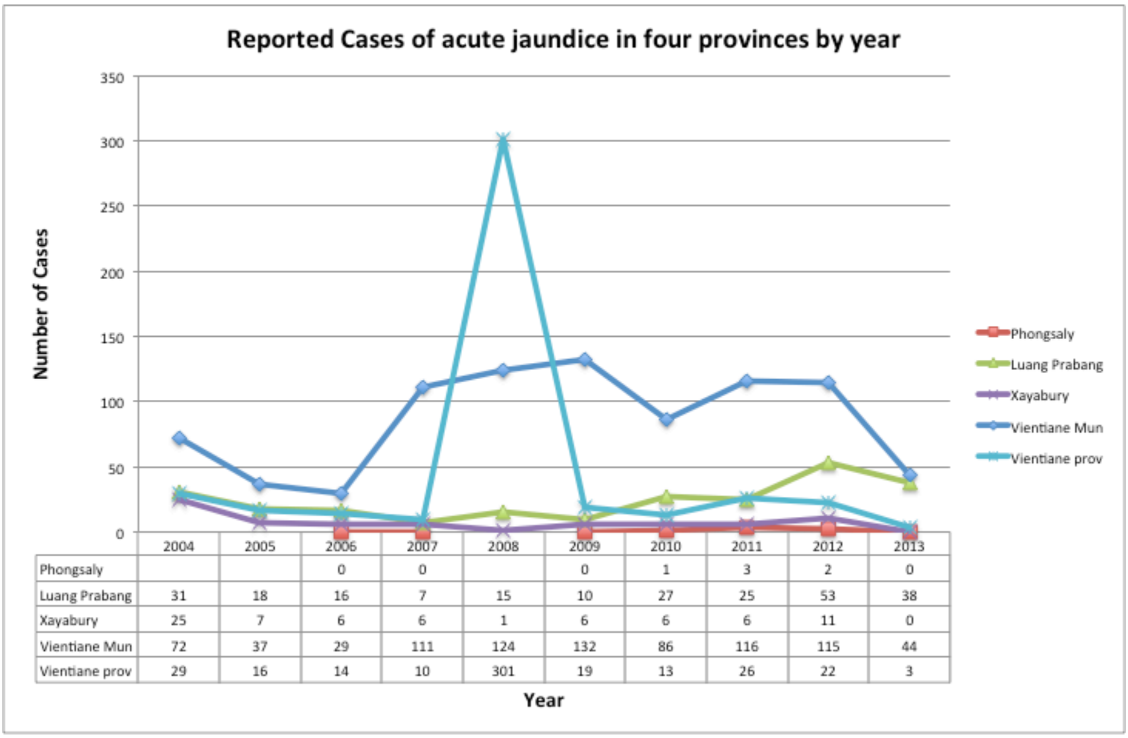


Figure 3-13 Reported cases and deaths of AJS in Lao PDR by province, from 2004-2013

Comparing the 3 study provinces and Vientiane municipality and province, over the same 10-year period there were a total of 1639 cases and 2 deaths related to acute jaundice syndrome. Vientiane province had the highest number of reported cases in 2008, accounting for 68.2% cases reported in the same year (Figure.3-14). The reason for this increase is unknown, however this is possibly due to a leptospirosis outbreak as an increase in the number of cases were seen after a series of floods in Vientiane in August 2008 (Mahosot Micro rev, issue no 6, 2009). It is also possible that the increase is in part an artefact of the surveillance system, as having a liver department at the hospital in Vientiane means that cases have a higher chance of being reported. Viral hepatic causes cannot be excluded either, including hepatitis E which has been detected in the province (Blacksell et al, 2007; Syhavong et al, 2010). Furthermore, Vientiane municipality reported the highest number of cases over the 10-year period, representing over half (52.8%) of total cases. The lowest number of reported cases was from Phongsaly, however, data is missing from this province for a few years (2004, 2005, 2008).



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Phongsaly			0	0		0	1	3	2	0
Luang Prabang	31	18	16	7	15	10	27	25	53	38
Xayabury	25	7	6	6	1	6	6	6	11	0
Vientiane Mun	72	37	29	111	124	132	86	116	115	44
Vientiane prov	29	16	14	10	301	19	13	26	22	3

Figure.3-14 Reported cases of AJS in 4 provinces by year; blacks represent missing data (not reported)

3.3.1.5 Meningitis

Between 2004 to 2013, there were a total of 3142 cases and 88 deaths due to meningitis reported in Lao PDR. The 5 provinces reporting the highest number of cases included Vientiane municipality (332 cases, 1 death), Houaphanh (273 cases, 11 deaths), Xiengkhuang (262 cases, 0 deaths), Bolikhamxay (323 cases, 8 deaths), and Savannakhet (647 cases, 11 deaths) with the highest reported cases of all 16 provinces; accounting for 58.5% of cases in the 10-year period (Figure 3-15). Although not too far behind the top five are Oudomxay (239 cases, 9 deaths) and Champassack (226 cases, 9 deaths) provinces. While Houaphanh and Xiengkhuang provinces are located in north, Vientiane municipality and Bolikhamxay province are part of central Lao PDR, with Savannakhet located in the south. The 3 provinces reporting the lowest number of cases again included Phongsaly (10 cases, 1 death), Sekong (6 cases, 0 deaths), and Attapeu (33 cases, 0 deaths) provinces.

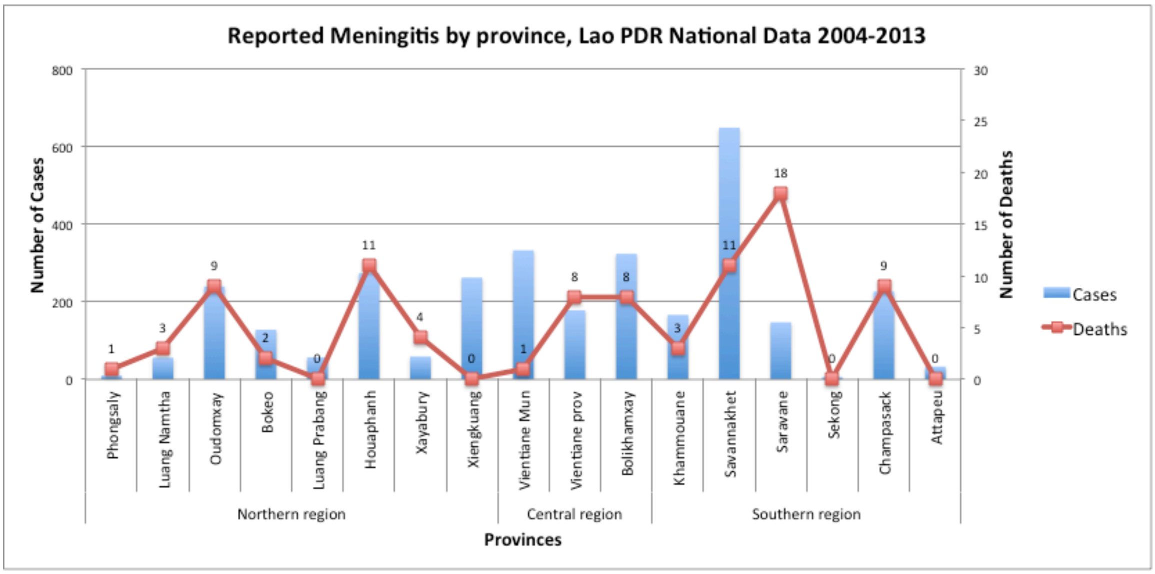
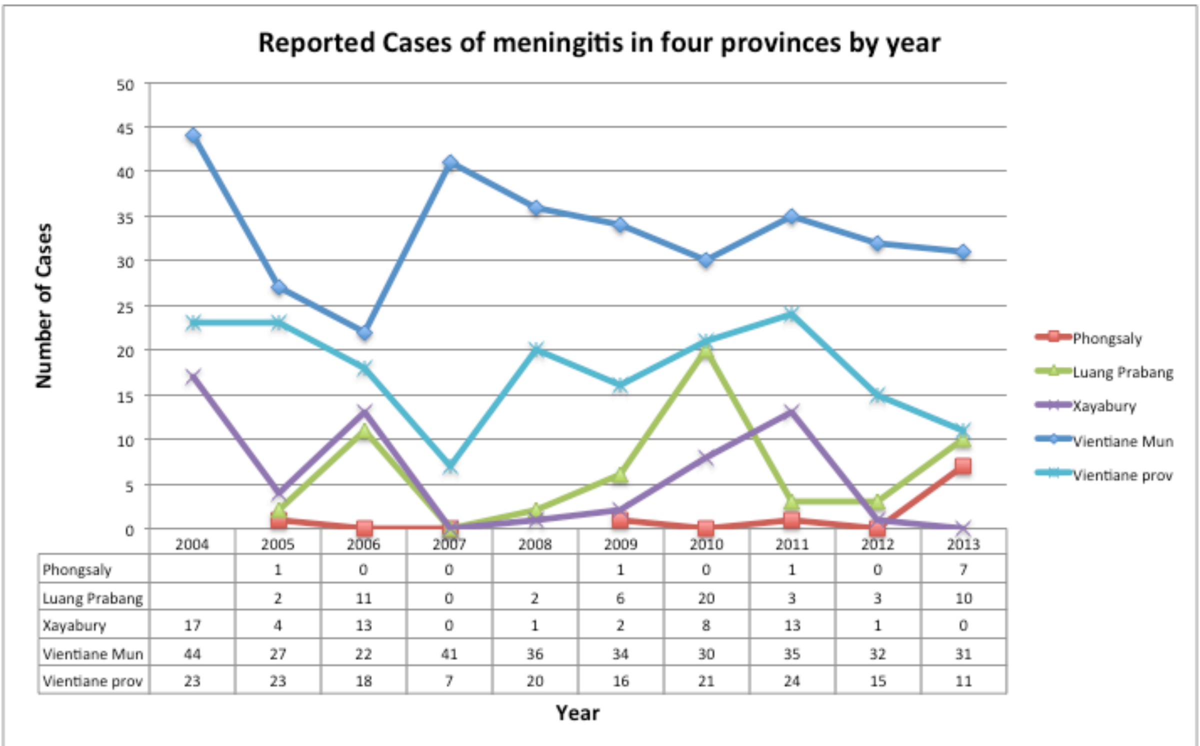


Figure 3-15 Reported cases and deaths as a result of meningitis in Lao PDR by province, from 2004-2013

Comparing the 3 study provinces and Vientiane municipality and province, over the same 10-year period there were a total of 636 cases and 14 deaths due to meningitis. Vientiane municipality reported the highest number of cases each year and over the 10-year period (52.2% of total cases) compared to the other provinces (Figure 3-16) with the most number of cases occurring in 2004 (44; 52.4% cases that year) and 2007 (41; 85.4% cases that year). This is followed by Vientiane province, which also has a higher number of cases each year and over the 10-year period (30% of total cases) compared with the other 3 (study) provinces. This is possibly an artefact of the surveillance system, as cases in the capital are more likely to seek health care and to be reported. However, there is again some missing information for 2004 and 2008 in Phongsaly and Luang Prabang provinces, with Phongsaly again showing the lowest number of reported cases. There are several possible causative agents for meningitis, including Q fever, brucellosis, and Japanese encephalitis, which are all known to cause meningitis in some cases. Therefore, consideration should be also given to these aetiologies given their potential for significantly poor outcomes.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Phongsaly		1	0	0		1	0	1	0	7
Luang Prabang		2	11	0	2	6	20	3	3	10
Xayabury	17	4	13	0	1	2	8	13	1	0
Vientiane Mun	44	27	22	41	36	34	30	35	32	31
Vientiane prov	23	23	18	7	20	16	21	24	15	11

Figure 3-16 Reported cases of meningitis in 4 provinces by year; blanks represent missing data (not reported)

3.3.1.6 Acute encephalitis syndrome (AES)

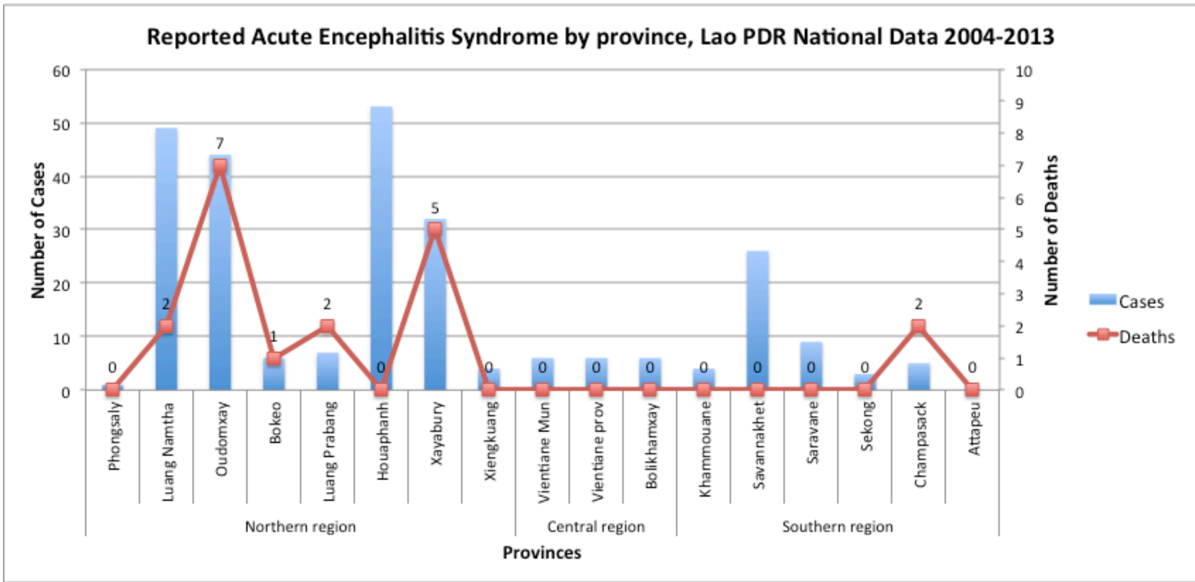
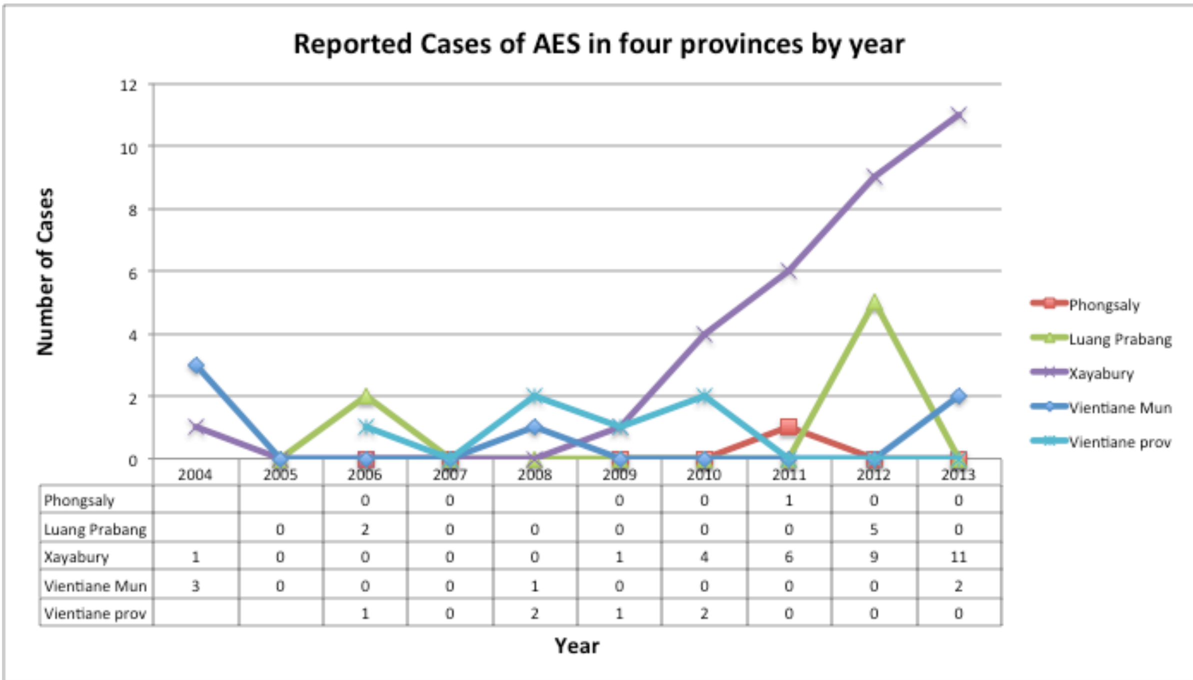


Figure 3-17 Reported cases and deaths due to AES in Lao PDR by province, from 2004-2013

During the 10-year period from 2004 to 2013, there were a total of 261 reported cases of acute encephalitis syndrome and 19 resultant deaths in Lao PDR. The 5 provinces reporting the highest number of cases included Luang Namtha (49 cases, 2 deaths), Oudomxay (44 cases, 7 deaths), Houaphanh (53 cases, 0 deaths), Xayabouri (32 cases, 5 deaths), and Savannakhet (26 cases, 0 deaths) provinces (Figure 3-17). These account for 78.2% of all reported cases and 73.7% of deaths during the 10-year period. Except for Savannakhet province located in the south, the rest are located in northern Lao PDR. Again, the 3 provinces reporting the lowest number of cases were Phongsaly (1 case, 0 deaths), Sekong (3 cases, 0 deaths), and Attapeu (0 cases, 0 deaths) provinces.

Looking at data from the 3 study provinces and Vientiane municipality and province, over the same 10-year period there were a total of 52 cases and 7 deaths from AES. Xayabouri province reported the highest number of cases overall (61.5% of total cases), showing an increasing trend from 2009 to 2013 (Figure 3-18). One plausible reason for this could be an increasing trend in Japanese encephalitis incidence, as the virus is known to be common in northern Lao PDR (Mayxay et al, 2013). This data could, therefore, also serve as a possible indicator for the disease and a prompt for further diagnostic investigation. Missing data again were Phongsaly, Luang Prabang, as well as Vientiane provinces (for 2004, 2005, and 2008), with Phongsaly therefore showing the lowest number of reported AES cases.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Phongsaly			0	0		0	0	1	0	0
Luang Prabang		0	2	0	0	0	0	0	5	0
Xayabury	1	0	0	0	0	1	4	6	9	11
Vientiane Mun	3	0	0	0	1	0	0	0	0	2
Vientiane prov			1	0	2	1	2	0	0	0

Figure 3-18 Reported cases of AES in 4 provinces by year; blanks represent missing data (not reported)

3.3.1.7 Overall summary

Examining the data provided by NCLE shows that the provinces reporting the most number of cases of illness (based on the top 5 provinces of all syndromes discussed above) seem to be located in northern Lao PDR. With the exception of Savannakhet, located in the south, which was in the top 5 for all syndromes discussed here. Possible reasons for a higher number of cases in the northern region could include better competency in health staff recognizing these syndromes versus other areas, frequent occurrence of these syndromes in the northern region versus other areas, or higher reporting in the region versus other areas. It has been suggested that differences in disease frequency exist in different regions of the country, which emphasizes the importance of heterogeneity in disease epidemiology within countries and have implications for therapy (Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013b).

It is important to consider that, being a syndromic surveillance system, the majority of diagnoses reported are clinically made and without laboratory diagnosis. Where low numbers of cases and/or deaths are reported it is unclear if this is due to low levels of reporting, lack of awareness or proper diagnostic capability, or failure of individuals to seek health care as a result of access barriers. It is likely a result of a combination of these factors, thus making it difficult to draw conclusions about true disease hotspots within the country. Thus emphasizing the requirement for analysing patterns in the reported syndromes to determine whether aetiologically specific investigations by the health authority with laboratory confirmation are necessary.

3.4 Discussion - links between survey observations, syndromic surveillance and the 4 study diseases

An exploratory analysis of the data collected through the 2011 ILRI/ACIAR survey, triangulated with information from the NCLE national surveillance program and secondary literature, demonstrates that northern Lao PDR is a potential area for transmission of pig-associated zoonoses, particularly hepatitis E virus, especially given the type of pig contact and rearing practices adopted in the region. Though laboratory confirmation is not possible for the majority of cases, mainly outside the capital city, the syndromes investigated through the national surveillance programme likely represent some of the zoonotic diseases under study in the 2011 survey and those that are of interest to this PhD research. Therefore, it has the potential to highlight problem areas for further investigation.

Direct comparisons between the two sets of data is difficult as the NCLE data is from the national level and does not specifically discuss zoonoses, while the 2011 survey involves a small subset of villages in 3 provinces. Nonetheless, some observations can be made from this exploratory analysis. Although *brucella suis* and *coxiella burnetti* were not detected in the 2011 ILRI/ACIAR survey, their presence in Lao PDR has not been excluded. Both diseases have been detected in cattle in Lao DPR and in neighbouring countries, such as Thailand (Vongxay, Conlan, Khounsy, *et al.*, 2012b; Douangngeun, Theppangna, Soukvilay, *et al.*, 2016; Ekpanyaskul, Santiwattanakul, Tantisiriwat, *et al.*, 2012; Suputtamongkol, Rolain, Losuwanaruk, *et al.*, 2003; Manosuthi, Thummakul, Vibhagool, *et al.*, 2004). Although JEV prevalences were found to be quite low in the 2011 survey, cases of acute encephalitis syndrome were highest in Xayabouri province, with an increasing trend in disease incidence between 2009 and 2013. Acute flaccid paralysis was also found to be relatively higher in Luang Prabang and Xayabouri provinces, though gaps in data reporting were found especially for Phongsaly. Luang Prabang and Phongsaly provinces also ranked in the top 5 for fever and rash (acute febrile illness syndrome). Although none of the study provinces ranked in the top 5 for acute jaundice syndrome and meningitis, other northern Lao PDR provinces did.

While human infection with hepatitis E has mainly been reported from the capital city, Vientiane, high pig seroprevalences have been reported from northern areas (Conlan, Jarman, Vongxay, *et al.*, 2011; Syhavong, Rasachack, Smythe, *et al.*, 2010; Blacksell, Myint, Khounsy, *et al.*, 2007; Conlan, Vongxay, Jarman, *et al.*, 2012). Thus, if human infections are contracted from pigs, hepatitis E is likely to have more importance in rural areas of the country (LOMWRU, 2008). Given the high human and swine HEV prevalences in the 2011 survey, it possibly contributes to the occurrence of acute jaundice syndrome in the human population. This raises concerns about potential exposures in women, particularly those who are pregnant or of child bearing age, as human female respondents were found to be at higher risk of infection in two of the study provinces (Xayabouri and Phongsaly provinces). The greatest clinical impact and poorest outcomes occur in pregnant women, in whom the case fatality rate can range between 20-30% and sometimes as high as 40% (Balayan, 1997; Labrique, Sikder, Krain, *et al.*, 2012). The influence of gender roles in pig production, particularly women who tend to be primary caretakers of household pigs, has been recognized as significant (Chittavong, Lindberg & Jansson, 2012; Phengsavanh, Ogle, Stur, *et al.*, 2011), and could, therefore, partly explain the higher risk of infection in females in participating villages in two of the provinces surveyed.

Further work would be needed to confirm the HEV serotype detected in the 2011 survey; though zoonotic genotypes are said to have been circulating in Xayabouri province at the time of the survey (personal communication, ACIAR project coordinator); as well as other potential etiological agents behind these syndromes. As mentioned in Chapter 1, HEV genotype 4 has been reported in northern Lao PDR in pigs proving that zoonotic genotypes do exist in the country (Conlan, Jarman, Vongxay, *et al.*, 2011). In neighbouring countries, genotype 4 HEV has also been detected in humans in the northern region of Vietnam (Hijikata, Hayashi, Trinh, *et al.*, 2002; Koizumi, Isoda, Sato, *et al.*, 2004). While genotype 3 has been isolated from pigs in Cambodia and Thailand (Caron, Enouf, Than, *et al.*, 2006; Cooper, Huang, Batista, *et al.*, 2005).

As alluded to previously, low numbers of cases and/or deaths do not necessarily imply an absence of these diseases or syndromes. However, surveillance systems can only function as effectively as the information is reported to it and underreporting of disease levels and data completeness can be a problem in poorer areas due to limited resources (Lescano, Larasati, Sedyaningsih, *et al.*, 2008). The multiple factors that influence their appropriate diagnosis and reporting makes it extremely challenging to draw conclusions about true disease hotspots within the country. Syndromic surveillance can be useful in monitoring disease trends, aiding early detection of human illness and triggering a rapid response when clusters are found, thereby reducing morbidity and mortality (Henning K.J., 2004). Other benefits include a lower resource requirement compared with active surveillance and potentially more efficient targeting of existing resources, and the ability to deal with multiple diseases of public health importance. However, challenges lie in efficient follow-up due to the difficulty in predicting how well syndromes correlate to diseases under surveillance (Henning K.J., 2004). Resulting in further challenges in the development of policies and treatment protocols that target disease prevention and control. Thus further investigation of causative agents is required. With this in mind, the findings emphasize the need for further developments in diagnostic capability and capacity in Lao PDR in order to both enhance disease surveillance and reporting and to appropriately and successfully address the disease burden.

Currently, NCLE's response to the data collected and reported through the indicator based surveillance system includes rapid risk assessments for unusual events, outbreak investigations, as well as collaboration with relevant stakeholders and sectors for training and coordination of the action response (NCLE, 2013). Weekly and monthly surveillance reports are also produced and distributed to providers at all levels of the system (NCLE, 2013). Further systematic analysis on disease trends revealed in these reports is warranted given that some of the syndromes reported are likely to represent endemic zoonoses such as hepatitis E, JE, as well as others. In view of the low level of awareness of these diseases in the country and the presence of risk factors for their transmission, consideration should, therefore, be given to endemic pig-related zoonoses. The higher risk of infection with HEV in women is concerning, particularly for pregnant women, and monitoring of acute jaundice incidence in this population group is vital to prevent adverse outcomes. Maternal and child health programs in the country should be made aware of these risks and engage in health education and promotion activities regarding exposure to swine and their related products during handling, slaughter, and food preparation, especially if pregnant.

The 2011-2015 One Health work plan of the Lao National Emerging Infectious Diseases Coordinating Office (NEIDCO) has zoonotic disease surveillance as a high-level priority. It is crucial for endemic zoonoses, such as the ones discussed in this thesis and others (for example, leptospirosis, trichinellosis, neurocysticercosis, etc.), to be included in the systematic analysis of surveillance data. Further enhancement of both the human and animal health surveillance systems is also necessary, in addition to being linked to higher-level policy outcomes advocated by the Lao Ministries of Health (MOH) and Agriculture and Forestry (MAF).

3.5 Conclusion

Pig production is an important income source in Lao PDR, particualrly for highland people, and systems and practices vary throughout the country and among different ethnicities. Inherent to pig rearing are risks of animal and human diseases, and producers face a number of challenges including diseases that cause high morbidity and mortality and resulting financial loss. With the government's strategy to promote local pig farming for food security and poverty alleviation through smallholder livelihood development and market orientation (Lao PDR Ministry of Agriculture and Forestry, 2010), it is imperative that these risks are minimized. Better linakges between human and animal diseases surveillance systems in the country is needed with the inclusion of endemic pig-associated zoonoses in the systematic analysis of surveillance information. Given the risk factors identified in the study population of the 2011 ILRI/ACIAR survey and the syndromes reported through the national surveillance programme, pig zoonoses likely represent more of the disease burden in the country than is presently known. Research into the diagnosis of these diseases is necessary to improve disease surveillance and disease burden calculations.

4 Knowledge, attitudes and practices of villagers in northern Lao PDR

4.1 Introduction

Pig husbandry is an important source of income in rural areas of Lao PDR. Risk factors for pig-associated zoonoses include food preparation and consumption practices, contact with swine in high-risk occupations, and general contact with infected pig faeces, bodily fluids, or birthing products as a result of poor sanitation and slaughter practices (Dean, Crump, Greter, *et al.*, 2012b; Corbel, 2006; Carcopino, Raoult, Bretelle, *et al.*, 2009; Kwak, Chu, Hwang, *et al.*, 2013; Hinjoy, Nelson, Gibbons, *et al.*, 2012; Meng, Wiseman, Elvinger, *et al.*, 2002; Bouwknegt, Frankena, Rutjes, *et al.*, 2008). Preparation and consumption of raw or undercooked pork is common practice in Lao PDR and is known to increase the risk of infection with *Brucella*, *Coxiella*, and hepatitis E (Dean, Crump, Greter, *et al.*, 2012b; Corbel, 2006; Hinjoy, Nelson, Gibbons, *et al.*, 2012; Blacksell, Myint, Khounsy, *et al.*, 2007; Bouwknegt, Frankena, Rutjes, *et al.*, 2008). In general, unregulated slaughter practices and poor hygiene and sanitation practices are also of concern for disease transmission (Corbel, 2006; Carcopino, Raoult, Bretelle, *et al.*, 2009; Kwak, Chu, Hwang, *et al.*, 2013; Aggarwal & Naik, 2009; Emerson & Purcell, 2003; Bouwknegt, Frankena, Rutjes, *et al.*, 2008). In addition, the proximity of rice fields to households that also rear pigs has been proposed as a risk factor for transmission of JE (Impoinvil, Baylis & Solomon, 2012; Liu, Gibbons, Kari, *et al.*, 2010b).

Information about the knowledge, attitudes and beliefs of the people with regard to pig-associated zoonoses and their risk factors for transmission is limited in Lao PDR and the wider Southeast Asia region (Burniston, Okello, Khamlome, *et al.*, 2015). Information on people's beliefs and practices surrounding health in general and health seeking behaviour is also lacking. The influence of culture, religion and ethnicity is important as they play a major role in health beliefs and treatment seeking practices. Health is commonly associated with spiritual balance as opposed to factors surrounding nutrition, hygiene and healthcare practices (Barennes, Tran, Latthaphasavang, *et al.*, 2008; Shirayama, Phompida & Kuroiwa, 2006). In Lao PDR, studies have shown that certain ethnic groups have an aversion to taking therapeutics if not deemed 'sick', impacting the efficacy of prevention and control programmes such as mass drug administration (MDA) for parasite control (Barennes, Sengkhamyong, Sambany, *et al.*, 2011; Bardosh, Inthavong, Xayaheuang, *et al.*, 2014a). Financial barriers influence health seeking behaviours, and are one of the reasons traditional medicine is commonly used and supported within the country. Other reasons for the use of traditional medicine include its perceived efficacy, cultural acceptance, minimal side effects, accessibility and lower cost in comparison to modern medicine (WHO & Lao PDR Ministry of Health, 2012; Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005).

This study aimed to examine disease incidence and to determine if qualitative assessments can be used to inform surveillance in the absence of robust diagnostics.

4.1.1 Use of qualitative research

Quantitative epidemiological methods have traditionally been the gold standard, but increasing recognition is being given to the need for qualitative methods, particularly when trying to understand the social, political and economic context or factors that influence disease transmission (Baum, 1995).

Qualitative research has been described as using a naturalistic approach, which seeks to understand phenomena in context specific settings (Hoepfl, 1997). Quantitative research uses experimental methods and quantitative measures to test hypotheses and aims to determine causality, predict, and generalise findings (Hoepfl, 1997). These two methods of inquiry produce different, and often complementary, information. Qualitative methods enable an understanding of phenomena for which there is limited information, to discover new or more in-depth information on things that are already known or where quantitative measures would not adequately describe or interpret (Strauss & Corbin, 1990). Qualitative research can be used to study how individuals and communities interpret health and disease, and examine interactions between various actors relevant to a given public health issue (Patton, 1990). Qualitative methodologies also provide the ability to relate information or findings to the reader in a way that may be more meaningful than quantitative methods. Health improvement can only result from initiatives embedded in local knowledge and that have local support (Baum, 1995). Participation of communities in the development and implementation of intervention programmes is crucial; the lack of which is the reason why many interventions fail.

Starting with the people most affected by pig-associated zoonoses, the study employed a mixed methods approach to look at all the factors and players relevant to these zoonoses as a public health problem in Lao PDR.

4.1.1.1 Knowledge, attitudes, and practices (KAP) survey methodology

KAP surveys can be used to obtain information on local health related knowledge, attitudes and practices and are a useful approach to try to understand the socio-cultural and economic contexts in which public health programs are implemented (Launiala & Size, 2009). The importance of local perceptions, health beliefs, social expectations, and behaviours in shaping patterns of infectious diseases is well recognized (Tanner, Chuquimia-Choque, Huanca, *et al.*, 2011; Helman, 2007; Nichter, 2008). Socio-cultural factors in transmission and control of pig-associated zoonoses have previously been explored in Lao PDR (Burniston, Okello, Khamlome, *et al.*, 2015). Benefits of conducting KAP surveys include ease of design and implementation and its usefulness in identifying interventions that are more likely to be suitable, acceptable and, therefore, successful in a community (Launiala & Size, 2009). However, there is a need to ensure data quality, as the accuracy of information can be influenced by many different factors including location of the interview, presence of other people, question formulation, sensitivity of topics being discussed, informant accuracy, and translation between 2 or more languages/dialects, etc. (Launiala & Size, 2009). There is also the concern of courtesy bias, whereby particpants may respond with answers perceived as favourable to the researcher (Bhattacharyya, 1997; Stone & Campbell, 1984).

KAP surveys often apply semi-structured or structured questionnaires (Launiala & Size, 2009; Tran, Odermatt, Singphuoangphet, *et al.*, 2007; Shirayama, Phompida & Kuroiwa, 2006; Sychareun, Hansana, Phengsavanh, *et al.*, 2013; Tokizawa, Nagai, Hirakawa, *et al.*, 2010) while some studies have used exclusively a qualitative or mixed methods approach (Strandgaard, Johansen, Aagaard-hansen, *et al.*, 2008; Greenhalgh, Helman & Chowdhury, 1998; Phongluxa, Xayaseng, Vonghachack, *et al.*, 2013). Perceived benefits of this quantitative approach include ease of design, implementation and interpretation as a result of quantifiable data, generalizability of small sample results to the larger population and cross-cultural comparability (Bhattacharyya, 1997; Stone & Campbell, 1984). Concern with this approach is that it provides a limited understanding of the socio-cultural context and underlying factors (Launiala & Size, 2009). This is rectified using a more mixed methods approach, incorporating qualitative research methodologies, thus reducing the limitations of single method designs and increasing the validity of data collected (Launiala & Size, 2009; Bhattacharyya, 1997; Stone & Campbell, 1984).

4.1.1.1.1 KAP survey using focus group discussions

Focus group discussions (FGDs) are considered an efficient method for collecting qualitative data with straightforward and inexpensive implementation and well described techniques (Khan & Manderson, 1992; Robinson, 1999). Focus group discussions are useful as rapid assessment tools, especially in studying attitudes and behaviours and often complement data gathered using other research methods. Defined as in-depth and open-ended group discussions, they last between 1-2 hours and explore a specific set of issues on a predefined topic (Robinson, 1999). They describe and understand the level of awareness, opinions, fears, problems, perceptions, interpretations, beliefs and behaviours of specific communities or groups of people in relation to a particular topic or issue (Khan & Manderson, 1992; Basch, 1987). They have been used to assess public attitudes to illness, experience of disease and health services, health behaviours, as a needs assessment and to evaluate health programmes (Robinson, 1999; Basch, 1987; Khan & Manderson, 1992). As a means to gather rich information in a social context, they are differentiated from individual in-depth interviews through group interaction and dynamics, an informal and relaxed atmosphere, and the open-ended nature of the discussions (Robinson, 1999; Khan & Manderson, 1992). This format allows participants to freely express their views and opinions in a natural setting. Robinson (1999) highlights additional advantages including encouragement of contributions from those who are often reluctant to participate in surveys or feel they have nothing to say, allowing those who are illiterate or have specific difficulties to participate without discrimination, and facilitation of discussions on more sensitive topics through less reserved members breaking the ice or providing mutual support.

Group dynamics can sometimes be a hindrance in focus groups and time limitations can prevent detailed discussion. Poor management can lead to dominance of discussions by few participants, and conflict or power struggles among those of different status, resulting in bias (Robinson, 1999). Other issues include the relatively small sample sizes and purposive selection of participants, that does not allow for generalisation of findings to the larger population (Khan & Manderson, 1992; Basch, 1987). Robinson (1999) states that generalizability of results can also be improved through the sampling strategy used to recruit participants and an advantage lies in bringing together diverse groups of people to discuss shared experiences. Bias can be introduced in the collection and interpretation of data if discussions are carried out in a subjective manner and further error can be introduced when carried out in indigenous languages that then require translation (Khan & Manderson, 1992). Back-translation is also not always possible when large amounts of data are involved or when time constrained. Khan & Manderson (1992) consider that data quality can be enhanced if analysis is done properly, noting the exact views expressed by participants, the number of participants expressing certain views, and drawing fairly stable conclusions. Crosschecking views and behaviours with observations also enhance data quality (Khan & Manderson, 1992). Observations by the researcher are also included in the discussion, where available and appropriate, as they provide context in which events occur and enables the researcher to see things participants may not be aware of or may be unwilling to discuss (Patton, 1990).

4.1.2 Study aims and objectives

Our understanding of local knowledge, attitudes and practices in relation to pig-associated zoonoses in Lao PDR is limited. This study aimed to determine sociocultural factors that influence human behaviour in the context of pig-associated zoonoses and ascertain the level of knowledge and awareness of villagers in relation to the study diseases or their associated syndromes and identify the main human health problems at the village level. Questions were framed to,

- Identify/understand perceptions surrounding human and animal health in general

- Determine level of awareness of zoonoses in general and beliefs surrounding disease transmission
- Identify health-seeking behaviours related to human health and influences on the decision to seek care and the type of care sought.
- Identify main animal health problems (with a focus on pig health) at the village level and practices related to animal health, with a specific focus on handling of sick or dead animals and animal products as a risk factor for the study diseases
- Determine the presence of other practices considered to be risk factors for the study diseases (and possibly other zoonoses) and attitudes towards them.

4.2 Materials and methods

4.2.1 Study design

This study employed a qualitative approach using FGDs and direct personal observations. These methods were used to enable access to people from different ethnic and educational backgrounds, to gain insight into their opinions, beliefs and experiences in an informal and comfortable environment. Triangulation with secondary data was also carried out to validate observations (Chapter 3).

Focus group discussions (FGDs) were carried out at the village level in each of the 3 study provinces in northern Lao PDR - Phongsaly, Xayabouli, and Luang Prabang. Attempts were made to organize formal focus groups (in terms of a pre-set time, duration of time spent for each FGD, and number of people included per session) but were more often of an informal nature as some participants would come and go or new participants would join part way through the discussions. An interview guide was used to direct the focus groups (Appendix II), with modifications as necessary depending on the participants' ease in responding, their focus/agenda in attending the discussions, as well as any time constraints on their part. A translator was used, but the moderator of the discussion was the researcher.

4.2.1.1 Participant recruitment

Focus group participants were selected by convenience (8-10 participants) and depended on who was available at the time of the discussion. In each village, the researcher and translator met with the village chief(s) to discuss the purpose of the study and to determine an appropriate time when villagers would be available. Participants were invited to join the focus group by the village chief. Where possible, separate focus groups were conducted for men and women, to create a comfortable environment for participants to communicate, however due to time constraints and/or work commitments in the fields, this was not always possible and some FGDs were of mixed gender. Focus group sessions lasted between 1-2 hours with the village chief selecting the time and location for the discussions, at the villagers convenience. Villagers aged ≥ 15 years of varying occupations, ethnicity, and educational background were encouraged to participate. Individuals who did not consent, or whose head of household did not consent to participate were not included.

4.2.1.2 Ethical considerations

Verbal consent was obtained from all participants at the start of each FGD; participants were asked if they were comfortable talking about the health of the household and livestock keeping practices in the village. A brief introduction to the researcher and translator was provided at the beginning of each discussion, as well as a brief explanation of the purpose of the study, types of questions that would be asked, time required for the discussion, and assurance that participants could withdraw from the discussion or from specific questions at any time should they choose. Reassurance that all responses would remain anonymous and confidential was given. Participants were requested to speak one at a time, to give each person an opportunity to express their views, and to respect the fact that all participants may not share the same opinions. Other participants or the village chief, if present, usually apprised participants who entered late of the topics of discussion.

4.2.1.3 Sample size and data collection

The sampling protocol used for the ILRI/ACIAR survey in 2011 was incorporated into the qualitative assessment at the village level with modifications. FGDs were to be carried out in 4 villages in Mai District, Phongsaly Province, and 4 villages in Xayabouri district, Xayabouri Province (the 8 ACIAR villages). For consistency, 4 villages were selected by the MOH from Luang Prabang Province (2 from Luang Prabang District and 2 from Chompet District) from the 59 ILRI villages. One village in Mai District, Phongsaly Province was excluded, as it was undergoing a human and pig intervention for taenia/cysticercosis involving a mass drug administration (MDA) programme. One village in Luang Prabang District was excluded, as the villagers did not wish to participate unless they were to receive treatment (villagers had previous experience of human samples being collected for testing with no feedback).

The interview guide was translated into Lao prior to being administered. Attention was paid to the ability of participants in understanding the questions being asked of and comfort in answering them, and modifications were made where necessary. Photographs were used to show clinical signs and symptoms of the study diseases and associated syndromes whenever necessary (Appendix II). Delicate topics were also handled with utmost sensitivity.

4.2.2 Data management and analysis of qualitative data

The researcher facilitated all FGDs with the help of the translator. Data for each focus group discussion was collected manually with responses and notes taken in English, while the translator related all questions and answers between participants and the researcher. Discussions were initially audio recorded, however this practice was discontinued as some groups were quite large and with children usually present for the discussions, there was a high degree of background noise.

Data was recorded electronically using Microsoft Word and entered into NVivo 10 for analysis. Inductive analysis or the 'general inductive approach' was employed to analyse results which allows for critical or significant themes to emerge from the raw data (Thomas, 2003; Patton, 1990 – from Hoepfl, 1997). Focus group discussion content was coded into major and minor (or parent and child) themes based on a pre-set thematic framework centred on the questions asked in each focus group. Under each theme summaries were created for each village using a matrix format. Summaries were further assessed, and findings are summarized below augmented with personal observations.

4.3 Results

4.3.1 Characteristics of the study villages

Villages included in this survey were all rural, with some being more developed than others and all located at various distances from the main district centre (Table 4.1).

4.3.1.1 Ethnic groups

In Phongsaly province study villages, most common ethnicities were Khmou and Tai dam (Table 4.2). In Luang Prabang and Xayabouri provinces, most villagers belonged to the Khmou, Hmong, or Lao loum ethnic groups.

Province	District	Village	# HHs	# Toilets	Number of FGs conducted*	# of FGD Particpants		Number of HV/TH/SH in village		
						Male	Female	HV	TH	SH
Phongsaly	Mai	Poungkao	22	20	2	7	10	1	1	1
		Omkaneng	30	8	2	8	14	0	2	2
		Sophoun	106	106	2	5	20	0	1	2
Luang Prabang	Chompet	Ang	93	93	2	8	9	1	0	1
		Donexai	59	20	2	9	9	1	2	0
	Luang Prabang	Tha Pene	112	104/5	1	4	4	0	2	0
Xayabouri	Xayabouri	Huay Keng	92	62	1	10	9	1	0	0
		Pha Xang	136	136	1	3	6	1	1	0
		Nong Nong	46	10	2	9	10	1	1	0
		Houay Loun	145	125	2	6	8	0	0	0

Table 4.1 Summary of Village Characteristics and Focus Group Discussions.
*Where only 1 FG was conducted, these were mixed groups with men and women. HH= household; FG (D)= focus group (discussion); HV=health volunteer; TH=traditional healer; SH=spiritual healer.

Province	District	Village	# Ethnic groups	List ethnic gps	Notes about village ethnicity
Phongsaly	Mai	Poungkao	1	Khmou	
		Omkaneng	2	Khmou, Tai dam	Only 3 HHs are Tai dam
		Sophoun	7	Tai dam, Tai deng, Khmou, Lao sung, Lao loum, Phou noy, Thai khao	Mostly Tai dam and Tai deng
Luang Praba	Chompet	Ang	4	Hmong, Khmou, Lao loum, Tai dam	Tai dam (1 person who married into this village)
		Donexai	1	Khmou	
	Luang Prabang	Tha Pene	3	Khmou, Hmong, Lao loum	
Xayabouri	Xayabouri	Huay Keng	3	Hmong, Khmou, Lao loum	About 20 HHs are Khmou and Lao loum
		Pha Xang	4	Hmong, Lao loum, Yao, Khmou	Mostly Hmong & Lao loum
		Nong Nong	1	Hmong	
		Houay Loun	2	Khmou, Lao loum	Mostly Khmou

Table 4.2 Ethnic groups represented in each study village

4.3.2 Main human health problems by province

Focus group discussions included questions about what participants considered to be the main health problems in their village and whether they experienced any of the symptoms or syndromes outlined in the 'Criteria for Illness' (Figure 4-1). This discussion took considerable time and participants were quite willing to discuss their health issues. In some cases, this was all that participants were willing to discuss and some would leave the FG once they had done so. Commonly mentioned symptoms and syndromes are described below and summarized in Table 4.3.

Patients admitted/who have presented to hospital or health centre with the following diseases, if diagnosis is made – Japanese encephalitis, hepatitis E, Q fever, or brucellosis. Alternatively, and more likely, patients diagnosed with the following syndromes – acute febrile illness, acute jaundice, central nervous (CNS) infections (with meningitis, encephalitis, or acute flaccid paralysis). Or with the following combination of symptoms:

1. Fever, headaches, sweats, joints or muscle pain

OR

2. Nausea, vomiting, loss of appetite (anorexia)

AND

3. Enlarged tender liver (hepatomegaly) or acute liver failure

OR

4. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis

Figure 4-1 Criteria for Illness used to capture information relevant to study diseases and their associated syndromes

4.3.2.1 Definitions

"Neurologic problems" was a term often used by discussants to describe a combination of symptoms including dizziness, back pain, headache, tingling in arms and legs, eye pain, joint (arthritic) and muscle pain, and fatigue.

4.3.2.2 Phongsaly province

The most commonly mentioned illnesses were gastritis, abdominal pain and "neurologic problems" in all three study villages. Combinations of headache, dizziness, muscle pain, and joint pain, sometimes with fever were often described as "neurologic problems." Diarrhoea and fever (sometimes with rash) during the hot season and respiratory symptoms (cold, flu, fever, etc.) in the cold/dry season or as the seasons changed were the next most commonly mentioned health issues. The exact cause of these illnesses was usually not known, as indicated by one participant:

"Here we also have problem with diarrhoea in hot season…don't know why, many households have people with diarrhoea" (Male FG, Poungkao village)

Discussants from Poungkao village described an outbreak that had occurred 2-3 years previously in which 6 children came down with fever, rash, headache joint and muscle pain of unknown cause. Fever with rash was also mentioned in Omkaneng and Sophoun villages in both adults and children. 'Itchy nodule' or fever with nodules was reported in adults & children, but more so in children. It is unknown if these were parasitic nodules or a term used to describe rashes.

Two cases of seizures were reported – one in was a 20 yr. old from Omkaneng village with epilepsy who died after falling into a fire during a seizure. After unsuccessful attempts at cure from a spiritual healer, a child in Poungkao village who had experienced seizures since the age of 2 (now 11 years old) was diagnosed with a "neurological problem" by the district hospital but was told that nothing could be done. Cases of high fever with convulsions were reported mainly in children in Sophoun village, believed to be encephalitis:

"We see a lot of people with high fever, but when we touch their body we feel it's very hot and the patients says they feel very cold, so we usually give them a cover…sometimes 3 or 4 covers which makes them feel warm but makes the temperature go high and patient gets overheated and sweats, and sometimes they have convulsions." (Male FG, Sophoun village)

"We don't know why [northern part of village sees many children with fever and convulsions]…we have a child, now 7 years old, in the past who had high fever and convulsions" (Female FG, Sophoun village).

4.3.2.3 Luang Prabang province

The most common ailments reported in Luang Prabang were gastritis and abdominal pain, and respiratory problems when the seasons changed or during the cold season. Respiratory symptoms included cold, cough, flu, sore throat, and pneumonia and occurred especially in children. In Ang village, it was suggested that the cause of gastritis in men was high alcohol consumption. Diarrhoea and acute febrile illness (AFI) were the next most commonly mentioned illnesses. AFI is often clinically diagnosed as dengue, of which a few cases were reported. Tha pene village mentioned a case of severe AFI with jaundice that was diagnosed as dengue; and having experienced a dengue outbreak in the village in June 2013. A participant at Ang village also stated that her daughter was diagnosed with a high fever and shock syndrome at a private hospital but was not informed of the cause. This child had experienced the same illness, 2-3 times previously.

"Neurologic problems" were mentioned in all 3 villages, and included symptoms of headache, body and muscle aches, dizziness, and tingling in the fingers and feet. Some suggested that this was a result of working hard in the fields. Tapeworm was reported as a problem in Donexai village. Adults are not included in school-deworming programmes that administer treatment twice per year, and some "*feel they have a lot of tapeworm*."

A possible case of rabies occurring 2-3 years ago was also reported in Tha pene village, where a villager had been bitten by a dog and developed symptoms of rabies 3 months later (photosensitive, itchy skin, did not recognize anyone) and died. The case was not laboratory confirmed.

Participants in Donexai stated that malaria was no longer considered to be a problem in the village, due to previous involvement of the Red Cross. The Red Cross had worked in this village from 2004-2012, providing training for a village health volunteer, medications for treatment of malaria and diarrhoea, and bed nets. No other symptoms were described as per our clinical criteria in all 3 villages.

4.3.2.4 Xayabouri province

The most common problems reported in the 4 study villages were "neurologic problems", diarrhoea sometimes with fever during the hot season, and numerous cases of AFI. "*Neurologic problems*" were stated as being very common, particularly in the elderly. Diarrhoea and abdominal pain was reported in all study villages, occurring more frequently in children. Cases of AFI, with symptoms of fever, headache, joint/muscle pain, were mentioned in 3 of the study villages – Huay Keng, Pha Xang, and Nong Nong villages. One of these cases in Nong Nong village was diagnosed as tick-borne fever, but aetiology of other AFI cases was unknown.

Gastritis, and respiratory symptoms in the cold season (cold, fever, pneumonia, cough, sore throat, and pharyngitis) were suggested as being very common, particularly in Huay Keng and Houay Loun villages. Respiratory problems were reported to be more common in children in Nong Nong, Houay Loun and Huay Keng villages. Some cases of nausea, vomiting, loss of appetite were reported in Pha Xang and Houay Loun village. Participants in Houay Loun village mentioned hepatitis as a problem and reported that 10 villagers with liver problems were diagnosed with hepatitis. When asked about the cause of the disease the response was unanimously that they did not know, as "the doctor did not say. " As one participant stated:

"Here we have a lot of hepatitis, because when we go to hospital the doctor diagnoses with hepatitis – when they get treatment some people get better and some people die." (Female FG, Houay Loun village)

Seizures were reported in all study villages except Pha Xang. Participants specifically mentioned a total of 5 cases, all of unknown cause. In Huay Kent village, one participant's wife has suffered from seizures for the last 7-8 years but had not sought care due to financial constraints. The chief of Nong Nong village (who also participated in the FGD) explained that his father had died after having a seizure and losing consciousness. Though he was taken to hospital and had a lumbar puncture performed, he was diagnosed with a neurological infection of unknown case. Houay Loun village has 2 children who suffer from seizures a few times per year. One participant suggested this was due to the use of unsterilized equipment to cut the umbilical cord at birth. Other cases of CNS problems that were reported included a female patient diagnosed with "*brain inflammation*" from Huay Keng village; a child diagnosed with encephalitis who died and a female patient with paralysis for 3 months after giving birth from Nong Nong village; and a child diagnosed with meningitis from Houay Loun village who survived but suffers recurring headaches.

Cases of malaria were reported in Pha Xang village, while tapeworm was reported from Huay Keng village. Gynaecological problems not necessarily associated with childbirth were mentioned in Huay Keng and Houay Loun villages with symptoms including vaginal discharge, uterine or pelvic pain, and/or inflammation.

Province	**Common illnesses**
Phongsaly province	Gastritis, abdominal pain "Neurological problems" – headache, dizziness, muscle and join pain, sometimes with fever Diarrhoea and fever, with/without rash Respiratory illness (cold, flu, fever) Fever with rash "Itchy nodules" or fever with nodules Seizures, fever with convulsions
Luang Prabang province	Gastritis, abdominal pain Respiratory illness (cold, cough, flu, sore throat, pneumonia) Diarrhoea Acute febrile illness (AFI)/dengue "Neurologic problems" – headache, body and muscle aches, dizziness, tingling in fingers and feet Tapeworm Rabies
Xayabouri province	"Neurologic problems" – headache, dizziness, muscle and joint pain Diarrhoea with/without fever, abdominal pain AFI (fever, headache, joint/muscle pain) Tick-borne fever Gastritis Respiratory illness (cold, fever, pneumonia, cough, sore throat, pharyngitis) Nausea, vomiting, loss of appetite Hepatitis Seizures, loss of consciousness Encephalitis, meningitis Malaria Tapeworm Gynaecological issues (possible STIs)

Table 4.3 Human health problems mentioned by FGD participants, by province

4.3.3 Main swine health problems by province

Focus group discussions also involved questions about the main health problems in pigs in the villages. Commonly mentioned symptoms and syndromes are described below and summarized in Table 4.4.

4.3.3.1 Phongsaly province

FGDs in Phongsaly revealed a number of sudden animal deaths (pigs, buffaloes, cows) had occurred during the hot/dry season (November to April/May). The most common problem reported in pigs was that they would "*look sad*", stop eating for several days and die; some having diarrhoea. The cause was unknown. Participants in Poungkao village said that between 2011 and 2013, lots of pigs had died after not eating for a few days. A similar outbreak in Omkaneng village in 2008 was described, where lots of pigs with fever and decreased appetite died after being ill for a few days. In general, diarrhoea with fever in pigs resulting in death was considered a recurring problem, particularly when the seasons changed (from cold to hot).

"Before when we have sick pigs, the ones nearby also get sick – they all get sick. But now, they see the problem is quite different. Even if have 5 pigs in the pen and 2-3 get sick and look sad, a few days later they die but then one month later they have the same situation again." (Male FG, Sophoun village)

"Sometimes pigs look good but [the] next day they die with no warning signs, but they don't transmit to other pigs." (Male FG, Sophoun village)

Some participants in Sophoun believe that the pigs die because of injections given to them by the District Agriculture and Forestry Office (DAFO) – they are uncertain about what is contained in these injections and believe it to be a vaccination or some sort of medication, but believe that it gives the pigs diarrhoea and causes them to stop eating and die. Some participants indicated not wanting their pigs to be vaccinated because of numerous pig deaths that occur every year. Cases of diarrhoea in new-born and weaned piglets particularly during the hot/dry season were also reported, as well as lung problems in weaned piglets. Aborted foetuses or stillbirths were reported as not occurring, but piglets dying shortly after birth were a problem. One possible reason given for this, in Omkaneng village, was the quality of care provided for the piglets by owners,

"If owner doesn't take care of the piglets they will all die." (Male FG, Omkaneng village)

When asked about what "*taking care of the piglets*" entailed, this equated to cleaning the pens, finding herbs and boiling it for the animal in times of sickness.

Female participants here also mentioned seeing lots of pigs and buffalo with cysts when slaughtered.

4.3.3.2 Luang Prabang province

Problems mentioned frequently included fever with eye discharge or rash, diphtheria, rash with sore throat and loss of appetite, bloody diarrhoea, and paralysis. Most of these illnesses resulted in death and the cause was unknown. Piglets dying during or shortly after birth, again of unknown cause, were reported in Donexai and Ang villages. Some participants believe these deaths may be related to penning the pigs. An example given from both focus groups (male and female) conducted in Donexai village was if pigs gave birth in the pen, the piglets usually died possibly because the sow accidentally squashed them. As a result, it is common practice to let the sow out into the forest 2-3 days before giving birth. They reported seeing fewer piglet deaths.

Tha pene village was the only village that reported their animals being fairly healthy. Being a tourist village and more developed in comparison to other study villages, participants stated having few issues of animal illness in the last 4-5 years,

"*Pigs here are quite healthy, because there aren't many, about 5 or 6 per household and villagers take care of them…. they are kept quite far [in fields] so not near people"* (Mixed FG, Tha Pene village).

4.3.3.3 Xayabouri province

In Huay Keng and Nong Nong villages, diarrhoea with loss of appetite resulting in death was reported as fairly common in May (hot season) and sometimes in the cold season. The cause is unknown; it was suggested this was related to animal nutrition.

"*Maybe we have different food, sometimes we don't know what causes it...sometimes we use vegetables we find in the forest, mix with corn and stylo and give it to the pigs. Maybe this causes diarrhoea*." (Mixed FG, Huay Keng village)

"*They suddenly die…sometimes they don't eat, have red skin and die*." (Mixed FG, Huay Keng village)

While male FG participants in Houay Loun village reported their animals were fairly healthy now, because of DAFO assistance in caring for them, giving vaccinations or injections, female participants indicated the opposite. Here, an illness perceived to be diphtheria was commonly reported, where pigs suffer swollen throats and later die. Reports of 4-5 pigs with possible rabies were also mentioned in Houay Loun village. Participants described the pigs as being aggressive, confused, attempted to bite people and later died. They did not believe these pigs had any dog bites, though did report a problem with dog rabies in the summer, with about 4-5 cases occurring in the previous summer (2013) alone.

Foetal abortions and stillbirths were not observed, but participants in Huay Keng and Nong Nong villages reported piglets dying a few days after birth as very common. Overall, Pha Xang village did not claim to have any problems with their pigs, but mentioned other problems with chickens and cows (not discussed here).

Province	**Common illnesses**
Phongsaly province	Sudden animal deaths (pigs, buffaloes, cows) Pigs: look "sad", severe loss of appetite Diarrhoea with/without fever Fever and loss of appetite Diarrhoea in new-born and weaned piglets Piglets dying shortly after birth
Luang Prabang province	Fever with eye discharge or rash Diphtheria Rash with sore throat and loss of appetite Bloody diarrhoea Paralysis Piglets dying shortly after birth
Xayabouri province	Diarrhoea and loss of appetite Sudden pig deaths Diphtheria (swollen throat) Rabies in pigs (and dogs) Piglets dying shortly after birth

Table 4.4 Swine health problems mentioned by FGD participants, by province

4.3.4 Awareness and perceptions about human and animal health and zoonoses by province

4.3.4.1 Phongsaly province

Discussions in Phongsaly revealed the belief that increased access to the villages, from road building, for example, has increased human exposure to disease and had a negative impact on animal health. They believe that disease (in general) is being brought back to the villages and making the people and animals sick. The reason for a number of animal outbreaks and deaths in the last 2-3 years is:

"*They have a road now – easy travel to and from town – so for example, when villagers go to market and buy infected meat, animals in the village get sick… Children that go to school in town and get sick with diarrhoea, pigs and dogs in the village eat their faeces and get sick.*" (Female FG, Poungkao village)

This implies some understanding of open defecation as being a contributor to disease transmission. Increased access to various products (food, chemicals, etc.) was also considered to contribute to an increased amount of disease in the villages. Therefore, the idea that with change and increased access to remote villages has brought more diseases exists. As a participant explained:

"*In 1970s and before, we only had salt and chilli pepper – had no chemicals that came from other towns, no other products – so people and animals were healthy. In recent years, lots of things changed, lots of products come to the village and lots of disease."* (Male FG, Omkaneng village)

With regards to zoonoses there was mixed, but little, awareness of disease transmission from animals to humans. Many participants were unsure about this,

"*When people get sick, they don't know if it's from the dead animals or not*." (Male, Poungkao village)

Those few who did show some awareness of zoonotic disease transmission were unsure of what to do about it. Some participants suggested that disease was transmitted through consumption of dead animals. Much guilt is associated with burying and not eating dead animals due to the investment that goes into animal rearing and the level of poverty experienced by many villagers. Some feel they have no choice but to consume these dead animals.

"*We feed [the animal] for 2-3 years and one day the animal dies, and we have nothing so we have to eat it…we don't know the cause of death, but we eat it*." (Male FG, Omkaneng village).

"*They can get sick from eating dead pigs [that were sick], but they regret burying the pig because it is wasteful so they eat it*." (Male FG, Omkaneng village).

"*When the first animal dies, it has a bad spirit that kills the animal – so they just eat it, no problem…*" (Male FG, Omkaneng village).

Some participants in Poungkao village suggested that consuming animals that died unexpectedly instead of burying them also made other animals sick, but were unsure of how this actually takes place. On the other hand, some participants in Omkaneng village held beliefs that bad spirits cause individual cases of animal deaths, while many deaths (more than 3) are likely caused by disease. In the case of the former, participants felt there was no problem in consuming the animal, while in the latter case the animals would be buried. Furthermore, participants from Sophoun village questioned whether some pigs died from vaccinations they were given by the DAFO. These were given 2-3 times per month, but as a result of pig deaths some villagers did not want to have their pigs vaccinated.

"Sometimes DAFO comes to village to vaccinate the pigs, which gives them diarrhoea and they don't eat and die.... maybe the DAFO gives the wrong injection, but lots of pigs die." (Male FG, Sophoun village)

Allowing animals to roam freely versus being penned was also believed to be more beneficial to pig health. As one participant describes,

"When pigs don't eat or look sad or not healthy, the villagers let the sick pig roam freely to let them walk around and get exercise." (Male FG, Sophoun village).

4.3.4.2 Luang Prabang province

Several male focus group participants presented some interesting ideas with regards to health and how to prevent certain illnesses. For instance, in Donexai_village, gastritis, a common affliction, was reported as a problem in overweight girls. Although gastritis due to alcohol consumption and sore muscles with fever and headache as a result of hard work were reported by participants in Ang_village, some male participants there believed that those who do not consume alcohol are more likely to suffer these problems than someone who does.

"*…The one who doesn't drink alcohol gets gastritis, back pain more than someone who drinks lots of alcohol and smokes…. They [non-drinkers] are more sensitive*." (Male FG, Ang village)

"*The mosquitoes don't like the [blood of] ones who drink and smoke a lot."* (Male FG, Ang village).

Female participants at Ang village shared the belief that drinking un-boiled water would give them kidney stones because of the concentration of sediments in the water. Their motivation to boil water for drinking was to avoid getting kidney stones.

With regards to zoonoses and disease transmission from animals (pigs) to human, there was considerable uncertainty about the possibility of this occurring, while some felt it was not possible or had never heard of it occurring. There was a general lack of awareness about zoonotic disease transmission.

"*Maybe it can, but we don't know*" (male FG, Donexai village)

"*No, people cannot get diseases from pigs*" (female FG, Donexai village)

"*Animals and people have different diseases*" (female FG, Donexai village)

"…[We] have never seen anyone get sick from an animal" (female FG, Ang village)

The few who were aware of disease transmission from animals to humans also believed that the opposite was true that animals get sick from humans,

"*If people are sick, the animals can get sick as well*." (male FG, Ang village)

A common practice in this village, likely common in most areas, is the interchangeable use of medications for human use bought from pharmacies for use also in animals. With respect to animal deaths, participants at Donexai village suggested that piglet deaths were possibly related to penning, in that the space the sow is confined to makes accidental killing of the piglets more likely. A number of villagers release their sows into the forest a few days prior to it giving birth and claim to see less piglet deaths as a result. Ang village participants also suggested a potential relationship between penning and pig deaths. They perceive this practice to affect the animals' nutrition, and prefer to let their pigs roam freely and forage for food. Other participants also reported that their pigs were healthy because of the "prevention drugs" bought from a drug seller in the district centre, which they administer to the animals themselves, though the exact drug(s) was not known. Tha pene village went a step further in attempting to prevent pig disease by not allowing their pigs to be kept in the village. The belief that certain behaviours would expose the animals to disease, in addition to the fact that this village is a tourist destination calling for improved village sanitation, has prompted them to keep their animals in fields located outside the village.

"*If kept in the village, the pigs usually get diseases – the road comes through the village, so bacteria come through the cars that come through*." (Mixed FG, Tha pene village)

4.3.4.3 Xayabouri province

Participants in Huay Keng village reported that the common ailments they experienced were caused by changes in the food they consumed. More specifically the quality of food products, particularly meat, was in question and was claimed to negatively impact human health. As stated by some participants:

"*…The food has chemicals, because we buy it [food] from the market. It's not natural, so can cause diarrhoea, etc*." (Mixed FG, Huay Keng village)

"*The important thing [is], when we buy beef or pork in the market, and we don't know the quality of meat and we eat it, it can cause diarrhoea…. there is no one to control the quality of the food*." (Mixed FG, Huay Keng village)

Similar to discussions in Ang village (Luang Prabang province), some female FG participants in Nong Nong village also reported that their motivation for boiling water was a fear of getting kidney stones, and boiling makes the stones easier to remove and the water safe to drink.

Another view expressed by participants was that heavy smoking is good for treating hypertension because it helps relax and decrease blood pressure. This was similarly stated in a household interview, where a head of household diagnosed with hypertension received this advice from fellow neighbours. In another household interview, it was suggested that male villagers believe that the government cares more about women and children getting sick and dying from disease, but does not mind as much if the men do so. As one interviewee stated,

"No one in the household has been sick in last 30 days because everyone has vaccinations….[only women and children get them, so he thinks] they [the government] doesn't want women and children to get sick or die but don't mind if men get sick/die." (Male interviewee, Nong Nong village)

The discussion around zoonoses revealed some awareness about disease transmission from animals to humans, though again at quite a low level with a lot of uncertainty, in all the study villages in Xayabouri province. Food consumption and contact with animals were mentioned as possible routes of transmission. Only one participant in Nong Nong village reported using protective equipment (gloves) and cleaned animals prior to administering injections to them for certain illnesses, such as, diarrhoea. As a few participants stated,

"*We can get diseases from pigs because we take care of them – feed them, etc. – so touch them. So we can get diseases from pigs*." (Mixed FG, Huay Keng village)

"*Maybe people get sick from animals, because when animal dies they don't want to bury it. They eat it. So maybe people can get diseases from dead animals*." (Mixed FG, Huay Keng village)

"*No [zoonotic disease transmission is not possible] because normally when we see dead animals, ex. Chickens, we put in a bag and bury it …so we don't get sick from the animal*." (Mixed FG, Pha Xang village)

"*If we eat [the] dead animal we will get sick, but if we don't we will be fine*." (Male FG, Houay Loun village)

"*Don't know if we can get sick from sick animal because no one get sick when animal get sick…and when we get sick, doctor didn't tell us if we can get sick from animal."* (Male FG, Houay Loun village)

"*We never heard that we can get disease from sick animals, because when we go to hospital they never mention that we can get disease from animals."* (Female FG, Houay Loun village)

Perceptions about animal health also varied between villages, particularly with regards to the practice of penning pigs.

"[Pigs] don't have any problems because they are kept in the pen..." (Mixed FG, Pha Xang village)

While some believed it was beneficial, others from Nong Nong village, preferred keeping their animals away from the village, in fields in the mountains, in the belief that animals would get sick if kept in the village and looked healthier if kept in the mountains. Furthermore, animals were only penned during sickness because of the perception that penning was detrimental to healthy animals who would stop eating and die. Likewise, in Houay Loun village, some participants felt that animals kept in the rice fields were healthier and less likely to get sick, possibly from contact with dogs or other pigs that were kept in the village.

Many participants demonstrated a lack of knowledge about the medications or treatments that were given to sick animals, either by the DAFO or those purchased from drug sellers by the villagers themselves. Treatment given often seemed to be for symptom relief as opposed to curative, with the exception of administering antibiotics or anthelminthics. For example, Pha Xang village participants reported that during outbreaks or when animal deaths occur, the DAFO comes to the village and administers injections to prevent disease spread. However, participants were unaware of what these injections were and yet believed them to work well. A similar view was expressed in Nong Nong village, that if given injections, the animal(s) would get better. Male FG participants in Houay Loun village also felt that the animals in their village are fairly healthy with fewer deaths because the DAFO comes to care for them by giving vaccinations or injections. Within the same village, however, there seemed to be a variation in practices with regards to treatment of sick animals. While some participants exhibited a 'laissez-faire' attitude towards treating ill animals, others reported treating both sick and well animals. For example, one participant stated that while sick animals are separated from well ones, she requests the DAFO to treat the well and not the sick animals.

"…if sick ones survive, they survive. If not they die." (Female FG, Houay Loun village)

4.3.5 Health seeking behaviours by province

Practices in each village tend to vary depending on proximity to a health care provider, be it a health centre or hospital, drug seller/pharmacist, trained health volunteer, or traditional/spiritual healer. While the first point of care differs according to accessibility and affordability, overall self-medication was common practice due to the financial constraints faced by many in this very rural population.

4.3.5.1.1 Phongsaly province

Participants reported usually seeking some sort of care for illnesses until they find a cure, with where they go depending on the illness, severity, and perceived cause. Some participants in Poungkao village stated that their first preference was the village traditional healer or health volunteer. Others go to the district centre pharmacy to buy modern medicines and later consult a traditional or spiritual healer.

When a person or household, or the village itself, is believed to have a bad spirit causing illness, the spiritual healer assists by performing sacrificial rituals, usually sacrificing an animal. If the cause is believed to be a 'disease', female participants stated first trying traditional medicine and later trying modern medicine. If the illness lasted for more than 10 days, they believed it was likely due to a spirit. The traditional healer uses medicinal herbs and plants to treat illnesses related to biological causes. The village also has a health volunteer with some health training, though no formal training. The health volunteer mainly gives instructions on taking medications, and sells paracetamol and some antibiotics. District health staff periodically comes to the village to check the medications to ensure quality. Some villagers go to this health volunteer first when experiencing illness or to a traditional healer or see both at the same time, and then to the town pharmacy if not better. The sequence of care seeking seems to vary as people go back and forth, though largely remains between these three providers. For children, participants reported first going to the pharmacy, followed by the hospital, and traditional healer.

The condition has to be quite serious to warrant going to hospital. Phongsaly province is located near the Vietnam-Laos border, with Dien Bien Phu province in Vietnam across the border from Phongsaly. Phongsaly provincial hospital is too far from Mai district so many cross the border to Vietnam if in need of hospital care.

"*First try health volunteer, at same time some people go to the spiritual healer; if these don't work they go to hospital district and then Oudomxay provincial hospital or Vietnam hospital [Dien Bien Phu hospital] for treatment*." (Male FG, Poungkao).

Various examples were provided of going from one care provider to another, and between modern and traditional medicine practitioners, with the hospital being a last resort. One scenario given was a child suffering from seizures since the age of 2 years (currently 11 years), who had only seen a spiritual healer and was told to avoid certain foods believed to cause the seizures. Although improvement was experienced, the seizures kept recurring and the child was taken to the district hospital,

"*…Was diagnosed with neurological problem but nothing can be done, doctor gave vitamin B for patient and told him to come back if symptoms return*."

In Omkaneng village, participants reported purchasing medications at the pharmacy if they could not afford hospital care. If unsuccessful, they would ask their neighbours for advice on traditional forest herbs. Some used traditional medicine before going to the town pharmacy, and so practices vary in this village, often influenced by available income. There are two spiritual healers and two traditional healers in this village who provide health advice. When these attempts fail, many will stop seeking care due to lack of funds. Those who can afford hospital care go to the district hospital and, failing that, will try Oudomxay hospital. Some participants stated a preference for going to the town pharmacy instead of the district hospital because of the lack of medications available. Drug sellers also come to the village from Oudomxay, Vientiane, or Luang Prabang to sell various medicinal herbs, tree bark, and syrups.

Sophoun village has a health centre located within the village, so villagers usually go there when experiencing mild illness; such as flu and fever, mild pain, fever and rash. The health centre is usually the first point of care because villagers only pay for medications, not consultations. The facility itself is quite basic and mostly provides medication prescriptions for treating illnesses that are diagnosed clinically. Some participants mentioned using both traditional medicine and modern medicine at the same time. The village has a traditional healer and some villagers consult both the traditional healer and health centre at the same time or the former followed by the latter if no improvement. There was a perceived benefit from seeing both the health centre and traditional healer simultaneously, as one participant explained,

"*If they want to get better fast, they go to see both*." (Female FG, Sophoun village)

The village also has 2 spiritual healers although this did not come up in the focus group discussion (see Chapter 6). If there is no improvement, care is then sought at the district hospital. Sophoun village has a main road running through it, making the district centre more easily accessible. If appropriate treatment or care cannot be provided there, some travel to Dien Bien Phu hospital in Vietnam, as most villagers here speak Vietnamese and the hospital has a Lao translator. Alternatively, those who do not speak Vietnamese sometimes prefer going to Oudomxay provincial hospital. Although, this hospital can cost more than going to Dien Bien Phu and does not provide some services, such as orthopaedic surgery, thus requiring transfer to Vietnam anyway. The district hospital is sometimes bypassed altogether for the hospital in Vietnam.

"*It is expensive, but it is necessary to go there if they get sick because they have to find some treatment.*" (Women FG, Sophoun village)

"[*If they go to HC and don't get better]...Usually go to Vietnamese (provincial) hospital directly, because even if go to district hospital, they cannot treat us either*." (Male FG, Sophoun village)

4.3.5.1.2 Luang Prabang province

In Donexai village, the first point of care when experiencing illness is the closest health centre located in the nearby Nom Phu village (also known as Nong Chong village). If the health centre is not able to provide necessary care some proceed to Chompet district hospital, the nearest district hospital, while others try traditional medicine. Medicinal herbs are usually procured through the 2 traditional healers in the village, or traders that pass through, or through advice from neighbours who have some knowledge about medicinal herbs. If traditional medicine fails many prefer going directly to the provincial hospital in Luang Prabang city, feeling that the district hospital is not able to provide a higher level of treatment than the health centre. As a few participants suggested,

"[*Go straight to the provincial hospital] because district hospital doesn't treat moderate to severe illnesses*." (Male FG, Donexai village)

"*HC and district hospital are quite similar in terms of capability. So if HC cannot treat them, they go directly to provincial hospital*." (Male FG, Donexai village)

"*...less people go there [district hospital] because the doctor cannot handle severe illnesses, only mild illnesses, and gives some medications*." (Male FG, Donexai village)

As ability to seek care mostly depends on available funds, villagers tend to go to the health centre first. For children experiencing moderate to severe illness, care is sought directly from the provincial hospital, as health centres and district hospitals are not always equipped to deal with them. Similarly, for adults, provided that funds are available and the illness is moderate to severe, care is sought directly from the provincial hospital. There is a military hospital in the city where treatment is subsidized and sometimes free for poor families from rural areas. Donexai village also has a health volunteer, with limited training, who sells a few medications (such as paracetamol, anti-malarials (chloroquin), and antibiotics) and administers injections bought from the pharmacy in Chompet district centre or the drug seller in Nom Phu village. The health volunteer also helps with minor conditions, small accidents and non-complicated childbirths. Participants also reported that the Red Cross provided the health volunteer with a malaria test kit with treatment for the disease, but the village does not see much malaria so this does not get used often. Male participants at Ang village reported purchasing medications from the village health volunteer or the pharmacy for treating mild illnesses. If the illness is more severe, they go to the nearest health centre in Nom Phu village. Female participants reported going to the health centre when experiencing illness and in emergencies consult the village health volunteer for medication. Similar to other villages, the health volunteer sells some medications (paracetamol, ampicillin). Traditional medicine is no longer widely used in this village, as it does not always work and knowledge of what to use has been lost with the passing of elders from the village. As stated by a few participants,

"*Usually go to health centre, don't use traditional medicine (traditional medicine) anymore because some people get better when they take it but most don't; it's not the correct medicine*" (Female FG, Ang village)

"*...also have cases that go to the health centre, district hospital and then provincial hospital and still don't get better. So after, they try traditional medicine*" (Female FG, Ang village)

"*Get traditional medicine from the forest, because some villagers have knowledge of which herbs can be used for different symptoms*" (Female FG, Ang village)

Those who do use traditional medicine use a few herbs known to be beneficial for certain symptoms. Some use it as a last resort, when seeking hospital care does not cure illness. The village does not have a traditional healer, but has a spiritual healer who uses magic spells to heal people when it is believed that spirits are hurting them. Participants also mentioned that some 70% of this village is of Khmou ethnicity and most of them are Christian; only 3 of 68 families in the village believe in 'spirits'.

Tha pene village has a health centre located within the village which is often the first point of care. If there is no improvement, the health centre usually transfers patients to the provincial hospital. Modern medicine is tried first and bought through the health centre, but participants reported supplementing with traditional medicine for certain conditions, such as gastritis, shoulder pain, STIs (syphilis). There are 2 traditional healers in this village; one, an FGD participant grows medicinal herbs for treatment. Participants also reported performing sacrificial ceremonies and killing their own pigs if they experience bad luck, sickness or have a problem.

4.3.5.1.3 Xayabouri province

Participants in Huay Keng village described self-medication as usually being the first step in dealing with an illness. If illness progresses, some participants stated going directly to the district hospital where illnesses are treated based on symptoms (often no diagnosis is made). Others buy medicines from the nearest health centre or from a pharmacy in town, of which there are a few located near the provincial hospital. There is no traditional healer in this village, though some villagers were aware of herbs that can be used for certain illnesses. Most participants described seeking some sort of care and going from one care provider to another because of treatment failure.

"*In the dispensary, we will tell the story/symptoms and the staff will do an exam and give some medication. If don't get better, we will find another treatment*" (Mixed FG, Huay Keng village)

For mild illnesses, participants in Pha Xang village reported the health centre as the first point of care, where the staff usually perform clinical examinations and prescribe medications. For severe illnesses, or if the patient has a high fever, they go directly to the provincial hospital. Most participants say they do seek care, even poor families who borrow money from family members or other people. Private conversation with another villager revealed the existence of a health volunteer and a doula in the village (this villager in conversation turned out to be the doula's husband) who helps deliver babies and has been given responsibility of the village's medicine stores, which she sells to people. While it was not possible to meet and interview the doula herself, due to other commitments causing her absence from the village, it was mentioned in this private conversation that the villagers normally have the doula with them for deliveries and rarely have complications, but if there are complications, patients are transferred directly to the provincial hospital.

Focus group participants had stated that there was a traditional healer in the village but the doula's husband revealed that this was not the case – it is possible that the traditional healer is from the neighbouring village, which has recently been combined with Pha Xang village, called Nasam village. Nonetheless, this traditional healer is usually seen for problems with gastritis, body/muscle pain (especially in the elderly) and for kidney problems, and uses medicinal herbs/plants from the forest for treating these ailments. Participants reported usually trying modern medicine first, and consulting the traditional healer if not improved or neighbours with some knowledge of medicinal herbs and plants.

Focus group discussions in Nong Nong village revealed that the first point of care varies between a private clinic in the district centre or the provincial hospital, or purchasing medicine from a pharmacist or seeing the health volunteer because the road to the nearest HC is quite poor. The main road to the provincial hospital runs through the village, making the provincial hospital more accessible. Before this road was improved people would go to the village health volunteer first. Since then, preference has changed for the private clinic or provincial hospital. For severe illnesses, care is sought directly from the hospital. Further discussion revealed the existence of three "private clinics" in town – it was later discovered that these are actually pharmacies located near the provincial hospital. Participants stated that these "clinics" are easier to go to instead of the hospital because patients get to see a doctor more quickly. Others prefer going there to avoid overnight hospital stays and missed work. This is more common practice, as opposed to going to a health care facility. There is a traditional healer in the village that some villagers consult for kidney problems, paralysis and fatigue. The traditional healer collects herbs or roots from the mountains. Traditional medicine is sometimes used by participants, sometimes used in combination with modern medicine and sometimes used after modern medicines fail to work. One female participant reported only using modern medicine as she was informed that traditional medicine would make symptoms worse.

Participants in Houay Loun village stated that for mild illnesses, or with a lack of sufficient funds, it was common practice for villagers to purchase medication from the pharmacy located near a market in town (not near the provincial hospital). Reasons for this included, the provincial hospital not being open at all hours (only 8-11am and 12-4pm) and, therefore, not accessible at all times, in addition to high transportation costs (about 300,000 Kip ($37.50 USD) per trip). Participants reported trying modern medicine first. If funds are available or for severe illnesses, participants reported usually going to hospital, as even pharmacies refer patients there if the illness is severe. There is no traditional healer in this village, but some participants stated using traditional medicine provided to patients at the hospital; as the Lao government is a strong advocate for traditional medicine. Participants also mentioned that a trader sometimes comes to the village to sell herbal medicines. Though some participants claimed to usually try modern medicine first, because it is relatively more expensive and usually has to be taken often or for long periods of time, traditional medicines is often bought and kept at home for use when needed. Participants also recognized that while traditional medicine works for some people it does not for others and not for everything. An example given was the use of traditional medicine for diarrhoea, mainly in children, which participants stated does not always work.

"*Sometimes we use a leaf, boil with water, and give to children but sometimes they don't get better*" (Female FG, Houay Loun village)

4.3.5.2 Financial barriers

FGDs revealed that for many people, going to a hospital is a last resort when other attempts at finding a cure or treating an illness fail. This can mean having to borrow money in order to do so, which some participants are willing to do in desperation.

"*For severe illnesses they will borrow money to go to hospital if have to - they feel if they don't go to hospital they will die*" (Male FG, Poungkao village)

"*If we have severe illness, we have to go to hospital because even if we go to clinic [clinic = pharmacy] they will suggest to go to hospital… If we don't have enough money for hospital, have to borrow money*" (Male FG, Houay Loun village)

If borrowing money is not an option, some are forced to stop seeking care due to insufficient funds. Several examples of this were given where participants purchased medicine from the pharmacy to treat an illness and did not go to a hospital because of a lack of funds. As reported previously, Sophoun village, in Phongsaly province, has a health centre located in the village itself, which is the first point of care because villagers are only required to pay for medications and not for any consultations. If a hospital visit is considered necessary, many participants in this province reported going across the border into Vietnam for health care. There are 2 hospitals in Dien Bien Phou province, the nearest Vietnamese province across the border from Phongsaly province. One is a provincial and the other a district level hospital. Participants said they usually go to the provincial one, located about 60km from Sophoun village. Patients are required to pay for hospital care in addition to costs for transport and crossing the border. Yet, many prefer going to Vietnam first and only choose to go to Oudomxay province if they are unable to speak Vietnamese. Oudomxay provincial hospital is 140Km from Mai district centre, and 150Km from Sophoun village. Although the cost of seeking care in Vietnam (Dien Bien Phu provincial hospital) can be high, participants believe that health care is more expensive in Lao PDR and choose to go to Vietnam instead.

"*If [illness is] not too severe, need 2 million kip for transport, etc.…[but] for similar type of illness, 2 million kip wouldn't be enough in Oudomxay - get more money in Vietnamese currency … health care is more expensive in Laos*." (Female FG, Sophoun village)

Interviews in Luang Prabang province revealed similar findings. Finances influence where villagers seek care, especially for adult illness. Participants seem more likely to seek hospital care for sick children than for adults. For adult illness, the health centre is the first point of care if no funds are available, and care is only sought from the provincial hospital if funds are available and the illness is moderate to severe. As mentioned previously, some go to the military hospital, where treatment is not as expensive (subsidized) and sometimes free for poor families from rural areas. For those with insufficient funds, the village chief can provide a letter explaining they are poor, making them eligible for free care. Often, the financial barrier to seeking care is in other costs, such as transport, which many cannot afford due to the distances.

At the time of this study, Xayabouri province did not have a programme for free care for the poor. However, a village chief in Houay Loun village informed the researcher that a letter could be provided by him, which allows villagers to owe money for health care received and make payment(s) later. Many focus group participants stated that unless money was available to go to the provincial hospital, they preferred going to the pharmacy first. A rough cost estimate given by participants in Houay Loun village suggested that approximately 1-2 million Kip (USD $125-250) was required to pay for treatment, consultation, documentation, etc. plus 300,000 Kip (USD $37.5) per trip for the cost of transportation to the hospital. A female FG participant suggested that the high cost of treatment was the cause of being poor, and reported that the cost of treating a meningitis patient in Vientiane was about 10 million Kip (USD $1250). Financial constraints were frequently given as a reason for using traditional medicine as an alternative source of care or treatment.

4.3.6 Risk factors and risky behaviours for zoonotic disease transmission

4.3.6.1 Animal husbandry and health

Part of the focus group discussions concentrated on animal husbandry, animal health and perceptions around animal health, with a focus mainly on pigs.

4.3.6.1.1 Animal husbandry practices

The most commonly kept animals in all study villages were pigs, buffaloes, cows, chickens and ducks. Dogs were kept in all the villages, but are typically not part of animal rearing systems in Lao PDR and are often stray or left to roam free. Some villages also had goats (mainly in LP and XB), while one village each had horses (Donexai village, LP) and a fish farm (Houay Loun village, XB).

With regards to swine production, most operations were of a small scale. Pigs were mainly allowed to roam free in most villages, with some households penning their pigs at night. The harvest/rainy season is usually the prompt for penning all animals, to prevent them from getting into the harvest and because of the significant amount of time spent working in the fields. Once the season is complete, pigs are again allowed to roam free. Few participants claimed to pen their pigs all the time (usually SPSP project participants). In fact some stated that they did not like penning their pigs, preferring to let them roam free instead due to the belief that penning actually contributes to the deaths that occur every year. As one participant states,

"*Maybe we pen the pigs too much, so they get thin and die" so some villagers prefer to let pigs roam freely because "we feed them naturally" that way*." (Male FG, Ang village)

Pens are mostly located within 100m of the households. The exceptions were Tha Pene village in LP, and Nong Nong village in Xayabouri where pigs roam free in rice fields located far from the village. Proposed reasons for this were that it kept the animals healthier because they were not near people and so less exposed to disease.

"*Pigs here are quite healthy, because there aren't many, about 5 or 6 per HH and villagers take care of them… They are kept quite far [in the fields] so not near people*." (Mixed FG, Tha pene village)

"*If kept in the village, the pigs usually get diseases – the road comes through the village, so bacteria come through the cars that come through*" (Mixed FG, Tha pene village)

"*…. If they are kept in the village they get sick, but if kept in the field in the mountain they look healthier."* (Female FG, Nong Nong village)

4.3.6.1.2 Separation of sick vs. well animals

Many participants reported separating sick animals from well ones by keeping them in different pens, to prevent disease transmission. One male participant also reported separating newly purchased piglets (from other villages) for 2 weeks until all vaccinations are administered, before mixing with other owned stock. This practice was highly variable even within villages. Reasons given by participants for not separating sick from well animals included laziness, a lack of knowledge on how to treat sick animals, not enough pens available or a perceived lack of effectiveness of this method. There were mixed feelings/perceptions on whether penning pigs keeps them healthy or causes them to get sick or die more easily. Participants from Pha Xang village stated that they do not follow this practice as they feel it is not effective.

"[*Separating pigs does not help much] because all the pigs get disease even if take well ones to the forest*." (Female FG, Omkaneng village)

"*When animals get sick, even if we separate they still transmit the disease [other animals get sick] so we don't separate*." (Mixed FG, Pha Xang village)

In Donexai village, where some villagers do separate sick from well animals, some reported trying to quickly sell sick pigs before they die. If able to do so, some seek treatment for the sick animals while others use prophylaxis for well animals exclusively, in the hope of preventing disease transmission.

4.3.6.1.3 Handling of sick or dead animals

The discussion on animal husbandry and health issues also included questions on the handling of sick or dead animals or animal products, including the use of protective equipment, such as gloves, the disposal of carcasses and slaughter practices. In most cases, protective equipment is not accessible or not used during slaughter or handling of dead animals or their products. Practices related to the disposal of carcasses varied. Access to protective equipment was mentioned as a barrier in Poungkao, Omkaneng, Sophoun, and Ang villages, and the common practice is:

"*….[to] wash hands before killing [the animal] and clean dust off knife and wash the meat."* (male FG, Poungkao village)

Nong Nong village participants did report sometimes using gloves, mainly when animals have diarrhoea or some sort of disease. Depending on the type of animal, however, protection is not always used to handle the carcass. Some male participants go on to explain that chickens and pigs usually die from disease so they use protection to handle them, but cows and buffaloes usually die of other causes (such as a snakebite) so they feel protection is not required. A female participant described using a mask and shovel to handle dead chickens, during 2 outbreaks in 2013 that resulted in a number of poultry deaths in the village, to avoid touching them for fear of catching the disease. If gloves were not available, plastic bags were used to cover hands before handling the dead birds.

Similarly, Houay Loun participants reported using plastic bags to cover their hands when killing or touching dead animals when gloves are not available. They also reported not using any protection when handling animal products (aborted foetuses, placentas, faeces) as they did not know about this kind of protection.

In most cases, the exact cause of animal deaths is not known. With regards to the burial of animals that died of an illness of unknown cause, many participants in Poungkao and Omkaneng villages stated that if an animal visually looks "healthy" (and not sick) even though it died, it would be consumed.

"*If the meat doesn't look beautiful or good, they don't eat it*" (Female FG, Poungkao village)

"It depends - if animal dies of disease but looks well in general, they will eat it" (Female FG, Omkaneng village)

Participants in Omkaneng village also reported consuming sick animals prior to their deaths. This is quite common practice in the village, and female participants suggested it is particularly common among male villagers. It was also reported that protective equipment is never used when handling sick or dead animals.

"*Mostly men that eat it [meat of sick animals] because they think they are healthier so no problem. Some women are scared to eat it.*" (Female FG, Omkaneng village)

In contrast, Sophoun village stated that DAFO is now consulted when animal deaths occur and villagers are informed whether the animal can be eaten. Whereas in the past the animals were consumed since the cause of death was usually unknown. In most cases they are buried, usually out of fear as suggested by some female participants.

"*Because when animals die, have a lot that die at same time and they [the villagers] are scared, so they bury them.*" (Female FG, Sophoun village)

This fear was similarly expressed in Donexai village, where participants stated that if an animal dies due to disease (regardless of what it is), it is buried out of fear of catching the disease. This applies mainly to small animals, such as pigs, and not necessarily to large ones.

"*We would eat a dead cow because it's big, and we regret [feel guilty] if we bury them*" (Male FG, Donexai village)

A pre-emptive measure described by some participants was to sell an animal that was sick and unlikely to survive to a trader, but if it died the animal would be buried.

Discussion with Ang village participants revealed a variation of practices when animals died of disease or unknown causes. Some reported burying them while others consume the animals, regardless of perceived cause of death. This is largely dependent on the size of the animal (large pig vs. piglet), because of the economic loss to the household as a result of animal deaths. As a few participants stated,

"*If a big pig dies, they eat the meat. If a small piglet dies, they just bury it*." (Male FG, Ang village)

"*If a pig dies suddenly, maybe with diphtheria, some people eat it and some don't [bury it*]." (Female FG, Ang village)

"*Some families eat dead pigs and some don't - even when many pigs die at the same time*" (Female FG, Ang village)

In Luang Prabang, the only exception to this practice was in Tha pene village, where participants (mixed FG) reported disposing of all sick animals that died. Chickens and ducks are usually incinerated, while larger animals are buried.

In Xayabouri province, animals were sometimes consumed depending on the cause of death as well. In Nong Nong village, dead animals are generally buried due to fear of disease transmission, and sometimes seriously ill animals considered unlikely to survive are killed earlier to prevent disease spread. Being the only exception among the study villages in Xayabouri province, participants in Pha Xang village reported burying all dead animals out of fear. Experience during a previous outbreak in the village has resulted in the cessation of dead animals being consumed. Houay loun village participants also stated that dead animals are typically buried, and are usually reported to the DAFO to request them to carry out the burial. They expressed some distress and guilt over having to follow this practice due to the economic loss. A buffalo typically sells for 7 million Kip (USD $875), but it takes 2-3 years to feed the animal before it can be sold.

"*..But if [it is a] big animal, it upsets us because we lost [a] lot of money*" (Male FG, Houay Loun village)

In Huay Keng village, it was also reported that some people choose not to bury dead animals and instead consume them. This behaviour is perceived (by some participants) as a possible source of human sickness, however participants are not certain if this truly occurs. Dead animals are sometimes dumped in a nearby river.

"*If we have time to bury, we bury it. If not, we will dump in the water.*" (Mixed FG, Huay Keng village)

4.3.6.1.4 Animal health reporting and training

Reporting of animal illness and death was inconsistent among the study villages. In Phongsaly province, Poungkao and Omkaneng villages had some participants reporting sick animals and deaths, especially during outbreaks. Participants in Poungkao stated that pig problems were reported to a "veterinarian" in the village, who works with the Smallholder Pig Systems project (ACIAR) and reports further to the District Agriculture and Forestry Office (DAFO). This "veterinarian" has had some training through the DAFO in Luang Prabang and Vientiane, and performs c-sections, castrations, and administers vaccinations as required. On the other hand, Sophoun village participants stated only reporting animal illness, not deaths, to a "veterinarian" who works at a fish farm nearby. He has some animal health training and is part of a Vietnamese government project that works with the Provincial Agriculture and Forestry Office (PAFO) and DAFO. Three other villagers in Sophoun had received some animal health training from an NGO project.

Some stated barriers to reporting included poor availability of and access to drugs for treating animal illness through the DAFO. For instance, Omkaneng participants reported that some villagers have had some training on administering vaccinations but the village has no budget to purchase medications/vaccinations. If villagers can afford it they buy medicines directly from the pharmacy or a Vietnamese trader in the district centre. Lack of funds also means the response from DAFO during outbreaks can be quite slow or non-existent, further deterring villagers from reporting in future.

In Luang Prabang province, Donexai and Ang village participants stated not reporting any deaths as the DAFO does not come to these villages because most are unable to pay for treatment or there is no current NGO involvement in these villages.

"*Deaths are not reported to anyone because there is no project here…. DAFO only works in villages where other NGOs/projects work, but not in villages that don't have any project*." (Female FG, Ang village)

Donexai village participants also explained that the DAFO typically sells medications to villagers and provides instructions for their administration. Villagers either administer it themselves or seek assistance from the village health volunteer. With regards to training, there is a proposed NGO project to provide animal health training in this village on nutrition, fertilisation, etc., that was still in the planning stages at the time of this visit. Participants also reported previous involvement of a European Union project that provided animal health training to the village as well as funds for purchasing pigs and chickens. Ang village participants stated that one of the villagers had received some training, but was not involved in matters related to animal health in the village as he is not considered government staff and is, therefore, not compensated. Consequently, villagers tend to purchase medications used in human medicine from the district centre to treat animal illnesses themselves.

In Tha pene village, participants stated reporting animal sickness and deaths to the DAFO because of fear of disease spread. However, they also stated that the DAFO only works with certain animals, specifically cows, buffaloes, and dogs, and not pigs, chickens or ducks. Although no animal health training has previously been provided in this village, participants expressed keenness to receive training on rearing pigs, particularly on nutrition, and wanted to see examples of what other villages do.

In Xayabouri province, deaths were reported in some instances but not consistently. Participants in Huay Keng village expressed uncertainty about what the DAFO does when investigating animal deaths and stated that some villagers consumed the dead animal(s) irrespective of reporting the death(s) to the DAFO. Outbreaks of illness or large numbers of deaths were often expressed as a trigger for reporting in the study villages. Again, barriers to reporting included inability to pay for any assistance or treatment received, the slow response by the DAFO in many instances, and the exclusive nature of their assistance to only those who can pay. Participants in Nong Nong village only reported large numbers of deaths to the DAFO. Furthermore, they reported that the DAFO carried out outbreak investigations for chickens and pigs only. With regards to health training, only one participant from Nong Nong village reported receiving some training through the DAFO on pig health and nutrition (administering vaccinations, treatment for some diseases, birthing and minor surgeries). Two villagers from Houay Loun received training on similar topics, one in Vientiane, which included visiting and learning from other farms.

4.3.6.2 Agricultural practices and flooding

Agricultural practices discussed in FGD included rice and other crops, as well as the rodent population because of their impact on the harvest and potential impact on disease transmission. Flooding was discussed due to their impact on the mosquito population and on disease transmission. Rice is the main food staple for the Lao people. All study villages stated having rice fields located within or at various distances from the villages (see Table 4.5). Various types of rice are grown, and rice fields can be located in or near the village or far away in the mountains. In Sophoun village participants indicated that the rice grown in the mountains requires less water but is more susceptible to being destroyed by rodents.

Participants in Ang village reported that those who grow rice in the mountains stayed there for days or weeks at a time during growing season. Because these fields are located far away, some return once the season is over or if there is business or a meeting being carried out in the village. This practice was mainly adopted by Hmong villagers who stayed in the fields and kept their animals with them. The Khmou villagers prefer to come back every night, and as a result do not grow as much rice as their Hmong neighbours. Nong Nong and Pha Xang villages also reported having rice fields located in the mountains, where these villages were previously located before being advised by the Lao government to move closer to the road for better access. Although the households moved, their rice fields still remain in the mountains and villagers travel (walk) the distance to tend their fields. Nong Nong village also keeps their livestock animals in the fields, moving them from one field to the next and using their vacant fields to grow crops.

Distance to rice fields	Province	District name	Village name	Comments
< 100m	PH	Mai	Poungkao	Fields surround HHs as village is in a valley
			Omkaneng	Fields located at bottom of the village
			Sophoun	Some fields across road from village; ~10m away
	LP	Chompet	Donexai	Some fields near village; <20m from some HHs
			Ang	2 families in village have fields in village itself
> 100m	PH	Mai	Sophoun	More fields in the mountains (different type of rice)
	LP	Chompet	Donexai	More fields in the mountains
			Ang	Most fields located in the mountains
		Luang Prabang	Tha pene	~200m (10min walk) from village
	XB	Xayabouri	Nong Nong	Fields are in the mountains (1hr 30 min walk from village); where village used to be located
			Pha Xang	Fields are in the mountains (1-2 hrs walk from village); where village used to be located
			Houay Loun	Fields are minimum 30-40 min walk from village.
			Huay Keng	Fields are in the mountains; ~1 km from village

Table 4.5 Distance to rice fields from the study villages

HH= households; PH =Phongsaly province; LP=Luang Prabang province; XB= Xayabouri province

Many villages also grow vegetables for consumption. Participants in Pha Xang village stated that they did not usually purchase vegetables from the market because traders use a lot of chemicals for fertilization. The villagers prefer to find them in the forest or grow their own, in which case they use animal faeces for fertilization. Donexai village participants expressed concerns about rubber plantations in the nearby mountains, about 1km from the village, owned by a Chinese company. Participants reported that the company uses chemicals to kill the grass and dumps waste into the river making it dangerous for them. The village chief mentioned reporting this to the DAFO as the chemicals have affected the soil in the area, and vegetation does not grow as well anymore. It was unclear what, if any, steps were taken to address these concerns.

In all study villages (except Houay Loun in Xayabouri province), participants reported rodents being a problem mainly in the rice fields and mountains, and sometimes in the villages during harvest season. This can be significant as rodents destroy the rice harvest. All participants reported frequently trapping and consuming rodents from the fields as part of their diet.

Based on participant responses, flooding has not been a major problem in these villages if at all. Flooding in the rice fields was reported as a problem in Poungkao, Omkaneng, Sophoun, and Houay Loun villages. Donexai village had a village flood in 2013, but no issues previously. All other study villages reported never having any flooding problems (Ang, Tha pene, Nong Nong, Pha Xang, and Huay Keng villages), while Ang village reported water shortages during the hot season (April/May).

4.3.6.3 Food consumption practices by province

FGD also covered food consumption practices, particularly around the staple diet, perceptions about food and food preparation methods. This was mainly to elucidate the villagers' meat and pork preparation and consumption practices.

4.3.6.3.1 Phongsaly province

The typical diet described by participants in Poungkao, Omkaneng, and Sophoun villages consisted of vegetables, bamboo, fish, snails, meat (rodents, domestic and wild pig, deer, squirrel, birds, and sometimes buffalo), and rice. This was the case for most villagers regardless of which ethnic group they belonged to. Some grow their own vegetables and hunt for meat to avoid spending money on food. No dairy is consumed in these villages. Hunting for rodents and other wild animals is common practice. The Lao government has banned hunting for wild animals in the country and the use of guns, but the rule is not strictly enforced in remote areas. Participants reported that hunting for consumption purposes is allowed but not for selling.

With respect to the quality of meat and the practice of consuming meat from animals that died as a result of illness or disease, participants in Poungkao and Omkaneng villages stated that this depended on the cause of death, though more often depended on the visual appearance of the animal/meat. If a pig appeared "healthy" when it died, its meat would be consumed regardless of the illness or cause of death. Although there is some awareness of zoonoses and the possibility of disease transmission through consumption of meat from a sick animal, this practice still occurs due to the large investment (input) into animal rearing and the economic loss to households when the animal dies.

"*If [the meat] looks bad, don't eat, if looks okay some will eat it."* (Male FG, Poungkao village)

"*If the meat doesn't look beautiful or good, they don't eat it"* (Female FG, Poungkao village)

"*We feed [the animal] for 2-3 years and one day the animal dies, and we have nothing so we have to eat it...we don't know cause of death, but we eat it."* (Male FG, Omkaneng village)

For some participants (male) in Omkaneng village, meat is not often consumed during the harvest season due to time spent working in the fields (perhaps only once per month). After harvest, hunting for wild animals is common practice so meat is consumed more often. Other female participants reported having meat 2-3 days per week, usually from wild animals or rodents trapped in the fields.

Pork was said to be consumed mainly for special occasions or ceremonies and is usually eaten as "laap," which is sometimes cooked and sometimes eaten raw. "Laap" is typically prepared for household spirit ceremonies or for out of town visitors. Female participants stated that women in the village usually consumed it cooked, though some did prefer it raw. For ceremonies or special occasions in both Poungkao and Omkaneng villages, it was reported that households usually fatten and kill their own pig and use only the meat for laap; other households can also purchase meat from them. Statements made by participants also suggested that organs were typically fried or used in soup, which is also how pork meat is sometimes consumed. For everyday consumption, pork is usually purchased from the market if money is available. Female participants in Omkaneng village also reported that pork was consumed about once per week and usually bought from the market in the district centre. Raw blood is consumed in this village and is particularly preferred among the male villagers. It is usually mixed with cooked pork meat when prepared.

"[*Raw blood is] Very delicious!*"(Male FG, Omkaneng village)

"*Don't eat raw blood often - eat for ceremony, HH sacrifice or wedding - about 10 times per year*." (Male FG, Omkaneng village)

"*Don't eat raw pork meat or organs, but eat raw blood - usually only men [do this] because they are stronger than women. If the man is weak, they don't eat raw blood*." (Male FG, Omkaneng village)

Participants in Sophoun village said they usually killed a pig or buffalo from the village, with other households being allowed to purchase some of the meat. Vietnamese traders also sell meat and fish in the village, but people prefer to go fishing instead. Women also find snails, while the men catch rats and squirrels. Some participants reported that local pork was more often consumed, typically bought from other villagers when they killed their own pig. Because of this, pork meat is consumed about once every few months. Participants reported disliking consuming raw pork because domestic pigs are perceived to have lots of diseases, so instead prefer raw wild pig and barking deer as these were less likely to have any diseases. However, some men in the village continue to consume raw pork laap and blood while the women choose not to out of fear.

4.3.6.3.2 Luang Prabang province

The typical diet in study villages in Luang Prabang province consists mainly of rice, vegetables (such as bamboo, greens, mushrooms), and meat (buffalo, beef, pork, rodents, chicken, other wild animals). Dairy was stated as not being consumed in these villages as well. In Donexai village, participants stated that buffalo meat, beef, and pork are usually bought from a trader that comes to the village, and exotic pig meat is sometimes purchased from the market. Villagers slaughter their own ducks and chickens for consumption, fish is caught from the river, and rodents are also trapped and consumed. Animals that die from disease are sometimes buried, particularly if they are small, but larger animals are often consumed out of guilt (from disposing of such large animals) and to avoid being wasteful.

"*We would eat a dead cow because it's big, and we regret [feel guilty] if we bury them*." (Male FG, Donexai village)

FGD participants reported consuming only cooked pork meat because raw pork causes abdominal pain. Pork is usually cooked on the fire or in soup and organs are boiled. Raw pig blood is sometimes consumed and sourced from owned pigs due to uncertainty of the quality of blood sold at the market. Pigs are often killed for weddings, sacrificial ceremonies, and New Year celebrations. Some female participants reported a preference for raw duck blood also sourced from owned ducks that are perceived as less likely to have any diseases. This is consumed about once per month or every 2 months, as ducks are considered expensive.

"*Pigs have a lot of disease, but duck is okay*" (Female FG, Donexai village)

Similarly, in Ang village, sources of meat included purchases from a trader that comes to the village, or slaughtering owned chickens/ducks about once per month, and trapping rodents in the fields daily. Animals that die of disease are also often consumed, including pigs, and even during outbreaks when numerous pig deaths occur. Pork meat is either bought from the trader or the market, depending on affordability. For ceremonies, villagers slaughter their own pig and for some this is reported to be the only source of pork. Pork is usually eaten cooked, especially if the pig died suddenly or due to illness. Some villagers also consume raw pig blood. Frequency of consumption ranges between a few times per month to a few times per year, but participants insisted that no raw meat was consumed.

"*Here we don't eat raw pork [meat], some people eat raw blood...don't eat raw organs, it smells bad*." (Female FG, Ang village)

Likewise in Tha pene village, participants stated that traders come to the village daily to sell meat (buffalo, cow, etc.) and some villagers purchase meat this way, but are unsure of its quality. They typically kill their own chickens and ducks for consumption, as many believe that their own animals are of good or better quality (because they are fed rice and corn and no food is manufactured with chemicals). Owned pigs are typically slaughtered for ceremonies or special occasions, but not otherwise as they are considered a large animal and are kept mainly for sale. During these ceremonies, raw blood is sometimes consumed and the meat is usually cooked. Participants also reported that female villagers and the elderly do not eat raw pork blood or meat, but consume it cooked.

4.3.6.3.3 Xayabouri province

The typical diet in Xayabouri province also consists of rice, vegetables (some grown in the village and some from the forest), meat and fish. Nong Nong village participants reported that some pasteurized milk was consumed and usually bought from the market. Participants in Huay Keng village stated that some children consumed soymilk and that packages of “Lactasoy soy milk” were sold in one of the small village shops. The town market is quite far from the village and so food is purchased only if funds are available. If not, they look for food in the forest. No dairy was consumed in the other study villages.

Animals dying from disease in Nong Nong village may be eaten depending on the cause and number of deaths. Participants stated that if many animals die or deaths are caused by "disease," perceived as more likely if large numbers of deaths occur, animals are buried out of fear of disease transmission. Otherwise, the animal would be consumed. Rodents trapped from rice fields are another source of meat/protein. If a household owns a lot of pigs, chickens, or ducks; they may be slaughtered for consumption once every 3 days or once per week. Animals are generally kept for selling and not for consumption (cows and buffalo). Some villagers will slaughter an owned pig two or three times per year for ceremonies or special occasions.

“*If we kill only for food, it is waste of animal...has to be for some tradition or occasion*.” (Female FG, Nong Nong village)

Participants reported eating raw laap, made with beef or buffalo meat sometimes mixed with raw organs. Villagers consume raw chicken-blood, though raw pork meat and blood is no longer consumed, as pigs are not considered very healthy.

Pha Xang village participants reported that if funds are available, meat or fish was bought from the market. If not, chickens are sometimes slaughtered, and rodents are trapped in the fields and eaten. Hunting was common practice, but the government has banned the use of guns so this is no longer possible. Pork is usually bought from the market, either once per week or once every 3 days, usually cooked in soup or fried. Participants reported that raw pork was no longer being consumed.

"*Before the elderly ate raw pork but not anymore because when some people eat raw pork they get sick. So the new generation don't eat*."

Some households consume raw blood, usually sourced from owned chickens that are considered healthier. In Pha Xang village, which mainly consists of Hmong and Lao loum ethnic groups, consumption of raw pork was considered taboo during the Hmong New Year and raw meat is not consumed even for traditional ceremonies. This did not arise among Hmong ethnic groups at Nong Nong village, entirely of Hmong ethnicity, where participants stated consuming raw beef or buffalo meat and raw chicken-blood but no longer raw pork meat or blood (pigs are not considered very healthy). Of the villagers in Pha Xang belonging to the Khmou ethnic group, participants stated that some men liked consuming raw blood. In general, however, this did not appear to be common practice in Pha Xang village.

"*Now people [everyone] don't eat raw, because have many diseases in animals, so they are scared to eat raw*." (Mixed FG, Pha Xang village)

In Houay Loun village, participants reported purchasing meat from the market or a trader that comes to the village. If funds are available, a buffalo is sometimes slaughtered and the meat divided amongst the village. Wild pig and rats are caught in the forest. Raw meat or blood is not often consumed, except for some men who like to eat raw laap but only made with beef and buffalo meat. Pork is usually eaten cooked; raw pork meat or blood is not consumed, not even wild pig. For ceremonies, participants insisted that they always cooked whatever animal they killed.

Participants in Huay Keng village similarly described purchasing meat from the market, as well as fishing as sources of protein. Owned animals, especially large animals, are not typically kept for consumption. If large numbers of chickens are available some are consumed. Rodents are trapped in the fields and consumed,

"*The rat eat our rice, so we have to eat it [rats].*" (Mixed FG, Huay Keng village)

Animals dying from unknown causes are sometimes consumed, even if the death(s) is reported to DAFO. Pork is usually consumed cooked, though some villagers consume raw blood bought from the market or from their own slaughtered pig. The frequency of raw blood consumption was reported to be low and that raw meat and organs were never eaten. Again, owned pigs are customarily slaughtered for special occasions, such as weddings, which participants suggested are infrequent.

"*If we have a wedding, we will kill our own pig. Women cook the meat, for the blood men usually eat raw but some women like to eat raw blood with [the] men*." (Mixed FG, Huay Keng village)

"*Some years, we have a wedding, have occasion to eat blood. Otherwise we don't eat."* (mixed FG, Huay Keng village)

"Some years we don't eat." (mixed FG, Huay Keng village)

4.3.6.4 Hygiene and sanitation practices

Focus groups discussions included questions surrounding hygiene and sanitation practices and looked at villagers' access to water sources, drinking water practices, hand washing and toilet use, and village/household waste practices.

4.3.6.4.1 Access to water

Most villages have water pumped from the mountains to large tanks in the village or piped to public taps/pumps (Table 4.6). In some cases, water is pumped directly to households. Villages where some or all households have water piped directly to them include Sophoun (PH), Tha pene (LP), Donexai (LP), Huay Keng (XB,) and Nong Nong (XB) villages. Households either have to pay to have it installed or install it themselves. Rivers are another source of water, particularly if tank levels are too low in the dry/hot season or if public taps are broken.

4.3.6.4.2 Drinking water practices

Participants in all study villages reported boiling water for drinking purposes, as water pumped to the village is not treated. This is common practice and part of the social norm, as most people believe it to be good practice, even though tap water is considered clean. Some participants reported doing this out of fear of getting kidney stones, while others reported it to be out of habit.

"*They [villagers] just do it normally [because it's normal*]." (Female FG, Poungkao village)

"This water is clean because it doesn't have any stones in it." (Female FG, Donexai village)

"Usually boil because water is concentrated with sediment...if they drink un-boiled water, they get kidney stones' (Female FG, Ang village)

However, this only occurs when people stay in the village and have no constraints on their time. If working in the fields or lacking sufficient time, many participants reported taking un-boiled water with them or using water directly from the river.

"*Water is from the mountains so very clean and tastes good*" (Male FG, Poungkao village)

"*…Never boil [water] because am lazy and in hurry to go to work.*" (Female FG, Omkaneng village)

"*Most people boil for drinking, but some people don't because they are lazy*" (Male FG, Sophoun village)

Tha pene village reported that most villagers purchase bottled water for drinking. River water is mostly used for other purposes, such as laundry, but some boil it for drinking. Pha Xang village participants stated that they recently started boiling water for drinking.

Province	District	Village	# Public Water taps/pumps	# Water tanks (If applicable)	Comments
PH	Mai	Poungkao	5	--	--
		Omkaneng	6	--	1 water tap broken
		Sophoun	0	6	6 water tanks in village, water piped to all HHs
LP	Chompet	Ang	7	1	Tank built in mountains to collect water and pipe to village
		Donexai	7	--	Some HHs have water piped directly to their houses
	Luang Prabang	Tha Pene	0	1	Mostly bottled water for drinking, river water for other uses. Most HHs have water piped to house from various sources; tank is upstream of river to collect ground water
XB	Xayabouri	Huay Keng	8	--	Some HHs have water piped directly to houses, if have money
		Pha Xang	13	--	--
		Nong Nong	3	1	The 1 tank is piped to 3 public taps; 7 HHs have water piped to their house
		Houay Loun	11	--	--

Table 4.6 Water source for study villages
HH= households; PH=Phongsaly province; LP=Luang Prabang province; XB=Xayabouri province

4.3.6.4.3 Hand washing practices

Hygiene discussions involved questions on villagers' practices related to hand washing, mainly before and after cooking or handling butchered meat or eating and after using the toilet. Most study villages reported hand washing was carried out at these times. However, the most common habit was using only using water and no soap. Personal observations by the researcher confirmed this during meal times in the villages and during interactions with some villagers. Participants in Omkaneng village mentioned that hand washing was performed following slaughter of animals, only using water. The only exception to this norm was Tha pene village, where participants reported always performing hand washing at the above-mentioned moments using soap and water. The village also had a school programme to teach children about hand washing.

There is a possible gender difference with regards to hand washing practice. Male participants in Sophoun village reported hand washing only with water after using the toilet, while female participants reported some use of soap and water while some only used water. In Houay Loun village, male participants stated always hand washing with water, and only sometimes with soap. On the other hand, female participants reported always using soap and water before and after eating and after using the toilet. When asked if there was a difference in practice between men and women in the village, participants indicated they were not aware of a difference but had noticed that some men washed with soap while others did not like to use it.

Several comments were made on the reasons for not using soap or times when its use was deemed necessary. Firstly, the use of soap was based on visual cleanliness of hands or the smell of food being prepared. Sophoun village participants reported using soap when cooking with "smelly" things, such as blood from slaughtering a pig or when touching raw meat. Male participants in Nong Nong village similarly described using soap if hands looked dirty, after touching blood or soil, and only used water if hands looked clean. Other comments included,

"*Use soap and water after the toilet and if hands don't look dirty only use water*"
(Male FG, Donexai village)

"*If hands are smelly they use soap*." [After using the toilet] (male FG, Omkaneng village)

Another factor that determines whether soap is used is availability of time. It was reported that if in a hurry or busy, or if working in the fields, only water was used for hand washing. Hand sanitizer was sold in the market at Nong Nong village, although no one claimed to use it. Parental teaching was another suggested reason for the difference between those who did and did not use soap.

"…Some children don't like it, depends on their parents' teaching." (Female FG, Ang village)

4.3.6.4.4 Household waste

Discussion about household waste disposal revealed a mixture of practices. The most common practices included dumping of waste near households or in surrounding areas and outskirts of the village, as well as near by forests and fields. This was reported in Omkaneng, Nong Nong, Pha Xang and Huay Keng villages. While some dump near or behind their household depending on the location of their household within the village, waste was observed throughout Omkaneng village, with the village smelling unpleasant (personal observation).

In Sophoun, Donexai, Ang, and Houay Loun villages, waste is dumped in open pits dug out in specific areas of the village.

Most villages in the study reported burning waste, typically when large amounts accumulate.

Dumping in or near rivers was also mentioned in Poungkao and Donexai villages. Some villages displayed a combination of these practices.

Tha pene village was an exception, having a distinct waste management system in place. Having a large waterfall located in the village as a major tourist attraction, the tourist centre in this village had purchased a truck to collect household waste daily. The waste is then taken about 2 km away where it is separated and incinerated.

4.3.6.4.5 Latrine use

Discussions included questions on the availability of latrines in the villages, whether they were shared or owned by individual households, used by the people, and alternatives to using toilets.

The most common type of latrine used is the traditional pit latrine with a pour-flush. Access to latrines varies and is illustrated in Table 4.1 showing the number of households with latrines in each study village. In only three study villages did all households have latrines, 6 villages had >80% of households with latrines, and 3 villages with <50% of households with latrines. Reasons for a lack of latrines included new households being built, households being moved due to road developments or existing latrines getting full, and most villagers lacking the expertise to build new ones.

In Poungkao village, almost all households were reported to have latrines (except 2), the Red Cross had distributed and installed latrines in 2009. New houses built since then, were built without toilets forcing inhabitants to use that of their parents' household. The village has reportedly made a contract with the district health office to use the toilets everyday or pay a fine, though it is not clear whether this is enforced. Participants explained that when toilets were first put in, they found it quite embarrassing and difficult to use but over time they got used to it. Male participants stated that some households with toilets did not use them at first because they felt uncomfortable. Those that still refrain from using toilets prefer going to the outskirts of the village or the forest. Female participants reported that the latrines are used mainly when participants are in village.

"*…Usually use the toilet when in the village, but when in the field they go to the forest*" (Female FG, Poungkao village)

In Omkaneng village very few households were reported to have toilets. Materials for the latrines were given to the village by an organization (the name of which participants could not remember) to build them. Those who had toilets reported using them all the time, although some still prefered going to the forest. Of those without toilets, some shared toilets with other households while others preferred going to the forest. Reasons for many households not having latrines included some households being moved to accommodate building of a road and existing toilets being destroyed, eventually becoming full, or new households were built and villagers lacked the expertise to build new latrines. Sophoun village participants reported that all households had toilets, which were mainly used when people were in the village, and not when working in the fields or in the forest.

In Donexai village, participants also mentioned previous involvement of the Red Cross in helping to build latrines in the village. Not all households have them, however, but participants reported that another project is supposed to be coming (they could not remember the name but believe it to be a government project with NGO assistance) that will provide materials to build them. The village had already contributed some money to the district health office (about 150,000 Kip (USD $18.75) per household) towards the project, about 3 years ago, but the project has since been postponed multiple times. Those that have latrines typically do not share them with other households, though some women do share with family members if their own household does not have one. Similar to other villages, households without toilets go into the forest. Latrines are mainly used when people are in the village and not when working in the fields. Female participants reported using latrines because they found it more comfortable, perhaps due to the benefits of privacy.

All households in Ang village have had latrines for 2 years prior to time of visit after a Red Cross intervention that provided the materials for building them. Participants reported that each household had to pay 100,000 Kip (USD $12.50) to build them. They also reported using the toilets in their household most of the time, but have found a problem with mosquitoes around the toilets.

"*...Where they have toilets they have a problem with mosquitoes...big mosquitoes around the toilet*." (Male FG, Ang village)

Some villagers still did not like using latrines, this being a new concept for them, and preferred going to the forest.

In Tha pene village, participants reported that 95% of the village had latrines that were used all the time. Those without their own toilet go to the household of a family member and did not go to the forest.

Ten households in Nong Nong village were reported to have latrines that are usually used and are not shared with other households. Those without go to the forest close to their household. Participants also reported seeking assistance with building more toilets in the village, but with no success. The cost of building a new toilet was approximately 650,000 Kip (USD $81.25), which is prohibitive for many people.

"*We already ask for help many times, but we did not get answer from the government office*" (Female FG, Nong Nong village)

Participants in Pha Xang village also reported that all households had latrines, thanks to a project 3 years ago that built them and they are now always used.

"*At first, people didn't like to use it but now they understand the importance of the toilet so they don't go to the forest anymore*." (Mixed FG, Pha Xang village)

Most households in Houay Loun village have latrines that are reportedly used by everyone. Even new households without toilets, as a result of leaving their parents' household after getting married, share with their parents or family members. Female participants stated that there were some villagers who did not like to use them at all. This was usually the elderly in the village, who still preferred going to the forest. Similarly, about 30 households in Huay Keng village did not have latrines, mainly because they were newly built. Some of these villagers used toilets in other households, but participants reported that most people went into the forest.

4.3.7 Acceptable measures for vector control

Focus group discussions included questions on vector control measures employed by villagers particularly with regard to mosquitoes, as the main vector for JE. In most FGD, participants reported that everyone in their village used bed nets. Most use them throughout the year, and especially during the rainy season due to the increased mosquito population density. Many participants expressed a preference for using bed nets and found it impossible to sleep without them out of habit; some stated that it made them feel warmer.

"*Cannot sleep without it, even if there are no mosquitoes...feel as if sleeping outside without the net*." (Male FG, Poungkao village)

"*…Bed nets are useful in the summer season because of lots of mosquitoes, but find it too warm under the bed net, though not as bad during the night so [they] use them*." (Female FG, Poungkao village)

"*We cannot sleep without bed nets - feel like we are sleeping outside the house*." (Male FG, Sophoun village)

"*If we don't sleep under the bed net, we cannot sleep because of lots of mosquitoes*" (Female FG, Nong Nong village)

Some villagers reported taking their bed nets with them when staying at the rice fields. Khmou villagers at Ang village reported taking their nets to the fields to use daily while there, whereas those of Hmong ethnicity do not follow the same practice. Participants in Houay Loun village, a mostly Khmou village, also reported using bed nets while staying in the fields.

In Huay Keng village, participants showed some awareness that sleeping under bed nets is protective from mosquito-borne diseases though also reported that not everyone used them. It is unclear why this is the case, although it is suspected that procuring bed nets post-NGO intervention might be the problem. Poungkao village participants explained that the Red Cross had distributed bed nets in 2004, the same year as the public waters taps were installed. They also reported having more mosquitoes than previously. The district health office continued to distribute bed nets every year from 2006 – 2009. In 2009, the Red Cross came back to build more water pumps and distributed more bed nets, but only for one year. The participants believe this was the case because the project director sold all the equipment for personal profit, and that this resulted in no bed nets being received. Ang village similarly reported that the Red Cross had distributed impregnated bed nets to the village in 2011, along with materials for building latrines. Omkaneng and Houay Loun villages also described previous NGO involvement in distributing bed nets, however could not identify the organization. Houay Loun village participants stated that those who got their old nets treated were also allowed to purchase new nets at half price.

However, these projects have since ceased in both villages and have left those who cannot afford to purchase bed nets to sleep without them.

In most villages, the use of insect repellents and insecticide sprays were non-existent. Participants were either not aware of them, or reported to not use them because there was no project or NGO intervention to make this available. Houay Loun village participants expressed fear with regards to using these products because of their chemical nature. Pha Xang village participants mentioned using mosquito coils. The only exceptions to this were Tha pene and Nong Nong villages – where some participants reported using repellents when going to the fields or the forest, in the evening around 5pm (dusk) and during the rainy season.

4.4 Discussion

A KAP survey was carried out to determine the sociocultural factors that influence human behaviour in the context of four pig-associated zoonoses and their related disease syndromes. Focus group discussions were carried out at the village level to ascertain and understand the level of knowledge and awareness of villagers with regards to these diseases, to zoonoses in general, and their risk factors. As well, the survey aimed to determine the attitudes and practices with regards to human and animal health and health seeking behaviours.

With regards to human health concerns, there were a number of recurring themes across the study villages. Most often, illness was clinically diagnosed if care was sought from a health care facility and rarely laboratory confirmed. Identification of the disease (or the occurrence of the study diseases – brucellosis, Q fever, hepatitis E, or JE) was not possible. Instead, participants more often described clinical symptoms or syndromes. What participants frequently described as “neurologic problems,” a large proportion of this is likely related to physical labour from working in the fields, However, without appropriate diagnosis it is difficult to know if other reasons or causes of these symptoms are involved. Gastritis was reported as a year round problem in all study villages; this is possibly related to dietary habits as well as high alcohol consumption in some villages, particularly in men. Acute febrile illness is another common ailment described in all study villages, with several possible causes.

It is a common feature of numerous diseases endemic to Southeast Asia (Suttinont, Losuwanaluk, Niwatayakul, *et al.*, 2006), which are often clinically indistinguishable from each other. In a number of cases these illnesses are clinically diagnosed as dengue and participants stated that malaria is no longer as big a problem in northern Laos. Suggested previously in the literature, malaria incidence in Lao PDR appears to be decreasing with heterogeneous transmission between regions in the country, the north having a lower incidence than southern Lao PDR (Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013b; White, Newton, Maude, *et al.*, 2012a). Mayxay et al (2013b; 2015) also reported that leptospirosis and Japanese encephalitis appear to be common in the north, while dengue and malaria are common in the south. However, information on the potential causative agents of acute febrile illness and their epidemiology in Lao PDR is significantly lacking and further investigation is required.

Other common problems reported by participants in all study provinces included respiratory illness and diarrhoea, particularly in children. These have been identified as leading causes of morbidity and mortality in Lao PDR, especially in children under the age of 5 years, most likely as a result of a lack of access to adequate water supply, sanitation facilities and appropriate nutrition sources, and limited access to health care facilities in remote rural areas with trained staff (WHO, 2011b). Seizures and encephalitis, again of unknown aetiology, were also discussed with participants in Phongsaly and Xayabouri provinces and a few cases described. Some were clinically diagnosed with CNS infections, but the aetiology was again not known. Knowledge of aetiological agents of CNS infections, and other syndromes is critical in order to guide empirical therapy, but is a significant challenge in resource-poor settings such as rural Lao PDR, thus making surveillance equally challenging because of insufficient diagnostic capability and widespread use of antibiotics (Elliott, Dittrich, Paris, *et al.*, 2013).

Discussions on pig husbandry and health revealed that pigs are mainly allowed to roam free with some penning occurring at night and during the harvest season. A common perception was that penning systems contributed to illness and death in pigs. This finding is different from the results from the 2011 ILRI/ACIAR survey

(Chapter 3) where most participants reported penned housing as the most common type of housing employed. Most pens were located within 100m of households, with two exceptions in Tha pene (Luang Prabang) and Nong Nong (Xayabouri) villages where pigs were housed far from the village. With regard to swine health, participants in all study villages except Tha pene village (Luang Prabang) reported diarrhoea as a problem, sometimes accompanied with depression and loss of appetite resulting in death, and piglets dying shortly after birth. Sudden deaths during the hot season were also a concern. In Luang Prabang and Xayabouri provinces, diphtheria with swollen throats, fever and rash were also common with most of these cases resulting in death. Possible cases of rabies in pigs were reported in Houay Loun village, Xayabouri province, without any laboratory confirmation, although participants mentioned dog rabies being a problem in the summer. Again, Tha pene village was the only exception and reported that their animals were fairly healthy because they were kept far away in the fields and not near people.

Beliefs about the cause(s) of illness varied among the study villages. The belief that increased access to villages has increased human exposure to disease and had a negative impact on animal health was expressed by a few participants. This has changed food consumption practices, which some believe has also affected human and animal health. Spiritual beliefs influence what villagers perceive to be the cause of illness and death, as has also been previously suggested in the literature (Barennes, Tran, Latthaphasavang, *et al.*, 2008; Shirayama, Phompida & Kuroiwa, 2006). Some believe that individual cases of animal deaths may be caused by spirits, where as many deaths are likely due to disease. Other potential causes of animal illness/deaths included administering vaccinations and penning of pigs. Allowing animals to roam freely and/or housing them away from the villages were perceived as beneficial to health.

With regards to human health, the level of knowledge and awareness of villagers in relation to the study diseases and their risk factors is quite low. Some interesting ideas were communicated, for example alcohol consumption was believed by some to improve health and the lack of this practice can predispose a person to more health issues. There was a significant lack of knowledge about medications or treatments that were acquired for human and animal illnesses, regardless of where care or treatment was being sought. Except for general awareness of taking antibiotics or painkillers, for example, specific details of diagnoses (if one was made) and treatments were usually unknown. Awareness of zoonoses was also quite low; many were unsure of the possibility of disease transmission from animals to humans occurring and were unsure of what could be done about it. There was some awareness of disease transmission through the consumption of sick/dead animals but not other modes of transmission.

Discussion around health seeking behaviour of villagers indicated that the first point of care is usually a health centre, if there is one located nearby. This is followed by a traditional healer, spiritual healer, health volunteer, or a pharmacist/drug seller, and the district hospital if one is located nearby. Villagers tend to go back and forth between using traditional and modern medicine, with traditional medicine being used often because of its affordability. Reasons for the more popular use of traditional medicine in Lao PDR have previously been discussed (WHO & Lao PDR Ministry of Health, 2012; Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). Severe illness appears to be the trigger for seeking hospital care and in some cases district hospitals are bypassed for provincial hospitals, as many villagers perceive the district hospital to have similar capability to a health centre. Illness in children also makes villagers more likely to seek provincial hospital care compared with adult illness, as childhood illnesses are often perceived to be moderate to severe and funds are often limited. Otherwise, hospitals tend to be a last resort.

Some provinces provide free care for the poor but other indirect costs, such as transport and food, are not covered, which makes seeking hospital care impossible for many people. Health care facilities in Luang Prabang and Phongsaly provinces provide this scheme for patients, but at the time of the researcher's visit this was not provided in Xayabouri province due to funding issues.

Non-medical factors play an important role in health seeking behaviour. While financial ability and perceptions and beliefs about health and illness are major drivers of health seeking behaviour in this study population, another aspect that did not come up in focus group discussions were the gender aspects of health decision making, as discussed elsewhere (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012; Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). Further research should be done on the role of gender in health care decision-making and its impact on health outcomes in this population. Lao PDR is a patriarchal society and permission from male figureheads or elderly household members is often required before seeking health care (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013).

With regards to risk factors for zoonotic diseases and behaviours with a potential impact on disease transmission and human and animal health, several findings were made. For instance, pig husbandry practices do not always involve the separation of sick animals from healthy ones and knowledge and use of appropriate protective equipment for the handling of sick or dead animals or animal products is quite poor. Sick animals are often sold or consumed if deemed likely to die because of the investment involved in rearing them and guilt felt by villagers if they are disposed of. In some cases animals are disposed of, but the practice varies depending on the size and value of the animal. Reporting of animal illness/death(s) is poor and reasons for this given by participants include low availability and access to drugs for treatment from the DAFO, slow or non-existent response from the DAFO when illness/deaths are reported, and lack of funds to pay for any interventions (treatments or vaccinations). Reporting practices also vary depending on the type of animals involved and/or if outbreaks or large numbers of deaths occur.

Many villages grow their own vegetables for consumption, in addition to rice, and animal faeces are sometimes used as fertiliser. While rodents are mainly a problem in rice fields, they are considered a nuisance in the villages during harvest season. Sources of meat vary in different villages, but in general are purchased from markets or traders that come to the villages or comes from slaughtered livestock. Although there is some awareness of zoonoses and the possibility of disease transmission through consumption of infected meat from a sick animal, this practice still occurs quite often. Pigs are often slaughtered for special occasions or ceremonies and can be eaten cooked or raw. Ceremonial events and large gatherings have historically been associated with outbreaks in China, Thailand, and Lao PDR (Takahashi, Mingyuan & Waikagul, 2000; Barennes, Sayasone, Odermatt, *et al.*, 2008). Raw pork meat and blood is reportedly consumed in some villages, usually from slaughtered pigs and sometimes bought from the market. Often male villagers were reported to consume raw meat and blood and not women or the elderly, since they are not perceived to be as strong as men. Further research on whether gender differences in consumption practices of raw meat and blood reflect the disease burden is needed to determine if a relationship exists. Some participants reported consuming raw pig blood but not raw pork meat, while others reported consuming neither. Instead a preference for raw duck or chicken blood or wild pig blood was reported, because these animals are perceived as having fewer diseases. Other raw meat (beef or buffalo) may also be consumed instead of raw pork. While this study focuses on pig-associated zoonoses, the impact of raw meat and blood consumption from other animals also needs to be considered.

Sources of drinking water at the village level in Lao PDR include rivers, streams, dams, protected and unprotected wells/boreholes, rainwater tanks, or piped water (MAF & FAO, 2014). Piped water appears to be more common in urban areas, while villages lacking road access, located in the uplands in northern provinces are less likely to have it (The World Bank, 2010a). For participants in this survey, access to a public water tap/pump or tank varied depending on funds available to villagers and previous involvement of NGO projects that assisted with building water systems and/or latrines. For drinking purposes, water is usually boiled when people are in the village but not when working in the fields or away from the village, where river water is usually consumed.

The number of households with latrines varies in each village, as does latrine usage. Some households with latrines still refrain from using them and instead prefer going to the village outskirts or the forest. As previously illustrated in the literature, latrine ownership does not always denote usage (Tran, Odermatt, Le, *et al.*, 2006; Bardosh, Inthavong, Xayaheuang, *et al.*, 2014b; Phongluxa, Xayaseng, Vonghachack, *et al.*, 2013). Many without latrines tend to go to the forest whilst some share with other family members. Latrines are also not used while working in the fields, often due to the large distances between them and the village. While most participants reported performing appropriate hand washing, this practice was quite mixed with regards to the use of soap as most often only water is used. Various reasons were given for this, including visual cleanliness of hands, the smell of food being prepared, if contact with blood or soil is made, availability of time, and, sometimes, parental teaching of children. Poor sanitation is also a concern in most of the study villages as the most common practice for dealing with household waste involves open dumping at various sites. Although bed net usage was said to be quite common, participants revealed that they are not always used while staying near the rice fields. Indeed, there may be an ethnic variation in this practice, which requires further exploration. Alternatively, it may be due to a challenge in procuring the bed nets.

There were a number of limitations and constraints encountered in carrying out this survey. Firstly, it was not possible to ask all questions in the interview guide in some focus groups. Some questions had to be omitted if there were time constraints or participants persisted in discussing other topics covered in the FGD, to keep them engaged and be appreciative of their time. A number of Huay Keng village participants left part-way through the discussion as they only wanted to discuss their health problems. Secondly, some groups were too large making it difficult to keep everyone focused, there were often children running around as well. Thirdly, some participants were shy, Pha Xang village participants in particular. Discussion with local SPSP staff later revealed that the project had stopped working with this village (1 of the 4 ACIAR villages) as they were suspicious of outsiders and not very cooperative. This may have affected responses given in the FG. Fourthly, translation between 2 or more languages/dialects can affect the accuracy of information given by participants. Responses were translated between English, Lao and sometimes a local dialect; responses were summarized and repeated back to participants to ensure correctness as much as possible.

Finally, a potential source of bias, is that the presence of an observer or researcher may alter the natural scene or influence participants' responses or behaviour (Hoepfl, 1997). Participants may respond with answers they perceive to be favourable to the researcher. Attempts were made to minimize this as much as possible through the methodology used in conducting the survey. Ideally, participants in FGD are homogenous with respect to characteristics relevant to the discussion, and participants are not known to each other, in order to facilitate free dialogue (Khan & Manderson, 1992). Homogeneity of participants was not necessary as the aim of the survey was to gather information on the diverse views, practices, beliefs, and opinions, which would be influenced by the different ethnic backgrounds, cultural beliefs, and age groups that participants belonged to.

4.5 Conclusion

Several factors play a crucial role in the transmission, prevention and control, of pig-associated zoonoses. Knowledge and awareness of the study diseases, their risk factors, and of zoonoses in general was found to be quite low in the rural study villages in northern Lao PDR. The attitudes and practices adopted by villagers in relation to human and animal health and health seeking behaviours are strongly influenced by financial circumstances, access to appropriate healthcare facilities, spiritual beliefs, and a lack of knowledge and resources to ensure the health of both animals and humans. This, as well as misconceptions about health, need to be addressed at the community level. Financial barriers play a significant role in the health seeking behaviour of people, as well as in food consumption practices. Ethnicity and culture are also important influencers of food consumption practices and perhaps play a role in hygiene practices adopted by many villagers. Important concerns that need to be addressed include the inadequate use of soap for hand washing, latrine use and household waste disposal practices and the factors that influence these practices, such as cost.

While it was difficult to get an estimation of disease incidence, this survey highlights the lack of and critical need to address diagnostic capability in the rural areas of northern Lao PDR, crucial for appropriate treatment and disease surveillance. In the absence of diagnostics the survey shows that qualitative assessments can be useful in assisting with syndromic surveillance and in gaining a more context specific understanding of zoonoses burden. This is extremely challenging in areas where knowledge and awareness of pig-associated zoonoses is low or the diseases of interest have overlapping clinical presentations. Qualitative assessments can play a role in finding and implementing culture appropriate control measures that will impact multiple diseases, and thereby improve biosafety and prevent disease transmission to the human population.

5 Health-seeking behaviour assessment at the village and hospital/health centre levels

5.1 Introduction

The public health care system in Lao PDR is formally organized into four administrative levels – central, provincial, district and village; with one government-funded provincial and district hospital in each province and most districts, respectively (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012). The public sector delivers most services through health centres and district, provincial, and central hospitals, while the private sector consists mostly of clinics with an increasing number of clinics and wards established within major hospitals (WHO & Lao PDR Ministry of Health, 2012). The private sector has a higher presence in urban areas but remains fairly small and is mostly unregulated (Alkenbrack, Jacobs & Lindelow, 2013; Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013).

A user fee was established in 1996 at most private and public health facilities with exemptions in place in public health facilities for specified vulnerable groups (WHO, 2011b). A user fee exemption policy, or "poor policy" (as described by respondents in this study), was established in response to out-of-pocket payments (the main source of health spending for households), which are seen as a barrier to those seeking healthcare. Very poor people can be exempted from paying for health services (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013) on certification from the village head. Implementation and coverage of health insurance schemes throughout Lao PDR is low (see chapter 2), with enrolment most common among civil servants and employees of larger private companies (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012, 2013). One of four schemes[6], the voluntary community based health insurance (CBHI) scheme, is meant to target approximately 50% of the population, described as the near-poor informal sector, but covers an estimated 2% (Alkenbrack, Jacobs & Lindelow, 2013). The vast majority of voluntary community health insurance schemes fail to reach most of their

[6] (i) State Authority Social Security (SASS) for civil servants; (ii) Social Security Organization (SSO) for private sector employees; (iii) voluntary Community-based Health Insurance (CBHI); and (iv) Health equity fund supported by external donors focusing on the poorest of the population (WHO, 2011b).

target population and tend to exclude the poor (Alkenbrack, Jacobs & Lindelow, 2013). Low enrolment, combined with many members suffering from chronic ill health, threatens sufficient revenue generation and financial sustainability of these schemes (Alkenbrack, Jacobs & Lindelow, 2013).

The government run public system in Lao PDR is poorly utilised. In 2008, an estimated 1.8% of the population was likely to seek care from a modern health care provider (The World Bank, 2010b). Poor geographical access to health facilities and limited financial ability to cover the costs of user fees, of travel and services, cultural norms and practices, as well as gender dynamics in decision-making are known to affect the utilization of formal health care in Lao PDR (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012; Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013; Alvesson, Lindelow, Khanthaphat, *et al.*, 2013). Even when health care facilities are accessible the dearth of adequately trained staff effectively distributed throughout the country, inadequate infrastructure and affordable drug supply exacerbate this problem. Accessibility remains a challenge, particularly for the rural poor, as ability to pay and distance to a health care provider are major barriers. About 54% of villages face access challenges. Pharmacies/dispensaries and hospitals tend to be located more than 2 hours walk away from most households, a problem that is exacerbated in rural areas in particular in villages with poor/ no road access (MAF & FAO, 2014; WHO & Lao PDR Ministry of Health, 2012). Access barriers combined with poor service quality has resulted in poor utilization of the health care system (WHO, 2012). The Lao government is, however, committed to improving the distribution of health infrastructure, performance of health care workers and improving facilities to improve utilization rates (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012).

Multiple social, individual, and environmental factors also affect health-seeking behaviour, including knowledge of diseases and their risk factors, perception of risk, gender and generational influences in health decision-making and cultural and religious beliefs and practices (Alvesson, Lindelow, Khanthaphat, *et al.*, 2013; Tanner, Chuquimia-Choque, Huanca, *et al.*, 2011; Nichter, 2008). Bypassing local health care facilities at the health centre and district levels to seek care at provincial and regional hospitals or in other countries in the region is common, especially for severe illnesses, due to the perceived quality of care available (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013; Alkenbrack, Jacobs & Lindelow, 2013).

5.2 Methodology

5.2.1 Aims of the survey

This assessment attempted to (i) determine the health seeking behaviours of villagers and patients presenting to a health care facility when experiencing illness (ii) consider the factors influencing choice of health care provider (iii) determine the impact of health seeking behaviour on duration and severity of illness and cost for treatment, and (iv) consider differences in health seeking behaviours between groups.

5.2.2 Study area

The survey was undertaken in a subset of households and health centres/hospitals within selected villages and districts in the 3 study provinces – Phongsaly Province, Luang Prabang Province, and Xayabouri Province (see Table 4.1, chapter 4 for a summary of the villages and their characteristics).

5.2.3 Study design

At village, household/individual and health care facility levels, structured interviews were administered to determine health-seeking behaviours, impact of illness and cost of illness on households, and behaviours that may affect exposure. Based on the findings of the focus group discussions (chapter 4) adjustments were made to the questionnaires. Questionnaires were divided into three sets of forms (Appendix 3):

1. Form 1 – 'Socio-demographic and animal factors' questionnaire with general questions regarding socio-demographics and socio-economic status (e.g. education level, income sources, animal keeping practices and a poverty score).
2. Form 2 – At village level, for ***households*** that experienced episodes of illness in the last 30 days, a second form on the 'Impact of illness and health seeking behaviours' was completed. This included questions regarding illness experienced, length of time

before seeking care, type of care sought, the severity of illness, impact of disease and direct and indirect costs of treatment.

3. Form 3 – For ***patients (or their parents/guardians) presented or admitted to a health care facility***, a second questionnaire on the 'Impact of illness and health seeking behaviours' was administered that included questions regarding type and severity of illness experienced, length of time before seeking care, type of care sought, diagnosis, impact of disease and direct and indirect costs of treatment.

5.2.4 Sample size and data collection – at village level

The sampling protocol applied for the ILRI/ACIAR survey undertaken in 2011 (see chapter 3) was incorporated into the assessment at the village level with modifications. Household interviews were carried out in 3 villages in Mai District, Phongsaly Province, 4 villages in Xayabouri district, Xayabouri Province (7 of the 8 ACIAR villages), and 3 villages from Luang Prabang Province (1 from Luang Prabang District and 2 from Chompet District). Two villages had to be excluded from the study as described in Chapter 4 (1 village in Mai District, Phongsaly and 1 village in Luang Prabang district). In total, 10 villages were included in the survey.

In each village, 15 households (HHs) were selected at random, at each 'X^{th}' interval using the formula: *Total # of HHs ÷ 15 (required # of HHs) = Interval (X)*

This method was adapted from methodology used by Sydara et al (2005) in a cross-sectional survey in southern Lao PDR. The first household was selected at random (by spinning a pen on a book) and every 'X^{th}' household was interviewed thereafter. Households were selected as randomly as possible and include those spread throughout the villages. Each household was geo-referenced. If household members were not home or did not wish to participate then households nearby were selected.

One individual was interviewed from each selected household (Form 1), either the head of household or an individual available with input from the rest of household. Form 2 was completed for each case of illness experienced in household during the previous 30 days, based on the 'Criteria for Illness' (see section 5.2.6). Village chiefs were interviewed to provide contextual village data and personal observations were recorded. Pre-survey visits were made to inform households of the survey and determine a time for interview that was suitable for participants. Household identification numbers were applied but respondent identities remained anonymous throughout this study and contributions were confidential.

5.2.4.1 Inclusion criteria

All members of the household were eligible to participate, with consent from the participant or the head of household. A member of the household is defined as someone who has slept within that compound for at least 6 of the previous 12 months. If a participant was under 15 years of age, parent/guardian and the child were required to give consent. The head of household or an older caregiver (≥ 15 years) could serve as proxy for non-adult household members (< 15 years). Infants were included from time of birth, if they resided in the household. All women, including pregnant women, were eligible to participate. If household members had died in the last 30 days, they were included if the head of household gave consent.

5.2.4.2 Exclusion criteria

Households were excluded if consent to participate was not given by the participant or the head of household. Individuals who met criteria for the ‘Impact of Illness and Health-seeking Behaviour Questionnaire (Form 2)’ but who did not agree to participate were excluded. Individuals who did not meet the criteria for being a member of the household were not included.

5.2.5 Sample size and data collection – at health care facility level

All health centres and hospitals located in/near the study villages and their respective district centres were included, specifically those mentioned by participants as a point of care. GPS coordinates of all the facilities were collected. Pre-survey visits were made to each facility to inform staff of the survey and determine a suitable time for the interviews. Hospital identification numbers were used, but identities remained anonymous throughout this survey and contributions kept confidential. Semi-structured interviews were administered to patients, if well enough, or to parents/guardians at the time of visit to the facilities and, where possible, at discharge to ensure all expenditures were recorded. The number of hospitals and health centres visited, as well as the number of patients meeting the 'Criteria for illness,' determined the number of interviews that were carried out.

5.2.5.1 Inclusion criteria

Patients that presented to or were admitted to a hospital/health centre with specific diagnosed diseases or undiagnosed syndromes, based on the criteria for illness were eligible to participate as long as consent was received from the patient (if able) or parent/guardian. If a patient was less than 15 years of age, both parent/guardian and patient (if able) were required to provide consent. The parent(s) or guardian(s) could serve as proxy for non-adult patients. Infants and all women, including pregnant women, were also eligible to participate.

5.2.5.2 Exclusion criteria

Patients at the hospital/health centre that did not meet the 'Criteria for Illness' were excluded from the survey. If consent to participate was not given by the patient and/or parent(s) or guardian(s), they were excluded.

5.2.6 Criteria for Illness

(i) Patients admitted or having presented to a hospital or health centre with the following diagnosed diseases: JE, hepatitis E, brucellosis, or Q fever

(ii) Patients with the following syndromes – acute febrile illness, acute jaundice, central nervous system (CNS) infections (with meningitis, encephalitis, or acute flaccid paralysis).

(iii) Patients with *fever symptoms* (headaches, sweats, joints or muscle pain *or nausea symptoms* (nausea, vomiting, loss of appetite/anorexia) *or*[7] *liver symptoms* (enlarged tender liver – hepatomegaly or acute liver failure) or *neurological symptoms'* (seizures or fits, change in mental state from

[7] **This was originally 'AND', but** because so few villagers/patients met the 'Criteria for Illness,' this was changed to 'OR' in order to capture more participants.

confusion to loss of consciousness, uncontrollable shaking of body parts/tremors, stiffness or paralysis).

5.2.7 Ethical Considerations

Questionnaires were translated into Lao and administered with the help of a translator. Form 1, was piloted at Mai District hospital. Careful attention was paid to the ability of participants in understanding the questions being asked of them (through summary and repetition of responses back to participants for clarification) and comfort level in answering them, and modifications were made where necessary (rephrasing of questions).

Verbal consent was obtained from all participants at the start of each interview; participants were asked if they were comfortable talking about the health and livestock keeping practices of their household. A brief introduction to the researcher and translator was provided at the beginning of each interview, as well as a brief explanation of the purpose of the study, types of questions that would be asked, and assurance that participants could withdraw from the interview or from specific questions at any time should they choose. Reassurance that all responses would remain anonymous and confidential was also given.

5.2.8 Data management and analysis

Questionnaire data was recorded on paper, followed by electronic entering using Epi Info™ 7 software (http://wwwn.cdc.gov/epiinfo/7/) by the US Centre for Disease Control (CDC). Data summary and analysis was carried out using Microsoft Excel.

5.3 Results

5.3.1 Characteristics of study participants at village and health care facility levels

In total, 150 household interviews (Form 1 socio-demographics and animal factors) were completed at village level, 15 per village (Figure 5.1). Four patient interviews at the health care facility level were undertaken as very few patients met the ‘Criteria for Illness’ (one diagnosed with Rickettsia and one with hepatitis B liver cirrhosis, included in the survey out of interest).

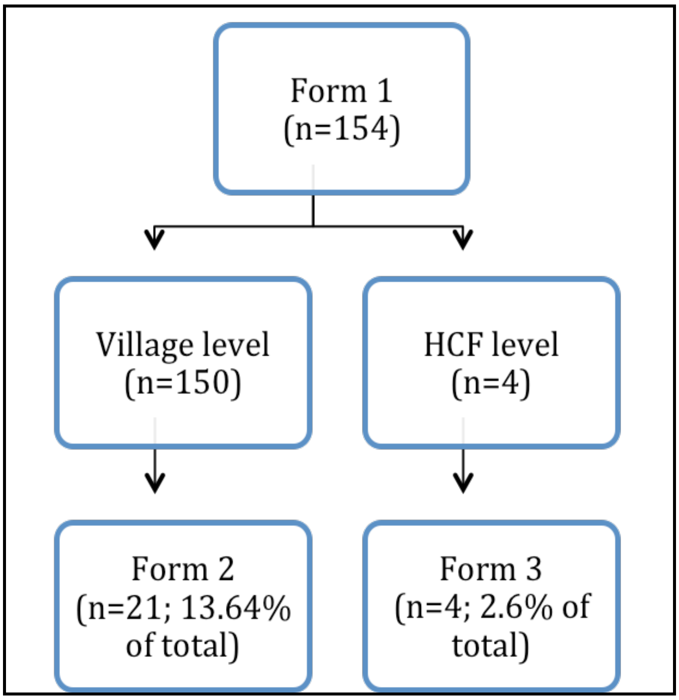


Figure 5.1 Village and health care facility questionnaires with number of participants for each; HCF= health care facility

Of the 154 respondents interviewed, 69% (106/154) were heads of households (HHs), 30% (47/154) were the spouse, child or parent of the household head, and 1 was another family member. Information on the heads of these remaining households was also collected.

5.3.1.1 Head of household demographics

Information on the household heads (HHs) was collected from all interviews (n=154). Most HH (90.26%; 139/154) were between the ages of 15 and 64 years, with 9.75% over 65 years (15/154). The majority of HH were male (85.06%; 131/154), with very few female heads (12.34%; 19/154). Gender information for HHs was missing from 2.6% of respondents (4/154). Over 50% HH had completed primary school (52.6%; 81/154), with 26.62% (41/154) completing secondary school, only 2.6% (4/154) completing further education (college, university, etc.), and 17.53% (27/154) not completing any education.

5.3.1.2 Non-household head participant demographics

All participants interviewed that were not HH were aged between 15 and 64 years, 85.42% (41/48) were female and 14.58% (7/48) were male. Of these participants, 64.58%

(31/38) had completed primary school, while only 14.58% completed secondary school, 2.08% did further education (college, university, etc.), and 18.75% (9/48) had not completed any education.

5.3.1.3 Household composition

Information on the number of individuals in each participating household was stratified according to age group and gender and showed roughly equal proportions of males and females in each age group (Figure 5.2). This was similar to the population level distribution based on estimates from the 2015 Lao PDR Population and Housing Census (Figure 5.3) (Lao Statistics Bureau, 2014, 2016). Overall there was an average of 6.3 members in each participating household (range 2-14), representing a total of 963 members in 154 households surveyed, and an average of 1.89 members attending school (278 of 963).

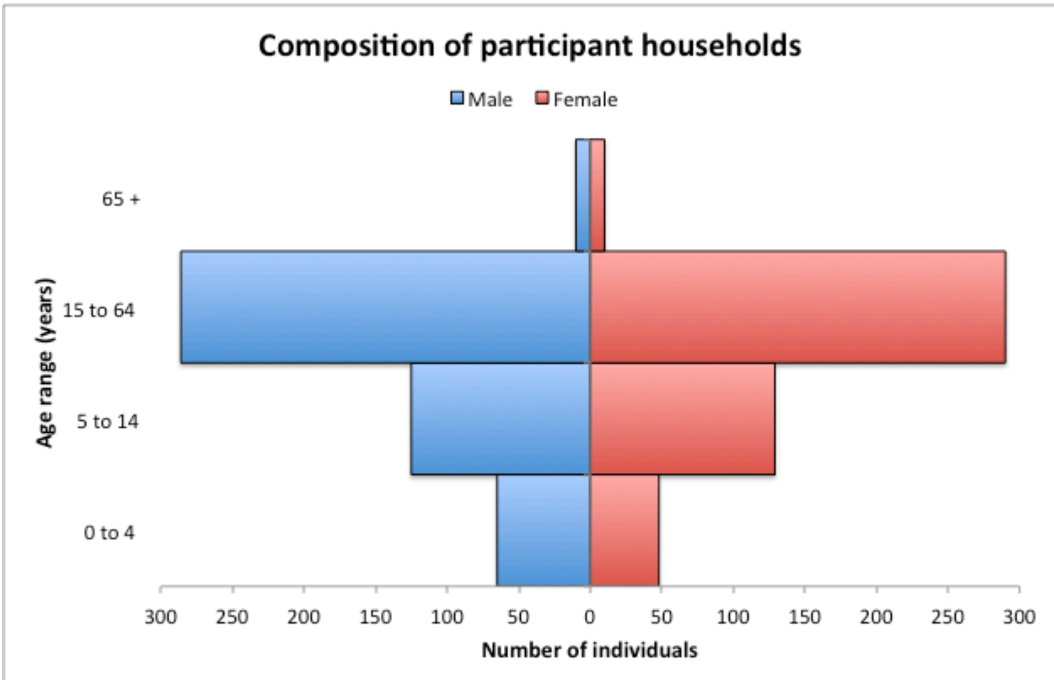


Figure 5.2 Age and Gender Composition of Participating Households

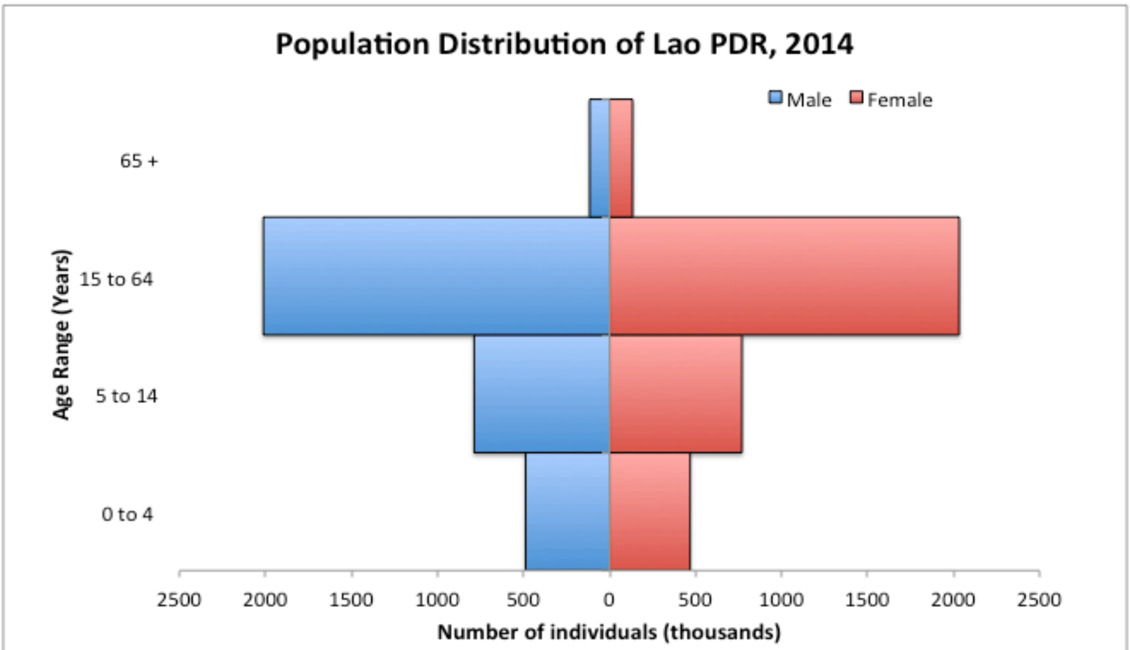


Figure 5.3 Age and Gender Distribution of Population of Lao PDR, 2014; based on estimates from the Lao PDR Population and Housing Census 2015.

5.3.1.4 Ethnicity and religion

More than half the respondents belonged to the Khmou or Lao Theung ethnic group (56.49%), followed Hmong or Lao Sung (22.73%). Other ethnic groups included Lao Loum (7.14%), Thai Deng (4.55%), Thai Dam (4.55%), Yao (2.6%), Phou noy (0.65%), and ‘other’ (1.3%; 1 Khmou and Lao Loum household, and 1 Phou Thai).

Most households reported to practice the ‘Spirit religion’ (72.08%), also known as ‘*Sadsana Phi,’* an animistic belief system. A lower percentage of respondents claimed to practice Buddhism (18.18%), with a small minority of households practicing Christianity (5.19%) or adopting a mixture of beliefs (4.55%; usually ‘Spirit’ and Buddhism/Christianity).

5.3.1.5 Household income sources

The main source of household income was crop farming (84.42%), particularly rice and coffee (Table 5.1) with 39.61% of respondents owning a rice field. Livestock keeping was an important source of secondary income for 69.68% of respondents and a tertiary income source for 7.19% of households. As a primary income source, owning a business or selling products was the second most common, for a small percentage of households

(5.84%), followed by livestock keeping (3.9%). Of those who stated livestock as their primary household income source, cows, pigs and chickens generated the most income. Most households did not have a tertiary income source (81.7%).

Income Source	1° source	2° source	3° source
	(% Of total participant households)		
Livestock	3.90%	69.68%	7.19%
Crop farming*	84.42%	4.52%	1.31%
Fishing	0.00%	0.65%	0.00%
Business or selling (own business)	5.84%	4.52%	3.92%
Paid employment	2.60%	5.81%	5.88%
Other	3.25%	0.65%	0.00%
None	0.00%	14.19%	81.70%

Table 5.1 Income source summary (*rice, coffee; highlighted percentages= top 2 income sources)

Other sources of income included full or part-time paid work (24.03%) or owning a business or selling products such as handicrafts, construction, food shops, etc. (7.14%). Full or part-time paid employment included the military, health care workers, teachers, factory workers, drivers, restaurant or tourism workers. Respondents were also questioned about receiving money from family members living away from the household, and 16.23% (25/154) of respondents indicated receiving money either once per month, every 2 to 3 months, every 6 months, or annually. Of these, 44% reported receiving money once a year.

5.3.1.6 Animal husbandry practices

Information on the number and type of animals maintained was collected, with more specific questions on pig husbandry practices and rice field ownership. Pigs (62%) and chickens (74%) were most commonly kept by households and in larger numbers (Table 5.2). One household in Pha Xang village, Xayabouri province, owned 5000 chickens, with most other households owning between 3 and 30 chickens.

Species	No. of HHs* (%)	Total no. of animals (%)
Cattle	44 (28.57)	238 (2.73)
Buffalo	43 (27.92)	171 (1.96)
Donkey	0	0
Goats	18 (11.69)	143 (1.64)
Pigs	95 (61.69)	522 (5.99)
Chickens	114 (74.03)	7262 (83.37)§
Dogs	49 (31.82)	111 (1.27)
Horses	1 (0.65)	2 (0.02)
Ducks	35 (22.73)	262 (3.01)
Total	-	8711

Table 5.2 Summary of animal ownership in participating households; *number of households that own animals, total number of households=154; §This includes the outlier household with 5000 chickens, total excluding outlier = 2262 (25.97%).

About 26% of households interviewed reported having animals that were sick or had died within the previous 30 days, accounting for a total of 467 animals. Furthermore, about 46.1% of respondents indicated separating sick from well animals.

Approximately 62% of participating households (95/154) indicated keeping pigs (Table 5.2). Of these, about 65% of households claimed to use penned housing for their pigs, with about 4% and 9% adopting free range and a combination of both practices (roam free in day time and penned at night) respectively. Information on the type of pig housing used was missing from 9.74% of households/interviews. Of those who owned pigs, over half of respondents (55.79%; 53/95) also claimed to keep or house pigs < 100 metres away from their household.

5.3.1.7 Household conditions and expenditures

Housing conditions varied between and within villages. The most common types of households being single storey houses made of bamboo (28.57% of respondents), double storey houses with one level made of brick/concrete and the top level made of wood (23.38%), and single storey houses made of brick/concrete or metal (17.53%). More than half of the dwellings were less than 3 rooms (57.14%), with 40.91% of households having 3 or more rooms (missing values from 3 households). Electricity was available in 78.57% of households, while 18.83% reported having no power. Ownership of various items by the household was also ascertained, as illustrated in Table 5.3 below, with the most commonly owned item being a mobile phone (86.36% of respondents). The top 5 items included a mobile phone, motorcycle, toilet, television, and DVD player. Toilet ownership (71.43%) was predominantly a traditional pit latrine with pour flush type. The main source of drinking water was a public pump or shared tap (96.75% of respondents), with remaining sources including river water, piped water to the household, a water well (possibly uncovered), and factory (bottled) water.

Item	Frequency of ownership	% of total (154 respondents)
Bicycle	33	21.43%
DVD player	97	62.99%
Mobile phone	133	86.36%
Motorcycle	113	73.38%
None	3	1.95%
Radio	34	22.08%
Television	108	70.13%
Toilet	110	71.43%
Tractor	4	2.60%
Vehicle	9	5.84%

Table 5.3 Summary of items owned by each participating household

Respondents reported spending an average of 239,188 LAK ($29.88 USD[8]) per week on food (ranging between 0 and 2 million LAK or $0 and $249.83 USD). The highest average weekly expenditure was among hospital patients interviewed ($87.44; range $18.74 - $249.83 USD) and in Donexai ($60.79; range $37.48 – $87.44 USD) and Tha pene ($53.55; range $3.75-$124.92 USD) villages. While the lowest average weekly expenditure was in Ang ($10.58; range $1.25-$37.48 USD), Omkaneng ($11.37; range $0-$49.97 USD), and Sophoun ($15.49; range $2.50-$37.48) villages.

[8] Currency conversion based on exchange rate from December 2013 - $1 USD = 8005.30 LAK (http://freecurrencyrates.com/en/exchange-rate-history/USD-LAK/2013/yahoo)

5.3.2 Impact of illness and health seeking behaviour – village household survey

Of all interviews conducted, 14% (21 of 150 households) of respondents had experienced illness in the previous 30 days that matched the 'Criteria for Illness.' These respondents at the village level were administered 'Form 2' questionnaire. Respondent households were exclusively from Omkaneng (n=2), Poungkao (n=10), and Sophoun (n=4) villages in Phongsaly province, and from Houay Loun (n=4) and Pha Xang (n=1) villages in Xayabouri province. No households in Luang Prabang province reported experiencing illness in the last 30 days that met our criteria.

For multiple types of illness experienced in the previous 30 days; 66.67% reported experiencing acute febrile illness, followed by generalized fever symptoms (fever, headaches, sweats, joint or muscle pain), nausea symptoms (nausea, vomiting, loss of appetite or anorexia), and CNS infections (meningitis, encephalitis or acute flaccid paralysis) in 47.62%, 23.81%, and 14.29% of respondents, respectively. Most illnesses occurred in participating villages from Phongsaly province. Additionally, 76.19% (16/21) of respondents claimed they (or their family member) had experienced this type of illness before, while 14.29% did not know. With regards to hepatitis E, Japanese encephalitis, brucellosis, and Q fever, only JE was reportedly diagnosed in 9.52% (2/21) respondents. One third of respondents did not know if they had ever been diagnosed with the study diseases.

The distance to the nearest health centre ranged between 0 -10 Km, with 66.67% of respondents reporting no health centre nearby. Only Sophoun village had a health centre accessible within the village. The distance to the nearest hospital was reported as between 5-20 Km from the villages, with Poungkao (Phongsaly province) and Houay Loun (Xayabouri province) villagers needing to travel more than 10 Km.

5.3.2.1 History of patient's illness and health seeking behaviour

Three households had an additional member who had experienced illness in the last 30 days, matching the criteria for illness (n=24). There were roughly equal proportions of males versus females (45.83% males and 54.17% females). Most respondents were between ages of 15-64 years (45.83%), with 37.5% aged 5-14 years, and 16.67% under the age of 5. Of these approximately 30% worked in agriculture/as farmers. Duration of symptoms ranged between 1 and 14 days, with 3 days being the most common. Clinical diagnosis was also the most common type of diagnosis made, with only about 21% of participants (5/24) receiving both clinical and laboratory diagnoses. Disease severity was described as mild and moderate by about 42% of respondents each. While only 17% of respondents stated that the illness was severe, approximately 92% of all respondents claimed they were unable to attend school or work as a result of their illness. One death was reported, however, since the exact cause of death was unknown it is unclear whether it was related to the illness under study. Most respondents recovered from their illness with no long term effects, however, one who had experienced a clinically diagnosed febrile illness was unable to walk, another suffered from chronic fatigue following an acute febrile illness and jaundice with liver symptoms (enlarged tender liver – hepatomegaly or acute liver failure), and a third respondent suffered from paralysis following acute febrile illness with CNS infection.

Most respondents (85.71%; n=21) reported consulting multiple health care providers for a given episode of illness. The majority, 90.48% practiced self-medication with medicines purchased from a pharmacy or drug seller, while 19.05% used home remedies. Traditional medicine was common, 23.81% and 33.33% of respondents consulted a traditional healer and spiritual healer, respectively. In terms of health care facilities, 28.57% visited a health centre with the majority going to a government hospital (district, provincial, or regional) at 61.90%. Reasons for not attending a health care facility were insufficient funds or having a mild illness. No respondent reported visiting a private facility and only one consulted a health volunteer. The primary response to illness was self-medication (66.67%); regardless of illness severity, this was followed by visiting a health centre (14.29%), use of home remedies (9.52%), and other practices such as consulting a health volunteer or a combination of self-medication and home remedies (9.52%). Most respondents reported seeking treatment within the first couple days of an illness (85.71%).

5.3.2.2 Household cost of disease

Costs associated with an illness also include indirect costs. Most respondents (80.95%) travelled between 0.2 and 20 km to reach a healthcare facility. The most common modes of transport used by respondents were walking or travelling by motorcycle (33.33% each), followed by car (23.81%) and bus (9.52%). Cost of transportation to a facility ranged between 0 and 4 million Kip ($0 - $500 USD) with most of respondents (71.43%) spending up to 100,000 Kip ($12.5 USD).

Respondents reported treatment including medications (such as antibiotics, paracetamol/painkillers, fluids/oral rehydration salts, anti-malarial drugs, cold/cough/fever medications, traditional medicine) with costs ranging from 10,000 to 2 million Kip ($1.25 - $250 USD), with most (76.19%) spending up to 500,000 Kip ($62.5 USD). Hospital stays costed between 0 and 20 million Kip ($0 - $2500 USD), with 76.19% of respondents spending up to 5 million Kip ($625 USD).

	Range ($ USD)	**No. of respondents**
Transportation	$0 to $500	$0 – $12.5 = 15 $12.5 – $62.5 = 3 > $62.5 = 2 NA = 1
Medications	$1.25 to $250	$0 – $62.5 = 16 $62.5 – $125 = 2 >$125 = 1 Don't know = 2
Hospital stay	$0 to $ 2500	$0 – $625 = 16 $625 – $1250 = 0 >$1250 = 1 NA = 4

Table 5.4 Costs associated with illness experienced by participating households (n=21), in USD

To cover costs, 42.86% of respondents reported using their own money and/or obtaining cash from selling farm animals (47.62%). Several (n=4) reported borrowing between 600,000- 4.5 million Kip ($75-$562.5 USD), to cover their costs.

As regards work lost due to illness, 57.14% (12/21) of respondents claimed no-one was enlisted to undertake their work during their sickness while 23.81% (5/21) claimed that another household member undertook their role, one acquired paid help (1 million Kip or $125 USD) and one claimed someone outside their household was unpaid to do their work. Where the patient was a child (57.14%), caregivers reported taking between 1 and 14 days absence to provide care; 28.57%, 19.05%, and 9.52% of caregivers claimed that no one did their work or that another household member took on this role or that someone outside their household (unpaid), respectively. Most respondents (76.19%) could not identify any long-term effects of the illness(es) within their household, with 2 each claiming to be unable to work, unable to walk, or suffering from on-going/chronic symptoms.

None of the respondents reported belonging to any health insurance scheme, and only 19.05% (4/21) were aware of such schemes being available. Most respondents (19/21; 90.48%) stated that having health insurance would influence how they accessed health care.

5.3.3 Impact of illness and health seeking behaviour – health care facility survey

Questionnaires (Form 3) were administered at health care facilities in or near the study villages and in the district centres, specifically those mentioned by study respondents. The sites visited included 3 facilities in Phongsaly province (2 health centres and 1 district hospital), 5 facilities in Luang Prabang province (2 health centres, 2 district hospitals, and 1 provincial hospital), and 2 facilities in Xayabouri province (1 health centre and 1 provincial hospital). The Form 3 questionnaires were administered to those who had experienced illness in the previous 30 days, matching the ‘Criteria for Illness, and had presented to a health care facility.

Only 4 interviews (2.6% respondents) were undertaken at health care facilities. Few patients were present at the health care facilities at the time of the survey and few met the clinical criteria for inclusion. Respondents were from Luang Prabang district and provincial hospitals (1 each), and Xayabouri provincial hospital (2). Of these 4 respondents, three experienced acute febrile illness and generalized fever symptoms (fever, headaches, sweats, joint or muscle pain), while one also had acute jaundice. One case was confirmed as rickettsia positive, while another was suspected of having rickettsia, and the third did not have any laboratory testing but was clinically diagnosed with pneumonia. Two respondents reported having a similar illness previously. A fourth patient was diagnosed with liver cirrhosis and chronic jaundice, possibly caused by hepatitis B, but laboratory diagnosis was not available at time of interview. This patient was first diagnosed with gastroenteritis at a health centre, before presenting to the Xayabouri provincial hospital. Three patients had blood specimens drawn for testing and rickettsia diagnosis was made using a rapid test kit. With regards to being diagnosed with the study diseases, respondents reported not being diagnosed or not knowing if they had ever been diagnosed with them in the past. Distance to the nearest health centre ranged between 0-6 Km, with one patient claiming to have access to a health centre within his village. Distance to the nearest hospital was between 2-20 Km from the patients' home village.

5.3.3.1 History of patient's illness and health seeking behaviour

Respondents were aged between 3 and 55 years, with 3 male and 1 female patient interviewed. Apart from one child, two respondents worked in agriculture/as farmers with the last working as a labourer. The patients were admitted for <1 (as outpatient) to 5 days, and had been ill for 2-10 days prior to the interview. Three of these respondents indicated being unable to go to work or school as a result of their illness, and all four described a moderate (2 respondents) to severe (2) illness.

The first point of care was self-medication and visiting a health centre for the two respondents in Xayabouri provincial hospital. Patients from Luang Prabang district and provincial hospitals, respectively, sought care from the health centre and government hospital. None of these respondents had visited a private facility or consulted a health volunteer, traditional or spiritual healer.

5.3.3.2 Household cost of disease

Respondents reported travelling between 2 and 20 km to reach a healthcare facility. Respondents reported travelling by motorcycle (2/4), tuktuk (1/4) or car (1/4). Transportation costs to a facility ranged between 10,000 and 50,000 Kip ($1.25 - $6.25

USD). Treatment included various types of medications (antibiotics, paracetamol/painkillers, fluids/oral rehydration salts) with costs ranging from 0-700,000 Kip ($0- $87.5 USD). Two patients reported the cost of hospital stay – one as an outpatient and the other spending 1.5 million Kip ($187.5 USD). Other costs, mainly for food, ranged between 500,000 and 600,000 Kip ($62.5-$75 USD).

To cover their costs, all respondents used their own money, though some were still in hospital and had not yet paid for their hospital stay. With regards to work lost due to the patient's illness, except for the child, time taken off through illness was 2 - 60 days. During this time either another adult from their household or no one was enlisted to do their work. Time off for the caregiver was 3 days, and in this case no one else was enlisted to do his or her work. Long-term effects of the illness on respondents households were non-existent or not yet known for 2 patients each.

Two respondents belonged to a health insurance scheme, from Luang Prabang and Xayabouri province, citing this as key in their decision to seek health care. Of the remaining two, one was not aware of its availability; though both stated that having health insurance would influence how they accessed a health care facility.

5.4 Discussion

This assessment, at village household and health care facility levels, focussed on the health seeking behaviours of villagers/patients when experiencing illness and examined factors influencing choice of health care provider. Information was collected on all households and from interviewees who were not head of their households.

The heads of households were predominantly male (85%). Education levels were fairly low, with only about half of all head of households (n=154) and about 20% (31/154) of non-heads completing primary education. At National level data indicate that while 92.2% of villages in Lao PDR have a primary school located within the village, only 16.7% have a lower secondary school (MoPI - Dept. of Statistics, 2012). National completion rates for primary, lower secondary and upper secondary schooling are 55.62%, 20.48%, and 12.45%, respectively (MoPI - Dept. of Statistics, 2012). These were lower in northern Lao PDR with completion rates of 48.82%, 13.38%, 6.59%, respectively and even lower for females at 41.66%, 10.43%, and 4.91%, respectively in the same region (MoPI - Dept. of Statistics, 2012).

Given that most of the village respondents in this survey were of the Khmou or Lao Theung ethnic group (56.49%), and were from Poungkao village (47.62%), in Phongsaly province and most households held animistic beliefs (72.08%); it was not possible to establish any associations between ethnicity, religion and health seeking behaviour. Household income was mainly generated from crop farming (84.42%), especially coffee and rice, though only about 40% of respondents actually owned a rice field. According to the 2012/2013 Lao expenditure and consumption survey (LECS), agricultural work made up 50.5% of income generating activities for respondents aged 10 years and older (MoPI - Dept. of Statistics, 2012). Owning a business or selling various products was the second most common as a primary income source, for a small percentage of respondents (5.84%), followed by livestock keeping (3.9%). Livestock keeping was an important secondary income source, at 69.68%. The 2012/13 LECS survey showed that nationally 28.2% of households operated a business, while 19.3% of northern Lao PDR households owned and operated a business (MoPI - Dept. of Statistics, 2012). Of those who specified livestock as the primary household income source, cows, pigs and chickens generated the most income. Pigs and chickens were the most commonly raised animals. Though less than half of the respondents indicated separating sick from well animals, and of those who owned pigs, just over half kept them <100 metres away from the household.

Contact with pigs is a known risk factor for hepatitis E, leaving pig farmers at high risk for acquiring infection (Hinjoy, Nelson, Gibbons, *et al.*, 2012). Pigs are also the primary amplifying hosts for JE because of their high natural infection rate, high viremia, a high birth rate providing a source of susceptible hosts, and the propensity for mosquito vectors to feed on them (Scherer, Kitaoka, Okuno, *et al.*, 1959). During times of peak transmission, virus amplification in susceptible pigs kept in close proximity to human inhabitants precedes epidemic transmission to humans. Pig rearing is common practice in northern Lao PDR and an important defence against poverty (Conlan, Khounsy, Inthavong, *et al.*, 2008). If close proximity to and contact with pigs is unavoidable, appropriate measures to prevent disease transmission to the human population, such as the use of protective equipment when handling animals and their products, improved hygiene and sanitation practices, etc. are crucial. Increasing knowledge and awareness of pig-associated zoonoses, their risk factors, as well as culture-appropriate measures that can be adopted to mitigate their spread is, therefore, necessary.

Housing conditions varied between and within villages; about 20% of participating households were without electricity. Toilet ownership was 71.43%, similar to the figure reported in the 2015 assessment on progress towards MDG targets related to sanitation and drinking water by the WHO (WHO & UNICEF, 2015). Most respondents owned a mobile phone (86.36%) and a television (70.13%). These could be targeted as a means of communication for health education and promotion to increase awareness of pig-associated zoonoses, affecting behaviour change related to disease transmission and risk factors, and improving the health and wellbeing of the Lao people. Mobile technology offers an innovative tool for increasing awareness and health promotion activities, such as improving immunization coverage rates (Caillet, Sichanh, Syhakhang, *et al.*, 2015; Kaewkungwal, Apidechkul, Jandee, *et al.*, 2015). It can facilitate improved access to and quality of health care, patient management, and health outcomes particularly among hard to reach populations (Kaewkungwal, Apidechkul, Jandee, *et al.*, 2015). The use of visual arts and media for health education and promotion activities has also been successful in other settings promoting locally relevant solutions that take into account social, cultural and economic conditions (Chávez, Israel, Allen, *et al.*, 2004; Barber, McEvan & Yates, 1995; McDonald, Antunez & Gottemoeller, 1999).

Expenditure on food also varied between villages and averaged around 239,188 LAK ($29.88 USD[9]) per week (between 0 and 2 million LAK or $0 and $249.83 USD). This amounts to 956,752 LAK ($119.51 USD) per month. Data from the 2012/13 LECS survey reported monthly food expenditure at 1,284,000 Kip ($160.39 USD) nationally and at 1,245,500 Kip ($155.58 USD) in northern Lao PDR, household expenditure on food in this study was lower. In Phongsaly, Luang Prabang and Xayabouri provinces, food expenditure averaged 1,346,200 LAK ($168.16 USD), 1,214300 LAK ($151.69 USD), and 1,188100 ($148.41 USD) LAK per month, respectively (MoPI - Dept. of Statistics, 2012). Monthly household expenditure on food was the highest compared with

[9] Currency conversion based on exchange rate from December 2013 - $1 USD = 8005.30 LAK (http://freecurrencyrates.com/en/exchange-rate-history/USD-LAK/2013/yahoo)

other goods and services consumed, such as medical care, education, etc. Interestingly, average monthly expenditure on clothing and footwear (54,800 Kip or $6.84 USD), medical care (51,400 Kip or $6.42 USD), and education (24,900 Kip or $3.11 USD) were lower compared with alcohol and tobacco expenditure (87,300 Kip or $10.9 USD) at national level (MoPI - Dept. of Statistics, 2012).

The number of respondents that matched the “Criteria for illness” was small; hence the sample size for the Impact of Illness & Health Seeking Behaviour Questionnaires (Forms 2 and 3) at the household and health care facility level was low (total n= 25). This presented a challenge in finding significant associations between factors that influence health seeking behaviour and their impact on health outcomes in the two groups. Nonetheless, some interesting findings were described. Firstly, acute febrile illness and fever related symptoms were the most common diagnoses and of the study diseases only Japanese encephalitis was reportedly diagnosed in 2 respondents. There is a lack of information regarding potential causative agents of febrile illnesses in Lao PDR (including non-zoonotic agents). Meanwhile existing information in the country comes mainly from the capital, where diagnostics of some causative agents is possible (Acestor, Cooksey, Newton, *et al.*, 2012; White, Newton, Maude, *et al.*, 2012a). Despite being a small country, there are notable differences in the causes of febrile illness in different regions of Lao PDR (Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013b). More research is needed to understand the aetiologies of fever, define their degree of heterogeneity in the country and the environmental and human determinants in order to inform health policy and development of appropriate and effective treatment protocols (Acestor, Cooksey, Newton, *et al.*, 2012; White, Newton, Maude, *et al.*, 2012a).

Clinical diagnosis was the most common method of diagnosing illness, regardless of health care facility level visited by a patient in this survey, highlighting the challenge of improving diagnostic capabilities in facilites outside of Vientiane. Self medication was the most common response to illness for 66.67% of vllage respondents, regardless of head of household gender and of disease severity. Self medication is common practice in Lao PDR and other Southeast Asian countries, where medications are often sold without a prescription (Nguyen, Thuy, Do, *et al.*, 2013; Caillet, Sichanh, Syhakhang, *et al.*, 2015; Stenson, Syhakhang, Eriksson, *et al.*, 2001; Sayasone, Erlanger, Kaul, *et al.*, 2009). This was followed by consulting a health centre (14.29% of village respondents). If not, a traditional healer, spiritual healer, health volunteer, or a pharmacist/drug seller was consulted, followed by the district hospital if nearby. Other studies have shown that local village health volunteers and informal care providers are the most frequently consulted, in addition to self-medication with traditional and modern medicine, presenting a clear preference for seeking local providers in response to illness (Alvesson, Lindelow, Khanthaphat, *et al.*, 2013). Villagers tend to go back and forth between traditional and modern medicine, with traditional medicine being affordable. Traditional medicine in Lao PDR is popular (WHO & Lao PDR Ministry of Health, 2012; Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). Alvesson et al (2012) found that this pattern of seeking care from conventional and alternative providers was believed to improve the prospect of recovery from illness; providers being more likely to provide the best care or treatment during the first consultation.

Perceived severity of the illness was observed to be a driver for seeking hospital care, in addition to financial ability, as previously reported (Alvesson, Lindelow, Khanthaphat, *et al.*, 2013). Local providers are often consulted on perceived familiar diseases, but if an individual is experiencing an unknown illness then care is sought from a healthcare facility (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012). District hospitals are often bypassed for provincial hospitals, as villagers perceive them to have inferior capabilities akin to a health centre. This can result in extended travel being required to seek health care services. Distances travelled to a facility ranged between 0-20 Km. Living within 10 Km from a facility, does not indicate ease of accessibility as access is dependent on road conditions, which are often impassable during the rainy season especially in mountainous rural areas of northern Lao PDR. Over half of villages (54%) in Lao PDR face challenges in accessing health care facilities as pharmacies/dispensaries and hospitals are located 2 hours walk away, and this problem is further exacerbated in rural compared to urban areas particularly in villages without road access (MAF & FAO, 2014; WHO & Lao PDR Ministry of Health, 2012).

The overall cost of disease to households experiencing illness ranged between $0-2500USD (20 million LAK) for transportation, treatment, and hospital stay. The user fee exemption or “poor policy” provides exemptions for the very poor from paying for certain health services (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). Hospital inpatients in this survey were unable to provide the total costs of their care. There is a lack of predictability in costs for inpatient hospital care that are required to be paid on a daily basis (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012, 2013). This has an effect on heath seeking behaviour as decisions to seek medical care are influenced by financial capability. Furthermore, fee exemptions do not include additional or indirect costs, which can be quite significant, such as transportation and food costs (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). This highlights the financial burden that is placed on patients without any health insurance coverage who rely on out of pocket payments. Borrowing money is not common practice, although some do depend on their social network for financial support if absolutely necessary (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013).

In this survey, most respondents were unaware of available health insurance schemes available but admitted that enrolment would influence their health seeking behaviours. There is a lack of understanding about health insurance even among those aware of the schemes, as identified in focus group discussions in one of the study villages, Houay Loun in Xayabouri province. Respondents stated that only a few villagers were enroled in such schemes as most could not afford the monthly premiums (based on the number of household members) and did not understand the advantages of the scheme. Financial barriers to making the premium payments have previously been identified in Lao PDR (Alkenbrack, Jacobs & Lindelow, 2013). In addition, those likely to enrol in health insurance schemes are more likely to suffer from chronic conditions, whereas healthy individuals fail to understand the requirement for such schemes (Alkenbrack, Jacobs & Lindelow, 2013).

Several limitations in this survey were identified. Firstly, although a broad "Criteria for Illness" was used to find eligible respondents, only a small sample matched this critera and comparisons between urban and rural villages, different demographics (age, gender, and socioeconomic status), as well as hospitalized and non-hospitalized cases from the two assessments (village and health care facility) were not possible. All attempts were made to select households as randomly as possible and include those spread throughout the study villages, in order to minimize selection bias. However, finding such a small sample that matched broad criteria for illness was not anticipated. As most respondents were from one village (Poungkao village, Phongsaly province), which was entirely of Khmou ethnicity, establishing a link between ethnicity and illness experienced by respondents or health seeking behaviour was not possible.

One recommendation for future work, and with a larger study sample, would be to calculate a poverty score in order to gain a better understanding the socioeconomic status of the villages. Based on a study of dengue and febrile illness in rural Cambodia (Huy, Wichmann, Beatty, *et al.*, 2009), this would help determine associations between poverty status and health seeking behaviour, disease duration, severity, and outcome.

As translation was done by a third party and not the author, the possibility of bias in translation cannot be excluded given that the questionnaires were carried out in Lao and had to be translated back to English and included responses that were subjective and difficult to quantify, such as providing exact costs for illness-related events that had occurred in the recent past. Lastly, the potential for information bias exists as respondents may have also provided what they believed to be acceptable responses, as can happen in studies on behaviour and health conditions (Sedgwick, 2015).

Addressing the many barriers to seeking appropriate health care will require cross-sectoral collaboration and coordination of multiple stakeholders, as well as community participation, to design and successfully implement solutions. Community participation is necessary in order to address barriers faced by those seeking care, to ensure that services are culturally and linguistically appropriate (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). The improvement of diagnostic capabilities in health care facilities located outside the capital city and strengthening of health care services in general, at all levels (health centre, district and provincial level hospitals) is key. This would prevent patients needing to travel large distances to receive appropriate, good quality care. Strengthening of health care facilities at all levels with an affordable, Lao-appropriate mix of methods for accurate diagnosis of treatable or preventable infectious diseases would improve our understanding of the geographical diversity of pathogens and their optimum treatments (Peacock & Newton, 2008; Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013b).

Improving knowledge and understanding of health insurance schemes and increasing health insurance coverage rates, particularly among vulnerable groups, is needed. As determined in a study by Li et al (2012) on factors affecting catastrophic health expenditures in China, households without insurance, located in rural versus urban areas, headed by a female, an unemployed person or a person with low level of education, as well as households having at least one member who was elderly, ill from tuberculosis or any chronic non-communicable illness, or hospitalized were more likely to suffer from catastrophic health expenditures. Many of these factors are present in this study population and certainly in Lao PDR.

5.5 Conclusion

Addressing the barriers to seeking health care in Lao PDR will require multi-sectoral collaboration and coordination of various relevant stakeholders, as well as community participation, to design and successfully implement culturally appropriate solutions. This requires the use of innovative tools for improving access to quality health care, especially in rural and remote areas. Local providers are most often the first point of care when experiencing illness and, strengthening their knowledge and capacity to provide appropriate and quality care is key, particularly at health centres and district hospitals. This not only tackles the barrier of distance to care but can also ease the cost of seeking care and perhaps improve health outcomes if appropriate prompt care is sought. The popular use of informal providers cannot be disregarded, as self-medication is commonplace as is going back and forth between care providers of modern medicine and traditional medicine. The popularity of “informal providers” as well as a service delivery assessment of formal health care providers will be explored in chapter 6. The lack of diagnostic capability has also been highlighted and emphasizes the critical need for development and more targeted research on causative agents of the diseases and syndromes most commonly diagnosed in these areas.

6 Healthcare provider service delivery assessment

6.1 Introduction

As discussed in chapters 2 and 5, the public health sector delivers most services through health centres and district, provincial, and central hospitals, while the private sector consists mostly of clinics with a growing number of private clinics and wards being set up in some major hospitals (WHO & Lao PDR Ministry of Health, 2012). The lack of adequately trained staff effectively distributed within Lao PDR, combined with inadequate infrastructure and an affordable supply of drugs, are major constraints within the formal health system. Language skills and high workload of health care workers are additional constraints (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). These problems are exacerbated in remote and rural regions and seeking care from multiple providers, both conventional and alternative, is commonplace (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012).

Village health volunteers (VHVs) who lack a professional medical background (also known as community health or local health care workers), receive training to provide a basic health service to their community (Sato, Pongvongsa, Nonaka, *et al.*, 2014). Benefits of utilizing VHVs include improving health indicators, particularly in hard to reach areas, and cost-effectiveness (Sato, Pongvongsa, Nonaka, *et al.*, 2014; WHO, 2006). However, the challenges of providing consistent good quality of service and in performance of VHVs have been recognized (Sato, Pongvongsa, Nonaka, *et al.*, 2014). Poor performance of VHVs is attributed to a lack of financial incentives, inadequate supervision and on-going training (Sato, Pongvongsa, Nonaka, *et al.*, 2014). To improve access to basic health services, particularly in rural and remote areas village health volunteers (VHVs) are expected to serve as local health service practitioners (Sato, Pongvongsa, Nonaka, *et al.*, 2014). Individuals are selected based on several criteria including being healthy, having primary or higher level education and being willing to undertake the role on a voluntary basis (Sato, Pongvongsa, Nonaka, *et al.*, 2014). VHVs generally sell a limited number of medications and provide consultations for minor conditions (Alvesson, Lindelow, Khanthaphat, *et al.*, 2013). Other activities include assisting and liaising with health centre staff in community outreach activities (e.g.

immunization campaigns), provision of health education, facilitating prenatal care, and event-based surveillance (Sato, Pongvongsa, Nonaka, *et al.*, 2014; Kaewkungwal, Apidechkul, Jandee, *et al.*, 2015). Their health duties are usually undertaken in addition to other economic activities. Some village health volunteers have discontinued their formal association with the Ministry of Health, and continue to practice in their communities (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012).

With the expansion of health markets over the last two decades, even in low and middle-income countries, the availability of medicines has increased in all but the most remote areas (Peters & Bloom, 2012). Pharmacies have become an important source of health care in these countries and are often the first point of care (Syhakhang, Stenson, Wahlström, *et al.*, 2001). Inappropriate and/ or incorrect use of medications and drug safety are of concern. The WHO has estimated that more than 50% of all medicines are prescribed, dispensed, or inappropriately sold and that half of all patients fail to take medicines correctly (World Health Organisation, 2002). Self-medication is common practice in many low and middle-income countries, and in Lao PDR, where numerous medications are available without the need of a prescription (Paphassarang, Tomson, Choprapawon, *et al.*, 1995; Caillet, Sichanh, Syhakhang, *et al.*, 2015; Stenson, Syhakhang, Eriksson, *et al.*, 2001; Nguyen, Thuy, Do, *et al.*, 2013).

Since the early 1990s, private clinics and pharmacies have become well established in urban areas in Lao PDR (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012; Epprecht, Minot, Dewina, *et al.*, 2008). Typically, the government runs pharmacies within public health facilities, with NGOs often setting up revolving funds for drug purchases (Stenson, Syhakhang, Lundborg, *et al.*, 2001). Pharmacies often function as outpatient clinics where patients obtain these medications, providing a key role as advisers to patients/clients (Stenson, Syhakhang, Lundborg, *et al.*, 2001). The need for enhanced government regulatory efforts for public and private pharmacies to improve the quality of their services has been emphasized (Stenson, Syhakhang, Lundborg, *et al.*, 2001). The MOH is attempting to license unlicensed pharmacies and drug vendors (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012), but the number of pharmacies or drug sellers in Lao PDR are unknown. In 1993 there were a reported 1690 private pharmacies, this number increased to about 2000 in 2001 of which, approximately 95% were run by non-pharmacists (Syhakhang, Stenson, Wahlström, *et al.*, 2001).

The role and quality of pharmacies and the services they provide is an important aspect of health seeking behaviour for Lao people. A National Drug Policy was adopted in 1993 in Lao PDR but concerns remain regarding the quality of pharmacy services and medicines and inappropriate prescribing and dispensing practices (Caillet, Sichanh, Syhakhang, *et al.*, 2015). The proportion of substandard drugs is reported as high and penalties for drug sellers selling counterfeit drugs have been recommended as an incentive to purchase drugs from reliable sources (Syhakhang, Lundborg, Lindgren, *et al.*, 2004; Stenson, Lindgren, Synhakhang, *et al.*, 1998). Caillet et al (2015) found that awareness of medicine risks was lower in peri-urban, and even more so in rural areas, compared with urban areas.

Traditional medicine is a major source of health care in many Asian countries (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005; WHO, 2002) and is key to the treatment and prevention of a large number of conditions and diseases in Lao PDR. Traditional medicine remains popular among the well educated and financially able. Being a high priority of the Lao government, the Ministry of Health (MOH) established a Traditional Medicine Research Centre in 1976, called the Institute of Traditional Medicine since 2010, and practitioners/healers play an important role in primary health care especially in rural and remote areas (WHO & Lao PDR Ministry of Health, 2012; Libman, Bouamanivong, Southavong, *et al.*, 2006; Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). Traditional medicine is also an integrated part of the Lao National Drug Policy (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012).

Being affordable, culturally acceptable and with few reported side effects; traditional practitioners (fortune-tellers, shamans, and herbalists) are a popular source of health care (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). Sydara et al (2005), in southern Lao PDR, found that 71% of household respondents cited its ability to cure was the reason for using traditional medicine. Even among health care workers traditional medicine is perceived as convenient and inexpensive, with long lasting effects (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). Traditional medicine is commonly used for fever, diarrhoea, paralysis, jaundice fever, and various aches and pains (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005; Libman, Bouamanivong, Southavong, *et al.*, 2006). It is not uncommon for people to receive advice from family members and friends on traditional medicine as well (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005). It is also common for individuals to use a combination of modern medicine and traditional medicine when treating an illness, with the belief that it gives the best outcome (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005; Alvesson, Lindelow, Khanthaphat, *et al.*, 2012); also mentioned in chapter 4).

About one third of the Lao population have animistic beliefs, referred to as "*Sadsana Phi*," where "*Phi*" means "spirit" (MoPI - Dept. of Statistics, 2005; Shirayama, Phompida & Kuroiwa, 2006). "*Phis"* are universal and diverse, and can be associated with people as well as places such as household, village, river, forest (FRDLOC, 1995). This belief system embraces the view that spirits can cause illness and ceremonial offerings and sacrifices, of food or animals, and various chants can treat these illnesses and appease the spirits (FRDLOC, 1995; Shirayama, Phompida & Kuroiwa, 2006). These rituals can be carried out by the individual seeking the spirit's favour or by enlisting the help of a spiritual healer or "shaman" (FRDLOC, 1995).

It is important to understand the roles that these health care providers play in how people perceive disease risk and make decisions about seeking health care and, therefore, the impact that such beliefs could have on disease interventions/control programmes (Nichter, 2008). The general beliefs and perceptions surrounding health, coupled with high levels of illiteracy and barriers to healthcare access further exacerbates the already low levels of healthcare utilization in Lao PDR (Barennes, Tran, Latthaphasavang, *et al.*, 2008).

6.2 Methodology

6.2.1 Aims of the survey

Lack of adequate training, resources and infrastructure prevent a health centre/hospital from providing the necessary patient care. The similarity in observed clinical signs between many diseases presents a challenge for diagnosis in facilities with limited capabilities, which can lead to incorrect diagnoses and disease under-reporting. This survey aimed to describe health centre/hospital routine service delivery in the study area and assess preparedness in managing patients presenting with symptoms of the study diseases (brucellosis, Q fever, hepatitis E, and Japanese encephalitis) or their related syndromes.

Furthermore, as ability to pay and distance to a health care provider are often major barriers, self – medication is a common practice in Lao PDR (Sayasone, Erlanger, Kaul, *et al.*, 2009). An understanding of the role of private drug-seller or pharmacists, traditional and spiritual healers, and health volunteers, and their practices and experiences may contribute to understanding the health-seeking behaviours of villagers and patients.

6.2.2 Study area

The survey was undertaken in the same villages, districts and health care facilities as the 'Health seeking behaviour assessment' (Chapter 5) in the three study provinces in northern Lao PDR – Phongsaly, Luang Prabang, and Xayabouri.

6.2.3 Study design – sample size and data collection

The assessment was divided into three parts and included semi-structured interviews of health care workers, private drug-sellers or pharmacists, traditional or spiritual healers, and village health volunteers. All questionnaires were translated into Lao prior to being administered (English versions are included in Appendix 4).

6.2.3.1 Health care worker interviews

Depending on size of the facility, a small sample of health care workers were interviewed using a semi-structured questionnaire. The number of health care workers to be interviewed depended on the number of health care facilities visited. A health centre and hospital census was initially planned for each of the three study provinces, this was not possible due to time and logistical constraints. Therefore, health centres and hospitals located in/near the study villages and their respective district centres were included, specifically those mentioned by participants as a point of care. GPS coordinates of all the facilities were collected.

Pre-survey visits were made to each facility in order to inform staff of the survey and set a pre-determined time that was suitable for conducting interviews. The number of interviews carried out was based on staff availability and willingness to participate. Hospital identification numbers were used, but identities remained anonymous throughout this survey and contributions will be kept confidential.

6.2.3.2 Private drug-seller or pharmacist interviews

Private drug-sellers or pharmacists in the same study districts were interviewed, identified by villagers and patients in the FGDs (Chapter 4) and health seeking behaviour assessments (Chapter 5) as a point for seeking care, while some were located adjacent to or in a health care facility or in the district centre. The number of interviews carried out was based on availability and willingness of the owners to participate. Interview identification numbers were used and personal identities remained anonymous throughout the survey with contributions kept confidential. GPS coordinates of their shop locations were also collected.

6.2.3.3 Traditional/Spiritual healer and village health volunteer interviews

In each study village visited, semi-structured interviews were conducted with traditional and spiritual healer(s), and/or health volunteer(s) living in or near the village. Those identified by survey participants as a point of care during times of illness were interviewed, as they potentially see cases that may not present to a health care facility or pharmacy. A similar questionnaire was used for all three practitioners with modifications as required. The number of interviews was based on availability and willingness to participate. Interview identification numbers were used, personal identities remained anonymous throughout the survey and contributions were kept confidential. GPS coordinates of their shop locations were also collected.

6.2.4 Ethical considerations

Questionnaires were translated into Lao and administered with the help of a translator. Due to the semi-structured nature of the interviews, as well as time and human resource constraints in the field, piloting of the questionnaires was not possible. Careful attention was paid to the ability of participants in understanding the questions being asked of them and comfort in answering them, and modifications were made where necessary.

Verbal consent was obtained from all participants at the start of each interview. A brief introduction to the researcher and translator was provided at the beginning of each interview, as well as a brief explanation of the purpose of the study, types of questions that would be asked, and assurance that participants could withdraw from the interview or from specific questions at any time should they choose. Reassurance that all responses would remain anonymous and confidential was also given.

6.2.5 Data management and analysis

Questionnaire data was collected on paper, followed by electronic entering using Epi Info™ 7 software (http://wwwn.cdc.gov/epiinfo/7/) by the US Centre for Disease Control (CDC). Data summary and analysis was carried out using Microsoft Excel. Interview notes and observations from the field were also recorded in Microsoft Word and analysed/summarized along with the questionnaire data where relevant. The responses for traditional and spiritual healer and village health volunteer interviews were combined for the analysis to look for any differences in perspectives. These were assessed separately from the health care worker and pharmacist/drug seller interviews. Health care worker awareness of the study diseases was computed for each disease with confidence intervals calculated using Wilson's method (Winpepi Describe manual, 2015).

6.3 Results

6.3.1 Health care worker (HCW) Interviews

In total, 10 health care facilities were visited during the period of fieldwork including five health centres, three district hospitals, and two provincial hospitals (Table 6.1 below). A total of 20 health care worker interviews were undertaken; seven at the health centre level, eight at the district hospital level, and eight at the provincial hospital level. Health centres typically assist district hospitals and provide care to the village they are located in as well as neighbouring villages. The number of villages covered by each health centre included in this survey ranged from two to 14 villages. These were generally small, with two to five employees, of which only three facilities had a doctor(s), nurse(s) and/or a midwife on staff. The district hospitals had between 20-40 employees with a few more doctors, nurses, midwives, pharmacists, and occasionally a laboratory technician on staff. They also had at least one inpatient ward, though paediatric inpatient units were limited to the provincial hospitals in Luang Prabang and Xayabouri. The district and provincial hospitals were said to see between 20 to 50 patients on a given day, while the health centres received less than 20 per day. Of the 20 health care workers interviewed, majority (85%) were female and ages ranged between 23 to 51 years. The majority of respondents were also doctors (75%; 15/20); with either college or university training; and other health care workers included three nurses, one midwife, and one primary health care worker.

Province	**District**	**Facility level**	**No. Sites**	**No. Interviews**
Phongsaly	Mai district	Health centre	2	3
		District H	1	4
Luang Prabang	Luang Prabang	Health centre	1	2
		District H	1	2
		Provincial H	1	1
	Chompet	Health centre	1	1
		District H	1	2
Xayabouri	Xayabouri	Health centre	1	1
		Provincial H	1	4
Total			10	20

Table 6.1 Health care facilities visited (H= hospital)

Respondents were questioned regarding their knowledge and awareness of the study diseases of interest. For hepatitis E, about half the respondents (45%; 95% CI 0.2582 to 0.6579) were aware of this disease, while the majority knew of Japanese encephalitis (JE) (75%; 95% CI 0.5313 to 0.8881) and only one each had heard of brucellosis and Q fever. Of those who were aware of these diseases, most did not know if hepatitis E, Q fever, or brucellosis were present in the district. About half the respondents (mainly from Luang Prabang and Xayabouri province) believed that Japanese encephalitis was indeed present in their district and an equal amount (50%) of respondents, from all three-study provinces, believed it was not. Most respondents had never diagnosed a patient with any of the study diseases, with only one and three respondents diagnosing a patient with hepatitis E and Japanese encephalitis, respectively. One respondent suggested that certain ethnic groups were more predisposed to acquiring JE, stating,

"There is lots of JE amongst Hmong people because they allow their pigs to roam freely" (female, medical doctor).

Most respondents, expressed a lack of confidence that patients presenting with these diseases (or syndromes and symptoms outlined in the 'Criteria for Illness', Figure 2-3, Chapter 2) would be accurately diagnosed at the facility where they worked, citing poor diagnostic capability as the main reason.

The interviews included questions about the most common reasons for patients presenting to a health care facility, the most common infections or signs and symptoms of an infection seen by the respondents, to gain an understanding of the types of illnesses commonly seen, and determine the presence of the study diseases or their associated syndromes.

The most commonly mentioned infections or signs and symptoms of infection, and reasons for visiting a health care facility, included fevers, coughs, colds, pneumonia, and diarrhoea (particularly in children and during the hot season). Also mentioned were other respiratory problems, body and muscular aches and pains, headaches, dizziness, hypertension, and gastritis. Specific infections mentioned included dengue, tetanus, rickettsia, and syphilis and other syndromes included meningitis, gastroenteritis, tonsillitis/pharyngitis, and fever with seizures. Dengue and rickettsia were said to be common causes of fever, and malaria was not often seen. Xayabouri provincial hospital respondents stated that five out of 10 patients presenting with fever was likely to be rickettsia positive using a rapid test. Since most illnesses are treated symptomatically, infections are not often laboratory diagnosed.

With regards to patients presenting with illnesses that matched the survey's "Criteria for illness" (Figure 2-3, Chapter 2), the most common response was acute febrile illness and fever symptoms (fever, headaches, sweats, joint or muscle pain) at 50% and 40%, respectively. This was followed by neurological symptoms (seizures, confusion or loss of consciousness, tremors, stiffness or paralysis; 15%), acute jaundice (25%), CNS infections (10%), liver symptoms (hepatomegaly or acute liver failure; 10%), and nausea symptoms (nausea, vomiting, loss of appetite; 5%).

With regards to diagnostics and treatment abilities, respondents were asked about the types of medications and diagnostic tests available at the facility where they worked. The most commonly given medications included antibiotics (mentioned by 95% of respondents), followed by analgesics (85%), vitamins (50%), vaccinations (15%), fluids or oral rehydration therapy (15%), and very little antimalarial medication (5%). When questioned about diagnosis, 65% of respondents indicated their facility had a diagnostic laboratory. However, most respondents (95%; 19/20) claimed that diagnosis was by clinical examination, with only four respondents (three from provincial hospitals) stating that laboratory diagnosis was also performed. Most respondents declared that their facility had malaria rapid test kits (70%), a microscope (45%), other rapid test kits (dengue, leptospirosis, rickettsia, typhoid, hepatitis B, and/or hepatitis C; 20%), a centrifuge (15%), sputum TB test (15%), standard blood work (5%) and x-ray (5%) capabilities.

Respondents at Luang Prabang and Xayabouri provincial hospitals stated that JE was usually diagnosed clinically as meningitis or encephalitis. If a lumbar puncture were performed to diagnose CNS infections, which was not often, a physician would communicate with Mahosot hospital or the National Centre for Laboratory and Epidemiology (NCLE) in Vientiane and coordinate delivery of specimens there as examination of them is not possible outside of the capital.

Other challenges that came up during the interviews included a lack of electricity and/or refrigeration at the health centre level, and therefore, the ability to store medications and vaccinations. Some health centres also lack the space to treat multiple (more than one or two) inpatients and sometimes care for patients at home, including performing child deliveries.

Questions were also asked with regards to patients' ability to pay for the health care and the use of health insurance. Most respondents (90%) believed that more patients would seek care if they had health insurance, and 75% believed that having health insurance did not affect the quality of health care that patients received. Some respondents indicated that individuals with health insurance had a number of steps to go through in order to receive care, while those who paid directly received care faster, however they were all perceived to receive the same level of care.

"...Because those with insurance – we have to be more careful with prescriptions given to them – you cannot give for more than 3 days. The patient has to come back. This way, patients lose time and have difficulties with transport, etc. ... They have to pay for all this." (Female, medical doctor)

"Those with health insurance have lots of steps to go through to get care. Those who pay directly can get care faster. But those with card don't have to pay – get same care as those without insurance, but it takes time." (Female, medical doctor)

Those without health insurance typically make out of pocket cash payments, although patients may be allowed to owe money with payments made at a later date or in instalments. A "poor policy" exists in some provinces where patients present a letter from their village chief, explaining their circumstances, which exempts them from paying for health care (at the time of the survey, this was available in Luang Prabang and Phongsaly, but not in Xayabouri province). Luang Prabang provincial hospital assists poorer patients who cannot afford the additional costs, such as food, while in hospital, through a fund that offers 10,000 kip per day and covers transportation costs when these patient(s) return home. In Xayabouri, it was suggested that more patients were seeking hospital care due to recent advertising about the availability of health insurance. Although, it was also pointed out that mostly government staff and private company employees were a part of these insurance schemes. A health centre physician expressed concerns that nearby villagers (and indeed himself) had, as they did not understand that health insurance involved monthly payments and were also afraid that having insurance would mean they would not receive the best care at the health centre because the doctor would not receive payment from them. There appeared to be a lack of understanding of how health insurance schemes work among some patients as well as health care workers.

6.3.2 Pharmacy/drug-seller (PDS) interviews

A total of eight interviews with pharmacists or drug sellers were carried out, of which one was in Chompet district (Luang Prabang province), two in Mai district (Phongsaly province), and five in Xayabouri district (Xayabouri province). These were selected based on participant identification (as a place where care was sought by themselves) and on proximity as some were located adjacent to or in a health care facility or in the district centre. Licensing of the pharmacies was not ascertained. Although not included in this survey, Mai district had a third pharmacy, however only two of the three were licensed. Of the eight respondents, five were male and the rest were female, and age of respondents ranged from 35-65 years. Aside from owning a pharmacy, four respondents were also trained medical doctors, and one each was a dentist and deputy chief of planning at the provincial health office. While most respondents (7/8) had completed a certificate/diploma/bachelors degree (one had only completed primary education), half the respondents did not actually have any specialist pharmacology training. One respondent in Luang Prabang province had received some training on indications and effects of drugs, which were one to two week workshops conducted by the Food and Drug Administration (FDA) government office that also required attendance twice each year. Respondents had spent between three to 25 years working at the pharmacy, which usually covered the entire district they were located in, and also managed between one to three employees. On a given day, half the respondents claimed to see between 20 and 50 clients per day, with 37.5% seeing between 50 and 100 clients per day. More than half the respondents sold traditional medicine, steroids, vitamins, analgesics, antibiotics, anti-pyretic, antacids/anti-gastric, and hypertension medications. In terms of what was prescribed by the pharmacist/drug seller, antibiotics, analgesics, and anti-pyretic medications were the most common with more than half the respondents prescribing these to client(s) seeking advice. It was also noted that clients usually knew and requested what they wanted to purchase or asked advice for mild illnesses.

Similar to some of the healthcare facilities above, the most commonly mentioned infections or signs and symptoms of infection, and therefore reasons for visiting a pharmacy/drug seller, included mild respiratory illnesses (fever, coughs, colds, flu), diarrhoea (particularly in the hot season), body and muscle aches and pains and headaches. Other respiratory issues were also mentioned (such as pharyngitis, pneumonia) and some gastritis. Specific diseases mentioned included scrub typhus, mumps, measles and chicken pox (varicella). With regards to patients presenting with illnesses that matched the survey's "Criteria for illness," as outlined in Figure 2-3 in Chapter 2, the most common response was acute febrile illness and fever symptoms (fever, headaches, sweats, joint or muscle pain) at 37.5% and 62.5% of respondents, respectively. Also mentioned were acute jaundice and nausea symptoms (nausea, vomiting, loss of appetite) at 25% each, and liver symptoms (hepatomegaly or acute liver failure) at 12.5%. Those with any type of severe illness would be more likely to go directly to the nearest hospital or would be referred there.

6.3.3 Traditional or Spiritual Healer and Village Health Volunteer interviews

Of a total of 10 interviews, two were health volunteers, and four each were spiritual and traditional healers. The types and locations of each provider are outlined in Table 6.2 below. The age range of respondents was between 43 and 90 years, with 80% being male. Half the respondents had only completed primary school, with 2 completing secondary school. Majority of respondents (80%) had spent five to 30 years in their respective roles.

Village	Province	HCP Type	No. interviews	Total
Ang village	Luang Prabang	HV	1	1
Donexai village		HV/TH	1/1	2
Thapene village		TH	1	1
Nong Nong village	Xayabouri	TH	1	1
Omkaneng village	Phongsaly	SH	2	2
Poungkao village		TH	1	1
Sophoun village		SH	2	2
Grand Total				**10**

Table 6.2 Type and location of health care providers (HCP) interviewed (HV=health volunteer; TH=traditional healer; SH=spiritual healer)

Village health volunteer training varied between volunteers. For instance, one male volunteer received training from government staff in a district hospital on the indications for certain medications, management of funds accumulated from drug sales, treatment of bed nets and use of rapid tests for malaria. Some receive medical training through the provincial government or from prior military involvement.

Respondents revealed that there are different types of healers:

1. "Mo – Thao" - a spiritual healer that has a spirit come into his/her body in order to help other people.
2. "Mo – Pao" (or "Mo – Mon") - a spiritual healer that uses magic spells to make spirits/ghosts leave the patient. Some perform rituals or animal sacrifices; they sometimes also treat injuries and accidents.
3. Traditional healer – uses traditional medicines such as herbs, roots, etc. to treat illnesses.

Training for spiritual or traditional healers also seemed to vary with some acquiring handbook information from district health offices (apparently supported by the WHO) on assorted herbs, etc. that can be used for specific illnesses such as malaria, diabetes, diarrhoea, liver problems, etc. (personal communication, traditional healer in Chompet district) or, more commonly, by learning from other healers or individuals with knowledge about traditional medicine (medicinal herbs).

All respondents claimed to see less than 20 patients per day. The participating health volunteers mainly sold/prescribed antipyretic medication, fluids, traditional medicine, some antibiotics, and/or administered medications bought by villagers (such as injections). One volunteer stated that district staff came twice each year to check the drug supply – review management practices, amounts sold, expiry dates, etc. Traditional medicine was often used because it is inexpensive compared with modern medicines. In some cases, clients without sufficient funds can make payments by offering gifts, for example, slaughtering a chicken. Traditional healers mainly prescribed and sold herbs, roots and various plants collected from the forest or grown by themselves, which are then ingested or used topically. Spiritual healers used spells or performed sacrificial ceremonies to appease the spirits in order to treat ailments.

Similar to the other care providers discussed above, the most commonly mentioned infections or signs and symptoms of infection, and therefore reasons to visit a health volunteer, traditional or spiritual healer included fever and mild respiratory illnesses (colds, coughs, fever, flu), and diarrhoea. Other issues mentioned were gynaecological concerns including sexually transmitted infections, such as syphilis and human papilloma virus, as well as abdominal pain, gastritis, and body and muscle aches and pains. Specific diseases mentioned were hepatitis B and tuberculosis. With regards to patients presenting with illnesses that matched the survey's "Criteria for illness," as outlined in Figure 2-3 in Chapter 2, most respondents (80%) claimed to see none of them, while the rest had seen patients with acute febrile illness (20%) and fever symptoms (fever, headaches, sweats, joint or muscle pain; 10%) and acute jaundice (20%). One traditional healer indicated that there used to be lots of febrile illness, typical of malaria, but this had decreased since the introduction of bed nets.

6.3.3.1 The role of the "spirit(s)"

Respondents described two kinds of spirits - those that can cause harm or make a person sick, and those that help people and use individuals as mediums to help others. These spirits can also be of various types, such as household, village, river, or forest spirits. They are essentially spirits of the deceased that can linger in a household/village/forest, and ways to appease them include sacrificial ceremonies or rituals or food offerings to the local monks in order to reach the spirits.

6.3.3.2 Health beliefs

All respondents were questioned about their thoughts around people's beliefs regarding how they get sick and are healed. While the way in which they treat/handle illnesses differ, it was a common belief between both types of healers that spirits can sometimes cause illness, as illustrated in the comments below:

"We get sick because a ghost follows us because it wants something with us or we disturbed their area …a traditional healer is used to contact ghost and find out what it wants."

(Male, spiritual healer)

"When the villager goes in the forest to find vegetables or bamboo, we pass through where the forest ghost stays and make them angry because we annoy them".

(Male, spiritual healer)

Some traditional healers recognized the more tangible causes of disease such as the consumption of contaminated food or use of chemical products (such as monosodium glutamate), or the occurrence and spread of disease outbreaks. Weather changes were also considered a contributing factor to the occurrence of illness. One health volunteer suggested that changing seasons (especially the cold), not having appropriate clothing, and not taking good care of one's children were all important.

Some healers also believed that villagers tended to try modern medicine first and then sought their help if the did not recover, as articulated below:

"If person feels the illness is not severe, they will take modern medicine and if get better they don't go to traditional healer. If severe, some go to hospital -not because they don't believe traditional healer but feel they should go to hospitals. If not healed, see healer."
(Female, Traditional healer)

"People usually seek treatment, they wouldn't not seek treatment - villagers usually go to health centre/hospital to try modern medicine first, if not better they come to see me."
(Male, traditional healer)

Most healers believe that performance of sacrificial ceremonies or rituals are necessary in order to appease the ghost(s) or spirit(s) responsible. Sacrifices can involve killing small animals, such as chickens or ducks, if the illness is not severe or a pig if considered severe or chronic. Ceremonies can also involve other food offerings and performance of chants or "magic spells".

"We make sacrifice to make them [ghosts] happy" (Male, spiritual healer)

"If illness is caused by ghost, everything done in hospital will not be enough, but if go to healer it will get better." (Male, spiritual healer)

"If they are healed by seeing the healer, it was because of the ghost wanting to play with them." (Male, spiritual healer)

"Sometimes have to sacrifice pig/chicken/duck, if we do ceremony it will work for our illness; remove one's bad luck with a ceremony… a healer doesn't know way to treat until he does the ritual." (Male, spiritual healer)

"People don't recognize when a spirit follows them and they have something bad happen to them, for example, get sick or have injury. So they go to hospital but still don't get better, so they contact the spiritual healer." (Male, spiritual healer)

"Every person's body has a spirit of different strength - some have weak spirits - when they are hurt by someone, it may not be so bad but in long term they get sick a lot. The healer will call their spirit back or make it stronger." (Female, traditional healer)

Traditional healers that use medicinal herbs, etc. believe that patients are cured because they are treated with the right medication for their illness. There is confidence in their ability to treat and in the efficacy of traditional medicines. Deciding whether to seek care at a health care facility (i.e. using modern medicine) or to use traditional medicine can depend on the type of illness being experienced. As one traditional healer explained, traditional medicine would first be used to treat an illness in his family and if there were no improvement, care would be sought from the hospital. If malaria was suspected or for severe illnesses, hospital care would first be sought in order to be tested for the disease and receive prompt treatment. If this did not work then traditional medicine would be used. For some diseases, e.g. sexually transmitted infection, it was believed that with modern medicine the infection would likely recur whereas with traditional medicine it would not.

6.4 Discussion

A three-part assessment was carried out using semi-structured interviews of health care workers, private drug-sellers or pharmacists, traditional or spiritual healers, and village health volunteers. One aim of this survey was to describe health centre/hospital routine service delivery procedures and assess preparedness in dealing with patients presenting with symptoms of the study diseases or their related syndromes. An additional aim was to understand the role of private drug-seller or pharmacists, traditional and spiritual healers, and village health volunteers, their practices and experiences to further understand the health-seeking behaviours.

6.4.1 Healthcare worker interviews

Healthcare worker interviews showed a lack of confidence among workers in the accurate diagnosis of patients presenting with these diseases, mainly due to the low or poor diagnostic capability in their facilities. While some basic diagnostic tools, such as microscopes and rapid test kits, were available at the provincial hospitals and most district hospitals visited, the tests required for diagnosis of the study diseases were not available. Testing for these diseases would likely be done in Vientiane capital at Mahosot hospital or the National Centre for Laboratory and Epidemiology (NCLE). Hence, a reliance on clinical diagnosis means that illnesses are mostly treated symptomatically. The most commonly given medications were also reported to be antibiotics, analgesics, and vitamins.

Knowledge and awareness of the study diseases was also very poor for brucellosis and Q fever, with some awareness of hepatitis E and most respondents being aware of Japanese encephalitis. The most common illnesses seen by respondents were respiratory illnesses, acute febrile illness and diarrhoea, previously identified as problems in Lao PDR (WHO, 2011b; Mayxay, Castonguay-Vanier, Chansamouth, *et al.*, 2013b). Given the disease heterogeneity within Lao PDR, as pointed out by Mayxay *et al* (2013b) and White *et al* (2012a), further investigations are needed to develop appropriate treatment guidelines and algorithms to manage patients presenting with these illnesses. As also found in the health seeking behaviour assessment (Chapter 5), health care workers revealed that participation in health insurance schemes is not very common, as there are still misconceptions or a general lack of understanding of how the system works.

6.4.2 Pharmacist/drug seller interviews

Findings from interviews with pharmacists or drug sellers revealed that half of the respondents did not have any specialist pharmacology training (4/8). Antibiotics and traditional medicine are some of the most commonly sold medications, with antibiotics and anti-fever medications being prescribed by pharmacists the most. Caillet *et al* (2015) found analgesics and vitamins to be the most commonly used modern medicines among respondents (villagers in Vientiane capital). Analgesics, antibiotics, and vitamins were also the most commonly sold medications in a survey by Syhakhang *et al* (2001) (in Savannakhet province). The most common ailments reported by respondents were respiratory illnesses, acute febrile illness and diarrhoea.

The need for more training has been recognized, as the problem of pharmacies being run by individuals without any pharmaceutical knowledge is a common occurrence (Stenson, Syhakhang, Eriksson, *et al.*, 2001; Syhakhang, Stenson, Wahlström, *et al.*, 2001). Awareness of the risks of low quality drugs and importance of product safety were also found to be low in studies by Stenson et al (1998) and Syhakhang et al (2004), and therefore needs addressing. Syhakhang et al (2004) found that drugs were perceived (by both consumers and drug sellers) to be of good quality if they treated an illness effectively and that expensive drugs were considered to be of good or better quality than cheaper ones. The need for better government regulation, through expansion of the system to de-license drug sellers that are not up to standard (Stenson, Syhakhang, Eriksson, *et al.*, 2001), particularly of private pharmacies (Stenson, Syhakhang, Lundborg, *et al.*, 2001) has also been acknowledged. Connecting specialty training with the authorization or licensing of a pharmacy is a possible way to deal with this problem.

Given the high levels of self-medication practice, pharmacists should also be seen as frontline HCWs as many do have some type of medical training (doctors or nurses), even if they lack pharmacology training, as also suggested by Stenson et al (2001). Furthermore, given that patients often make their own diagnosis/assessment prior to asking for specific medications, without any prescription or recommendation by the pharmacist or drug seller, the need to consider health education of the public on appropriate/rational drug use, particularly with the use of antibiotics, is also present.

6.4.3 Traditional healer, spiritual healer and village health volunteer interviews

Interviews with village health volunteers, traditional healers and spiritual healers also revealed that the education level of these practitioners was often quite low. Half of the respondents had only completed primary education (5/10) with only a few respondents (3) finishing secondary or higher education.

Questions on the most common ailments seen were analysed together for the three practitioners, as the purpose of the question was to get a sense of the incidence of patients (in the villages) with undiagnosed syndromes, such as acute febrile illness, that do not present to a health centre or hospital. Similar to the HCW and pharmacist/drug seller interviews, the most common ailments seen were acute febrile illness, mild respiratory illnesses, diarrhoea, and some gynaecological issues and STIs.

Participating health volunteers (2/10) stated mainly prescribing and selling anti-pyretic medications, fluids, and traditional medicines. They also reported selling antibiotics and/or administer medications bought by villagers (such as injections), though not all village health volunteers do this, as the practice is technically not allowed because of the risk of adverse reactions (communication by one of the health volunteers interviewed). The performance of village health volunteers has previously been studied in Lao PDR by Sato et al (2014), who discussed the importance of selecting appropriate volunteers capable of cooperating with members of their community as well as networking with important figures, such as government officials, in order to improve their performance. Strengthening their role in communities would, therefore, be important in ensuring that appropriate care is sought for the treatment of illnesses, and in attaining sustainable village participation in disease prevention and control activities.

Embracing an alternative belief system, as is the case for a significant proportion of the population in Lao PDR, many spiritual and traditional healers believe that spirits provoked by people who disturb them in some way are the true causes of illness. Spiritual healers mostly perform sacrificial ceremonies, using spells and rituals. They share the belief that performing these ceremonies to appease the spirits, because modern medicine would not be enough, is what heals those suffering from an illness or injury. Some traditional healers also believe that illness is influenced by food consumption practices and weather changes. They mostly use herbs, roots, and plants from the forest or grown in their home gardens that are ingested or used topically for treatment, and believe that healing occurs by using the right medicine and/or performing spiritual ceremonies. Confidence in the efficacy of traditional medicine is evident and is one of the reasons for its popularity, as discussed elsewhere (Sydara, Gneunphonsavath, Wahlström, *et al.*, 2005; WHO & Lao PDR Ministry of Health, 2012). A study by Caillet et al (2015) found that many users of traditional medicine also believe it is not harmful and about half of their study participants believed them to be safe even when overdosed; awareness of risks associated with traditional medicine was limited and half of the study participants were not aware of poor quality medicines made available in the market.

Overall, there is a definite need for improvement in the education and training of all the care providers interviewed, with particular attention to those in rural areas, as also suggested by Caillet et al (2015), with lower access to resources and the movement of more educated individuals to urban centres seeking better opportunities. Given the diverse ethnic backgrounds, language skills also require consideration to ensure clear communication between patients and care providers, particularly in health care facilities (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). Better access to essential equipment and medicines is an important and challenging problem that needs tackling. Addressing the lack of knowledge and awareness on the pig-associated zoonoses investigated in this study (and in general) among health care providers, including pharmacists and alternative health practitioners, could potentially be a function of the field epidemiology training (FET) program. This would help to strengthen community surveillance and, therefore, the national surveillance system, with all care providers reporting disease events. As well, it can provide invaluable experience for FET participants in outbreak investigations.

The KAP survey (Chapter 4), health seeking behaviour assessment (Chapter 5) and findings here show that care is often sought from a traditional healer, spiritual healer, village health volunteer, or pharmacist/drug seller, depending on their proximity to the village, sufficient funds available, and perceived chances of successfully treating an illness. Alternating between or using a combination of modern and traditional medicine is common practice. A trigger for seeking hospital care is often the severity of an illness, as indicated by pharmacist/drug seller participants and also village focus group participants (Chapter 4) who reported that in some cases district hospitals are bypassed for provincial hospitals, as district hospitals are perceived to have similar capability to a health centre.

Although one of the limitations of this assessment was a fairly small sample, it identifies another potential way of documenting the incidence of patients with undiagnosed syndromes, such as acute febrile illness, that do not present to a health centre or hospital. With the establishment of stronger connections and collaboration between the various types of health care providers and practitioners, this could serve as a way to inform public health authorities of on-going or new health concerns/events and also advise the development and successful implementation of disease prevention and control programs. Another aspect to consider is health education of the public on appropriate or rational use of medicines, particularly with the use of antibiotics, which is noted to be easily accessible without requiring a prescription, and is more popular in urban areas where the demand is higher (Alvesson, Lindelow, Khanthaphat, *et al.*, 2012). Inappropriate or overuse of medications, such as antibiotics, has potentially precarious consequences with the development of drug resistance. An assessment on the impact of these "informal services" on antibiotic usage and drug resistance should be considered in future research and development programs.

Other limitations of this assessment are that there was no differentiation between public and private pharmacies and participants were not questioned about their licenses. This information was not collected partly to avoid offence but also because they were identified by villagers in the focus group discussions as points of care (chapter 4). As well, medicine quality and safety, for either traditional or modern medicine, and awareness of medication risks and product safety were not investigated. The purpose of this survey was to determine the role that drug sellers/pharmacists play in health seeking behaviors, as opposed to licensing status, product quality and safety. As well, they were identified by respondents interviewed in the villages and health care facility surveys (Chapter 5). Syhakhang et al (2004) found that majority of consumers interviewed in their study (73%) did not worry about drug quality, while financial barriers were their main concern. As translation was done by a third party, the possibility of bias in translation cannot be excluded given that the interviews were carried out in Lao and translated back to English. Lastly, the potential for information bias exists as respondents may have also provided what they believed to be acceptable responses, as can happen in studies on behaviour and health conditions (Sedgwick, 2015).

6.5 Conclusion

The capacity of health care facilities in northern Lao PDR, in appropriately diagnosing patients with the study diseases, is poor. Outside of provincial hospitals, the possibility of investigating causative agents of disease is next to none and clinical diagnosis is the only option in most cases. While it was difficult to get an estimation of disease incidence in this survey, it highlights the absence of and critical need to address the diagnostic capability in the rural areas of northern Lao PDR.

Healthcare workers lack confidence in the ability to accurately diagnose patients and knowledge and awareness of pig-associated zoonoses is low among all the care providers in this survey. Where care is sought outside of the formal health care system, other practitioners play important roles in health seeking behaviour. The need for more education and training of all types of care providers discussed in this assessment, especially in rural areas, cannot be more emphasized. Furthermore, the establishment of stronger connections and collaboration between the various types of health care providers, could serve as a way to inform public health authorities of on-going or new health concerns or events and also advise the development and successful implementation of disease prevention and control programs.

7 Discussion

7.1 Lao PDR human and animal health system – need for improvement

Lao PDR has a poorly utilised public health system with few safety nets in place for the poor. Out-of-pocket payments are high and make up majority of the health expenditure in the country, about 62.6% (WHO, 2011b; Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). Countries with a high level of out-of-pocket payments are more likely to have a higher proportion of households experiencing catastrophic health expenditures (Tangcharoensathien, Patcharanarumol, Ir, *et al.*, 2011). In Thailand, a country that has had notable economic and social development achievements, out-of-pocket expenditure on health has reduced from 27.2% in 2002 (when the country achieved universal health coverage) to 12.4% in 2011 (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015). By 2002, Thailand's population was covered by three public health insurance schemes[10], one of which is the Universal Health Coverage Scheme (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015). Social health protection was introduced in Lao PDR in 2002 (see Chapter 2), offering four coverage schemes but coverage remains low among the country's population at 14% (Alkenbrack, Jacobs & Lindelow, 2013).

Aside from obtaining development partner funding, the Lao government health expenditure has been limited over the years, with total health expenditure as a percent of GDP between 2005 and 2013 ranging between 1.9% and 4.3% (2.0% of GDP in 2013) (The World Bank, 2016b). Total health expenditure as a percent of GDP in Thailand did not change significantly between 1994 and 2012, ranging between 3.5% and 4.5% (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015) but the Thai health system depends largely on domestic funds with considerably low contributions from development partners (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015). Thai investment in health infrastructure has been made possible because of strong

[10] 1) Civil Servant Medical Benefit Scheme (CSMBS) for civil servants and their dependents, 2) Social Health Insurance Scheme (SHI) for private sector employees, and 3) Universal Coverage Scheme for the rest of the population (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015).

political commitment and increased investment in district health systems over provincial health infrastructure (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015).

The Lao government expressed commitment to strengthening disease prevention and supporting diagnostics and treatment capacity development at the central and regional levels in the VIIth Five Year Health Sector Development Plan (2011-2015). However, details on a strategy for enhancing laboratory diagnostic capacity are not outlined in the plan (Lao PDR Ministory of Health, 2011). Essential diagnostic and therapeutic equipment are concentrated at central/regional and provincial hospital level, along with highly skilled health care workers, resulting in poor service quality and utilization of health centres and districts hospitals (Akkhavong, Paphassarang, Phoxay, *et al*., 2014; WHO, 2012). Low motivation of health care workers, conflicts of interest (public health workers offering private services outside of facility hours to supplement income and meet patient demands), and lack of training and career advancement opportunities all hinder quality of care and impact on patient trust in rural areas (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). Improvements in health service quality are also focused on the central, regional and provincial levels in the VIIth Five Year Health Sector Development plan. Consideration should also be given to district health systems that can better target rural and remote populations that are not likely to access health care at provincial or higher level facilities.

Gaps in access to health care facilities between urban and rural/remote areas and rich and poor exist in Lao PDR, despite the network of health facilities covering 93% of the country's population within a 90-minute walking distance (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). The 4th Lao expenditure and consumption survey (2007 – 2008) found that it takes 3 hours to reach a health facility in the highland areas compared to 48 minutes in lowland areas (Lao Department of Statistics, 2009). Findings from all three surveys here (chapters 4, 5, and 6) confirm that proximity to a health care provider plays an important role in where care is sought. The first point of care is typically a health centre if located nearby; otherwise a local traditional healer, spiritual healer, health volunteer, or a pharmacist/drug seller is consulted, followed by a hospital. Household and hospital questionnaire data (chapter 5), indicated that self-medication was the most common method of dealing with illness and the first point of care, next to visiting the health centre. Going back and forth between traditional and modern medicine practitioners is common, with traditional medicine often used due to its affordability. Lack of finance is an important barrier to seeking health care in Lao (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). A severe illness is often the trigger for seeking hospital care and in some cases district hospitals are bypassed for provincial hospitals, as many perceive district hospitals to have similar (poor) capability as a health centre. This bypassing of local and district level facilities for those at higher level is recognised as a problem (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). The poor diagnostic capacity in most facilities, lack of confidence of health care workers in the ability to diagnose HEV, JE, brucellosis and Q fever (and other zoonoses) along with poor knowledge and awareness of these diseases, show that quality of health care also plays a factor in the health seeking behaviour of Lao people (Chapter 6). Overall improvements in the quality of health care provided in the country will require increased government investment in facilities and equipment, human resources, and increased financing of recurrent costs (Alkenbrack, Jacobs & Lindelow, 2013).

Improving the quality of care and human resources available are key elements in expanding health insurance coverage, which is significantly low in Lao PDR (Tangcharoensathien, Patcharanarumol, Ir, *et al.*, 2011). The "free care" policy, which sets mandated user fee exemptions for vulnerable populations at public health care facilities (mainly for antenatal, delivery, and post-natal care, and treatment for children under 5 years of age), is financed by pooled government and donor funding (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). This has not been successful since funding was not allocated for this and the system relies on village leaders verifying poverty status of the poor on an ad-hoc basis (Tangcharoensathien, Patcharanarumol, Ir, *et al.*, 2011). In some cases, patients are allowed to defer payments to a later date or pay in instalments (Chapter 6). Health equity funds supported by external donors assist with financing care for the poorest of the population in some areas of the country (WHO, 2011b; Tangcharoensathien, Patcharanarumol, Ir, *et al.*, 2011). General dependency on donor funding challenges the long-term sustainability of this system, highlighting the need to alignin donor initiatives with national priorities to improve the Lao health system and enable access to primary health care services in rural and remote areas.

Health insurance was shown to decrease expenditure on self-treatment in a few studies in Vietnam (Axelson, Bales, Minh, *et al.*, 2009; Wagstaff & Pradhan, 2005). Given the high availability of medications available without prescription in many countries, including Lao PDR, this shows promise. Coupled with improved and continued training and professional development of conventional and alternative health care providers (pharmacists/drug sellers, village health volunteers, traditional healers), an improvement in health insurance coverage in the country may help to improve rational drug use and decrease inappropriate use of medications leading to drug resistance.

7.1.1 Alternative health care providers

As indicated by this research, where care is sought outside of the formal health care system, other practitioners, such as VHVs, pharmacists/drug sellers, and traditional healers, play important roles in health seeking behaviour, and should be viewed as essential resources to serve rural and remote areas. The problem of human resources in Lao PDR will be addressed by the National Strategy for Human Resources for Health 2010–2020, which proposes to upgrade village health volunteers (VHVs) to qualified health workers at the village level with a six-month training course and incentives (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). This is a promising step, as improved training of all health care providers was identified as an important issue (Chapter 6). Formal training and licensing for practitioners of traditional medicine is also needed, as has been implemented in Thailand (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015).

Training for community providers should include information on pig-associated zoonoses and others that are endemic to the area of practice, risk factors for transmission (disease epidemiology) and methods of prevention and control that can be implemented locally. Addressing the current lack of knowledge and awareness on pig-associated zoonoses among health care providers surveyed, including pharmacists and alternative health practitioners, could be a function of the field epidemiology training (FET) program. This would help to strengthen community surveillance and, therefore, the national surveillance system, with all care providers reporting disease events. As well, it would provide invaluable experience for FET participants in outbreak investigations.

Community based health education programs employing participatory approaches to learning, as used by Hien et al (2008) among community leaders in rural Vietnam and others (Keoprasith, Kizuki, Watanabe, *et al.*, 2013; Onyango-Ouma, Aagaard-Hansen & Jensen, 2005; Ohnishi, Nakamura & Takano, 2007), can also be used to increase awareness of pig-associated zoonoses among local health care providers. This creates opportunities for intersectoral collaboration and empowers community leaders to develop culturally appropriate and sustainable solutions to health issues faced in their communities. Adopting an 'integrative medicine' approach to a public health system that emphasizes healing and wellness of the person as a whole (Bell, Caspi & Schwartz, 2002) by involvement of other health care practitioners in disease initiatives would be beneficial as they can be influential mediators in their communities and reach areas that the formal health care system cannot. Community outreach programmes have been recommended to help influence decision-making processes on when to seek healthcare, through fostering positive relationships between health care providers and communities (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013), and can also be used to improve immunization coverage rates (WHO, 2013). Use of mobile technology for health education and promotion activities also offers a potential tool for influencing behaviour change and improving access to and quality of health care received, as well as outcomes, among underserved populations (Kaewkungwal, Apidechkul, Jandee, *et al.*, 2015; Meankaew, Kaewkungwal, Khamsiriwatchara, *et al.*, 2010). Kaewkungwal et al (2015) reported that the use of technology could facilitate information sharing and communication between health care personnel and village health volunteers in remote areas and also help improve immunization coverage. These tools would be extremely useful in rural and remote areas, particularly during the rainy season (May to October) when they are often inaccessible, and vector borne and water related diseases (such as Japanese encephalitis, hepatitis E, leptospirosis, etc.) have higher incidences during and following the wet season (Okello, Burniston, Conlan, *et al.*, 2015; Vke, 2011; Bounlu, Insisiengmay, Vanthanouvong, *et al.*, 1998; Conlan, Vongxay, Jarman, *et al.*, 2012).

Public awareness of zoonoses in general is an area that requires attention. This study found awareness among respondents to be low (chapters 4 and 5) even though respondents within communities were exposed to multiple risk factors for transmission of pig-associated zoonoses. These included the consumption of raw pork, poor use of protective equipment for handling of animals and their products during slaughter and disease outbreaks, and poor hand hygiene and sanitation practices. Addressing the knowledge gaps among human and animal health care providers, alongside community health education programmes would be beneficial. Given that pig production is an important income source, especially in highland areas of northern Lao PDR (Conlan, Khounsy, Inthavong, *et al.*, 2008), increased knowledge and awareness of zoonoses and their risk factors is needed, in particular, for hepatitis E since high human and pig seroprevalences were observed in the ILRI/ACIAR surveys undertaken in 2011 (63.52% and 75.82%, respectively) with higher risk of infection in women (chapter 3). Increased attention should also be given to Hepatitis E in this population, specifically pregnant women and those of childbearing age, by maternal and child health programs in the country. Hepatitis E is clinically significant in pregnant women, with case fatality rates ranging between 20-30% and sometimes as high as 40% (Balayan, 1997; Labrique, Sikder, Krain, *et al.*, 2012).

The main focus at local health centre and district levels is mother-newborn-child health (MNCH), including reproductive health, free delivery and care of children under 5 years of age, access to trained skilled birth attendants, antenatal care, family planning, and immunization services (Lao PDR Ministry of Health, 2011). Engagement in health education and promotion activities regarding exposure to swine and their related products during handling, slaughter, and food preparation, especially if pregnant, should also be mandated through MNCH programmes.

7.1.2 Veterinary services and animal health in Lao PDR

The animal health system in Lao PDR is facing multiple challenges that affect the quality and quantity of veterinary services provided. The information system for collecting animal health data is basic and prioritizing resources for dealing with animal disease is extremely difficult (FAO, 2005). The lack of veterinarians and animal health technicians is problematic, and only limited training schools are available within the country (FAO & MAF, 2013). Provincial and district agriculture and forestry extension offices (PAFOs and DAFOs) are under-resourced, unless they are engaged in donor-supported projects or programmes (FAO & MAF, 2013). Limited access to veterinary expertise has resulted in low vaccination coverage in livestock, high animal mortality rates, and poor husbandry practices (FAO & MAF, 2013; Werner, Gray & Bastin, 2002). Given the importance of swine production in Lao PDR, and rising demand for pig products, strengthening the animal health system is crucial. Dependency on donor funding dis-incentivises government investment. Alignment of donor initiatives with national priorities, as well as harmonization of projects in different provinces, is key to sustainable development.

Inadequate knowledge and awareness on the risk of animal diseases by farmers and financial constraints, are additional barriers for seeking help and/or implementing appropriate disease prevention and control measures (FAO & MAF, 2013; Werner, Gray & Bastin, 2002). Findings from the focus group discussions (chapter 4) show this to be the case among respondents in northern Lao PDR. Awareness of zoonoses and risk factors for disease transmission was low, and practices related to dealing with animal illness and death (separation of sick animals, use of protective equipment, reporting of animal deaths, consumption of infected meat, etc.) were suboptimal. Low availability and access to drugs for treatment from the DAFO, and slow or non-existent responses from DAFO when illness/deaths are reported, and a lack of funds to pay for any interventions (treatments or vaccinations) were seen as major barriers by respondents. This presents a challenge for the rural poor, in alleviating their financial burdens and bringing themselves out of poverty. Addressing this situation requires strengthening of the district level veterinary system, improvement of knowledge and practices in livestock production and disease prevention among farmers, as well as increased training and resources for DAFO staff focusing on animal health and disease, zoonoses, risk factors for transmission as well as appropriate prevention and control measures. This can lead to improved productivity, and together with the formation of farmer groups for marketing of animal products can increase smallholder household income and reduce rural poverty (MAF & FAO, 2014; Werner, Gray & Bastin, 2002). Similar platforms, for human health care providers, can be used for education of farmers and district level staff on animal health and zoonoses risks in order to improve husbandry practices and implement appropriate disease prevention and control measures.

7.1.3 Disease surveillance – incorporation of zoonoses in national surveillance

The Lao national surveillance system, coordinated by the National Centre for Laboratory and Epidemiology (NCLE) requires nation-wide reporting of 17 notifiable diseases and syndromes from all level and types of health care facilities. The system functions from the health centre level to the national level, with the ability for village health workers, ports and immigration checkpoints to report information to the district health office and onward as well (NCLE, 2013; Ancheta, Mendoza, Pachuen, *et al.*, 2010)]. A systematic analysis of disease trends revealed through this system is needed with consideration afforded to endemic pig-associated zoonoses, given that some of the syndromes reported likely represent zoonoses such as hepatitis E, Japanese encephalitis, trichinellosis, taeniasis/cysticercosis and others. A range of prevalences has been reported for these zoonoses, some quite high as summarized by Okello *et al* (2015). Mayxay *et al* (2013b) also found leptospirosis and scrub typhus to be important causes of acute febrile illness in Lao PDR.

Laboratory confirmation is required from every case for some of the diseases/syndromes reported to NCLE, such as acute flaccid paralysis (AFP) and fever and rash, making liaison between national and local laboratories essential for sample collection and referral (NCLE, 2013). There is a gap in diagnostic capacity between Vientiane capital and other areas of the country in both the human and animal health sectors, with poorly resourced district level human laboratories and non-existent animal laboratories. Addressing the challenges faced in laboratory diagnostic enhancement in Lao PDR will require innovative approaches and multi-sectoral cooperation (Phommasack, Moen, Vongphrachanh, *et al*., 2012).

There are a number of collaborative projects with various agencies and institutions to enhance disease surveillance and laboratory capacity in Lao PDR, with a strong focus on emerging zoonoses and those with pandemic potential and few projects focused on endemic zoonoses (see chapter 2). There is opportunity and need for collaboration between the national human and animal health sectors in order to address the diagnostic and surveillance challenges. Using the Mekong Basin Disease Surveillance (MBDS) as a model, which promotes shared disease surveillance and outbreak response through integration of the human-animal sector interface, thereby strengthening community surveillance and laboratory capacity (Phommasack, Jiraphongsa, Ko Oo, *et al.*, 2013). Expansion of this system to the rest of the country and inclusion of endemic zoonoses, especially those linked to poorer outcomes (for example, hepatitis E in pregnant women), would be beneficial and sustainable through the sharing of resources and expertise between the two sectors.

There is a need for better supervision of the data collection and reporting process for both human and animal disease surveillance as well. Gaps in data reporting are a concern, as identified in the analysis of Lao national data (chapter 3) where low numbers of cases and/or deaths were reported in some provinces. This does not necessarily imply a lack of presence of these diseases or syndromes. It is unclear if gaps are due to low levels of disease reporting, lack of awareness or proper diagnostic capability, or failure of individuals to seek health care, though is likely a combination of factors as underreporting is suspected to be a problem in poorer areas with physical, social or economic barriers to health care. Where laboratory capacity is insufficient, syndromic surveillance plays an important role in monitoring disease trends and early detection of outbreaks. It is potentially a more efficient method of targeting existing resources, and provides the ability to deal with multiple diseases of public health importance. However, as discussed previously (chapter 3), challenges lie in efficient follow-up due to the difficulty in predicting how well syndromes correlate to diseases under surveillance (Henning K.J., 2004).

7.2 Socio-cultural factors that influence health

Other barriers, that relate to the social determinants of health, and also need to be addressed in Lao PDR are poverty, road accessibility, education, language and gender roles in society (Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). For women, age at first marriage and level of education has been found to influence health outcomes (Thome & Pholsena, 2010). Further research is needed on whether gender differences in consumption practices of raw meat and blood are associated with disease burden (chapter 4). Language barriers, particularly among ethnic minorities, as well as gender and generational dynamics also influence health care decision-making processes (Alvesson, Lindelow, Khanthaphat, *et al.*, 2013; Tanner, Chuquimia-Choque, Huanca, *et al.*, 2011; Nichter, 2008; Sychareun, Phommachanh, Soysouvanh, *et al.*, 2013). Inequitable access to health services and poorer health outcomes are also more likely to be higher in rural, poor and ethnic minority populations (Akkhavong, Paphassarang, Phoxay, *et al.*, 2014). Ethnic diversity in Lao PDR adds another dimension to understanding cultural influences on health seeking behaviour, health beliefs, food consumption practices, and hygiene and sanitation practices (Burniston, Okello, Khamlome, *et al.*, 2015), unlike Thailand, which has a population that is largely of Thai ethnicity (96%) with very few ethnic minorities (Jongudomsuk, Srithamrongsawat, Patcharanarumol, *et al.*, 2015). Ethnic homogeneity may remove a level of complexity in understanding sociocultural influences on health seeking behaviour and for delivery of health care, especially when dealing with language barriers and traditional beliefs in rural or remote areas.

Beliefs about health and causes of illness varied among respondents in this study (chapters 4 and 6), and among different ethnic groups (Burniston, Okello, Khamlome, *et al.*, 2015; Barennes, Tran, Latthaphasavang, *et al.*, 2008; Shirayama, Phompida & Kuroiwa, 2006). Cases of illness or death (in humans or animals) are sometimes attributed to spiritual causes that require ceremonial offerings and sacrifices, of food or animals, to treat these illnesses and appease the spirits (FRDLOC, 1995; Shirayama, Phompida & Kuroiwa, 2006). Other potential causes of animal illness or death included administering vaccinations and penning of pigs, while housing animals away from the villages was perceived as beneficial to health.

7.3 Use of a mixed methods approach

This study highlights the importance of using mixed methodologies in understanding the public health issue of pig-associated zoonoses and in finding solutions to them. Baum (1995) asserts that there is increasing recognition of health as being more complex than the absence of disease, and that it is instead an intricate mix of social, political, economic and environmental factors that reflect complex issues of power, status and resource distribution. Augmenting quantitative methodologies with qualitative methods allows research to focus on individual factors that may be important in understanding social, political, and economic factors that influence disease transmission. Factors that would otherwise be missed or underestimated by the sole use of quantitative or epidemiological methodologies that tend to focus on populations as a whole. Therefore to understand and describe the needs of communities, or factors that influence their health and wellbeing, using a mixed methods approach is necessary.

Qualitative research can be used to study how individuals and communities interpret health and disease, and to examine interactions between various players relevant to a given public health issue (Patton, 1990), as seen here. Used in combination with quantitative research methods, it allows research to draw on the strengths of both methodologies while minimizing weaknesses (Johnson & Onwuegbuzie, 2004). The benefits of such as an approach include the ability to add meaning to numbers using words, pictures and narratives, and vice versa to add precision to the latter using numbers (Johnson & Onwuegbuzie, 2004). It can be useful in answering broader research questions, produce more complete knowledge to inform theory and practice, and potentially provide stronger evidence for a conclusion through convergence and corroboration of findings (Johnson & Onwuegbuzie, 2004). There are challenges posed by this approach, since it involves understanding multiple approaches and how to combine them and analyse the data appropriately. Conducting the research can be difficult for a single researcher if multiple methods are used concurrently, making it more expensive and time consuming (Johnson & Onwuegbuzie, 2004).

7.3.1 Movement towards a One Health approach

The zoonotic disease burden is characterized not only by morbidity and mortality, but also in monetary losses through income reduction, animal production losses, and the cost of interventions and/or treatment (Kock, Croft, Dixon, et al., 2012). Measuring this burden can help to identify ‘hotspots’ of disease and areas where zoonoses management would have the greatest impact (ILRI, ZSL Living Conservation & Hanoi School of Public Health, 2012). Applying a One Health (OH) approach will enable a better understanding of the burden as well as help identify and ensure the use of the most efficient and effective disease control and prevention methods that are available, and may also justify the cost of certain interventions.

There is some evidence of a One Health approach in Lao PDR. Firstly, the Field epidemiology training programme (FETP/FET) in Lao PDR was developed to address critical shortages in public health practitioners and incorporates One Health principles through training of individuals from both human and animal sectors (Phommasack, Moen, Vongphrachanh, *et al.*, 2012; CDC, 2015). The MBDS network is another important example, where memoranda of understanding between the human and animal health sectors at provincial and district levels in a number of MBDS sites allow for collaborative activities, including joint investigations and training, which can serve a model for expansion nationally (Ancheta, Mendoza, Pachuen, *et al.*, 2010).

The LACANET One Health Surveillance and Laboratory Network project, funded by the European Union and initiated in March 2014 (to run until February 2018), will develop a bi-national network between Lao PDR and Cambodia including partners from human, animal, and wildlife health sectors (One Health Network Southeast Asia, n.d.). LACANET aims to enhance laboratory and surveillance capacity, for detection and investigation of zoonoses through knowledge exchange, training, information sharing and coordinated response activities, within and between countries. This involves collaboration between the Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit (LOMRU) and the Lao PDR National Animal Health Laboratory (NAHL) for training in diagnostic techniques for national priority diseases. The project also looks at land use changes and the role of wildlife on disease dynamics and emergence, including diseases such as Japanese encephalitis, leptospirosis, rickettsial diseases, trichinellosis, and more. Similarly, the USAID PREDICT project aims to expand wildlife surveillance and enhance capacity for early detection and response to novel/emerging zoonoses with pandemic potential (USAID PREDICT, 2002). This involves establishing diagnostic capacity at NAHL for viral testing and improving knowledge of zoonoses surveillance and awareness of emerging diseases and coordination of animal and human surveillance activities with the local FAO office and NCLE (PREDICT Consortium, 2015).

Therefore, Lao PDR may build much needed OH trans-disciplinary capacity to determine the disease burden of zoonoses through enhancement of surveillance and laboratory capacity. Increased attention is also needed however at district and local levels, especially in rural and remote areas of the country, to improve access to quality health care diagnostic services and address under-reporting of disease in poorly resourced areas. More work is needed on designing and implementing culturally appropriate interventions that target multiple diseases in the same co-endemic areas (Okello, Burniston, Conlan, *et al.*, 2015). Sustainable integration of these skills, tools and resources into the routine national surveillance system once donor funded projects are completed will be the key challenge. Incorporation of the One Health approach into the national system would increase cost-effectiveness of disease prevention and control measures and improve efficiency of surveillance and response activities, thereby strengthening human and animal health systems as a whole (Burniston, Okello, Khamlome, *et al.*, 2015).

8 Conclusion

The need for further research on the burden of pig-associated zoonoses and the factors associated with an increased risk of transmission has been previously recognized (Burniston, Okello, Khamlome, *et al.*, 2015) (Conlan, Vongxay, Jarman, *et al.*, 2012). Given the importance of pig production systems in Lao PDR for food security and poverty alleviation (Lao PDR Ministry of Agriculture and Forestry, 2010), as well as in the greater Southeast Asian region, minimization of disease risks is imperative. This research was an exploratory analysis of the risk factors associated with pig-associated zoonoses, in particular the study diseases (hepatitis E, Japanese encephalitis, brucellosis, and Q fever), evaluation of the knowledge, attitudes and practices related to zoonoses and health in general, as well as health seeking behaviour, and an assessment of health care capacity in dealing with these diseases.

Using a mixed methods approach to analysis allows for a closer look at the stakeholders relevant to the public health issue of pig-associated zoonoses in Lao PDR. Qualitative assessments are useful in assisting with syndromic surveillance and in gaining a more context specific understanding of zoonoses burden, and also play a role in finding and implementing culture appropriate control measures to impact on multiple diseases. Through the analysis of empirical and secondary data, risk factors for pig-associated zoonotic diseases were identified in the study population, in the context of strong sociocultural and ethnic influences. Coupled with the syndromes reported through the Lao PDR national surveillance programme, pig zoonoses likely represent more of the disease burden in the country than is presently known. Integration and harmonization of the human and animal surveillance systems, under a One Health approach, is necessary with the inclusion of endemic pig-associated zoonoses in the systematic analysis of surveillance information, particularly syndromic surveillance. This will enable a better understanding of the disease burden, improve efficiency and effectiveness of disease control and prevention measures and prove to be more cost-effective.

Knowledge and awareness of these diseases was low among respondents, as well as resources to ensure the health of both animal and humans, and warrants critical attention. All surveys also highlighted the absence of and critical need to address diagnostic capability in the rural areas of northern Lao PDR, particularly at local and district levels. Improving access to quality health care and, therefore, health outcomes, especially in rural and remote areas, requires innovative approaches to address barriers, and collaboration with informal providers at local and district levels that play important roles in health seeking behaviour. This research highlights the propensity for misdiagnosis and underreporting of pig-associated zoonoses in Lao PDR and supports the need for inclusion of these zoonoses in the World Health Organization's (WHO) current list of neglected zoonotic diseases (NZDs) or the development of a list for Asia.

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9 Appendix I

Chapter 3 - tables

	Total number of HHs in village	Total number of people living in the village	Distance from village to district centre (Km)	Travel time from village to district centre by motorbike/boat (hrs)	Total no. toilets in village	Who paid for these toilets?
ILRI						
Tha pene	112	545	30	0.6	89	Villagers themselves
Ang	78	502	26	2	6	Villagers themselves
Donexai	59	343	24	2	7	Villagers themselves
ACIAR						
Houayloun	-	1115	18	1	125	Both - villagers and external body
Sophoun	-	528	11	0.3	50	Villagers themselves
Nong Nong	-	275	15	0.5	5	Villagers themselves

Omkaneng	-	247	6	0.1	6	Both - villagers and external body
Pakxang	-	812	10	0.2	118	Both - villagers and external body
Houaykeng	-	905	16	0.6	75	Both - villagers and external body
Poungkhao	-	MV	15	0.6	23	External body (NGO, Government, Other)

Table 9.1 Characteristics of study villages, 2011 ILRI/ACIAR Survey (Questionnaire Part 1-for village heads and/or committee members); '-' question not included.

Village (n)	HEV* (95% CI)		JEV (95% CI)	
Xayabouri province				
Huaykeng (11)	80.00	(49.02-94.33)	0.00	(0-27.75)
Houayloun (20)	70.00	(48.1-85.45)	5.00	(0.89-23.61)
Nongnong (9)	44.44	(18.88-73.33)	22.22	(6.32-54.74)
Phaxang (30)	80.00	(62.69-90.49)	0.00	(0-11.35)
Phongsaly province				
Omkaneng (11)	63.64	(35.38-84.83)	0.00	(0-25.88)
Poungkhao (6)	83.33	(43.65-96.99)	0.00	(0-39.03)
Sophoun (26)	46.15	(28.76-64.54)	0.00	(0-12.87)
Luang prabang province				
Ang (16)	93.75	(71.67-98.89)	0.00	(0-19.36)
Donexai (16)	62.50	(38.64-81.52)	0.00	(0-19.36)
Tha Pene (15)	13.33	(3.74-37.88)	6.67	(0-20.39)

Total (160)	**63.52**	**(55.80-70.60)**	**2.52**	**(0.98-6.29)**

Table 9.2 Human disease prevalence by village in percent (95% Confidence Interval); n=number of samples; * 1 null result excluded; prevalences highlighted in red are top 3 (high)

Province (n)	**HEV*(95% CI)**		**JEV (95% CI)**	
Xayabouri (69)	72.46	(60.95-81.61)	4.35	(1.49-12.02)
Phongsaly (43)	55.81	(41.11-69.57)	0.00	
Luangprabang (47)	57.45	(43.28-70.49)	2.13	(0.38-11.11)

Table 9.3 Human disease prevalence by province in percent (95% Confidence interval); n=number of samples

Village (n)	HEV (95% CI)		JEV (95% CI)	
Xayabouri province				
Houaykeng (10)	80.00	(49.02-94.33)	10.00	(1.79-40.42)
Houayloun (22)	77.27	(56.56-89.88)	0.00	
Nongnong (9)	77.78	(45.26-93.68)	22.22	(6.32-54.74)
Pakxang (30)	63.33	(45.51-78.13)	10.00	(3.46-25.62)
Phongsaly province				
Omkaneneg (11)	90.91	(62.26-98.38)	0.00	
Phoungkao (6)	100.00	(60.97-100)	0.00	
Souphoun (25)	88.00	(70.04-95.83)	0.00	
Luang Prabang province				
Ang (15)	93.33	(70.18-98.81)	6.67	(1.19-29.82)
Donexai (16)	50.00	(28-72)	31.25	(14.16-55.60)
Tha Pene (9)	55.56	(26.67-81.12)	22.22	(6.32-54.74)

Total (153)	**75.82**	**(68.45-81.92)**	**9.15**	**(5.53-14.77)**

Table 9.4 Pig disease prevalence by village in percent (95% Confidence Interval); n=number of samples; prevalences highlighted in red are top 3 (high)

Province (n)	**HEV (95% CI)**		**JEV* (95% CI)**	
Xayabouri (71)	71.83	(60.46-80.96)	8.45	(3.93-17.24)
Phongsaly (42)	90.48	(77.93-96.23)	0.00	
Luangprabang (40)	67.50	(52.02-79.92)	20.00	(10.5-34.76)

Table 9.5 Pig disease prevalence by province in percent (95% Confidence Interval); n=number of samples; * JEV MAC results - intermediates included in total 'n'

ໂຄງການປັບປຸງລະບົບການລ້ຽງໝູຂອງຊາວກະສິກອນ
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Appendix II

Focus Group Discussion – Knowledge, Attitudes and Practices – Interview guide

Thank you for agreeing to participate in this discussion. My name is …….. I am working on behalf of the University of Edinburgh and am following up on the survey that was done in 2011 by ILRI and ACIAR.

The purpose of this group discussion is to learn more about what diseases are important in your community, what people in your community do when they have an illness and where they go to seek treatment. We are also interested in how people interact with animals in their homes.

We expect the discussion will take about one to two hours. I will ask some questions to begin the discussion, and you are free to contribute, as you feel comfortable. There are no right or wrong answers to the questions; we are interested in your own opinions based on your own experiences or the experiences of others you know.

We ask you to respect each other's opinions, even when they are not the same as yours. Please understand that your participation is voluntary, so you may choose not to participate, or if you don't want to answer a particular question you don't have to, and you are fee to leave at any stage. Your responses will also be strictly confidential and anonymous. The discussion will work best if only one person speaks at a time.

[Remind participants that the discussion will be recorded]

Interviewer instructions:

- Fill in numbers |__|__|
- Write answers on lines ________________________

I. Interview Identification

101. Interview date (mm-dd-yy) |__|__| -- |__|__| -- |__|__|

102. Interview number |__|__|__|
103. Interviewer's name ______________________________
104. District name and ID ______________________________
105. Village name and ID ______________________________
1.
106. GPS reading latitude (north/south) in degree with decimal
|__|__| |__|__|__|__|__|
107. GPS reading longitude (east/west) in degree with decimal
2. |__|__| |__|__|__|__|__|
108. Time interview started (24 hour clock: hh-mm)
|__|__| -- |__|__|

109. Are you comfortable talking about health of people in your household and village?
0. No
1. Yes

110. Are you comfortable talking about livestock keeping in your household and village?
0. No
1. Yes

II. Human health

201. What are the main ethnic groups in this village?
202. What are the main human health problems in the community? *[List and Rank (PE exercise)]*.
203. Have you or anyone you know in the village ever had any of the following combination of symptoms? (Check all that apply)
1. Fever, headaches, sweats, joint or muscle pain
2. Nausea, vomiting, loss of appetite (nausea)
3. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis

204. Have you or anyone you know in the village ever been diagnosed with any of the following?

1. Acute febrile illness (38° C or 100.4 F or above)
2. Acute jaundice
3. Central nervous system (CNS) infection (meningitis, encephalitis, or acute flaccid paralysis)
4. Enlarged tender liver (hepatomegaly) or acute liver failure

205. Where do people in the community tend to go to seek treatment or advice when they get sick? Do they tend to self-medicate? *(*Researcher to map locations where people seek care)*

206. Why do people go to XXXX for their treatment or advice? (Probe: financial reasons, traditional beliefs, proximity to home, trust in service, etc.)

207. Are there reasons why someone in the community would not seek treatment? (E.g. at what point is it cost prohibitive, how much is too much, how far is too far, or how sick do people think they need to be before seeking treatment)

208. Do people tend to go to more than one place for treatment or advice?

209. What types of medicines do people first try? (Traditional vs. western)

210. When people buy medicines from the pharmacy/drug-seller, do they receive any information about the medicine from the drug-seller? (E.g. how much to take and how often)?

211. Do people worry about the medicines they get from the drug-seller? (Quality/effectiveness)

212. What do people do when medicines don't work?

213. Do younger and older people in the village tend to go to the same places to seek treatment for their illness?

III. Animal questions

301. What types of animals do people in the community keep in their home area?

302. Do people in the village keep any animals separate from each other? If so, which ones and why?

303. In general, do you think these animals are fairly healthy or sick? Is it easy to keep them healthy?

304. Do you think it's possible for a sick animal to transmit their illness to humans? If not, why not?

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If have pigs in the village:

305. Are they kept near the household (<100m from house)?
306. Are they mostly kept in pigpens or allowed to roam freely?
307. How do people in the village feel about keeping pigs penned?
308. What are the main health problems in pigs?
309. Do people tend to separate sick from well animals?
310. Have there been any dead piglets when pigs give birth (fetus abortions or stillbirths)?

311. Do people tend to wear any protective clothing or equipment when handing animal products – like aborted fetuses, placentas, feces, etc.?
312. How do people in the community feel about using protective clothing or equipment?
313. What do you do with dead animals, when they die?
3. (Prompt if necessary: Butcher and eat animal or part of animal, Sell animal or parts of animal, Give meat away to friends/neighbours, Throw carcass away, Burn the carcass, Bury the carcass, Feed carcass to other animals, etc

314. Are animal deaths reported to anyone?
315. ***If YES*** – whom do you report the animal deaths to?
(Prompt if necessary: relative/friend, village veterinary volunteer, village chief, district agriculture and forestry office (DAFO), provincial agriculture and forestry office (PAFO), etc)
316. Have you attended any awareness/training programmes that have talked about animal health before?
317. ***If YES*** – what was the training about?
(Prompt if necessary: animals passing diseases to humans (zoonotic diseases), vaccination, markets, good animal husbandry practices, animal health, etc)

IV. Agricultural practices

401. Are there rice fields in this village?
402. If so, are they located <100m from the household or where pigs are kept?
403. Do you see lots of rodents in the rice fields – throughout the year? In rainy season?

V. Vector control

501. Do people tend to use mosquito bed nets, or insect repellents, or insecticide sprays?
502. Do people tend to use insect repellents on children (to prevent getting mosquito bites)?
503. How do people in the village feel about using mosquito bed nets, insect repellents and insecticide sprays? (any difference between adults and children?)
504. Apart from mosquitoes, are there any other insects that bother people or animals?

VI. Hygiene and Sanitation

601. How many toilets are there in this village?
604. Are toilets mostly shared between households or owned and used by one household/family? For those who own one, do you let other households use your toilet?
602. If owned, what is the principle type of toilet used by members of your household?
(Prompt if necessary: flush toiler, traditional pit latrine, ventilated improved latrine, etc)
605. For those who own a toilet, do you always use it? If not, where else do you tend to go?
606. For those who do not own a toilet, where do people tend to go mostly?

607. What is the principle household source of drinking water in the village?
4. (Prompt if necessary: Piped drinking water in residence, Public pump, Water from protected well, Water from unprotected well, River, etc)
608. If water is from untreated source, do people tend to boil water for drinking purposes?
609. How do people in the community feel about boiling (treating) water for drinking?
610. Do people tend to wash their hands before and after cooking/handling butchered meat?

611. Do people tend to wash their hands after going to/using the toilet?

612. Is flooding common in this village (in the rainy season)?

613. Where does household waste usually get dumped? (E.g. open refuse, open sewage)

VII. Food consumption practices

701. What is the staple diet or popular dishes in this village?

702. Do people consume any dairy? If so, how is it prepared?

703. (Do people in the village consume pasteurized dairy products? If so, where does it come from?)

704. Do people in the village eat pork? If so, how is it prepared?

705. Do people eat raw or undercooked pork meat (including organs)?

706. If so, where does this meat usually come from? (E.g. own pigs killed in village, other villages, market)

707. How often do people tend to ear raw or undercooked pork?

VIII. Interview conclusion

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

801. Are there any questions you have for us?

____

____

___

802. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

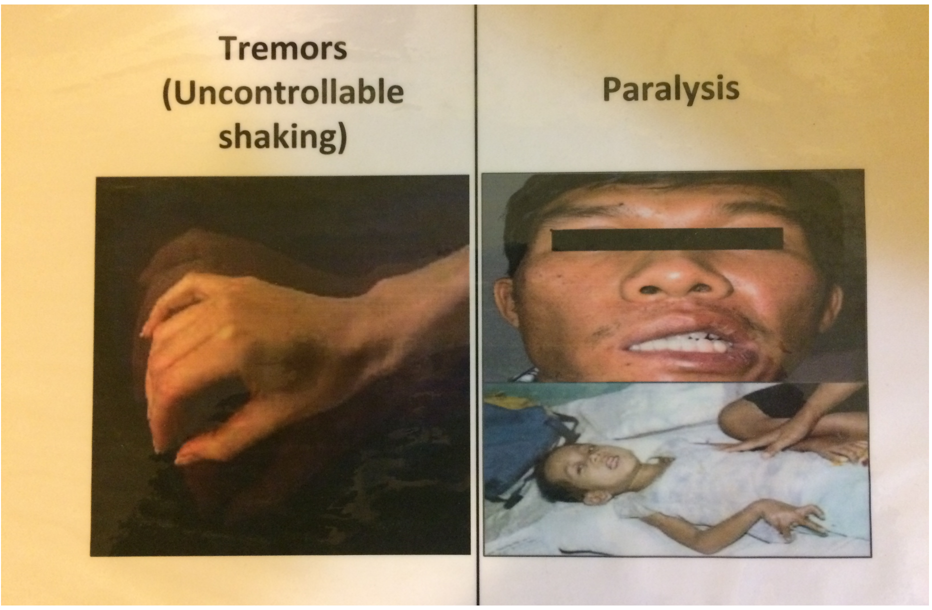
___

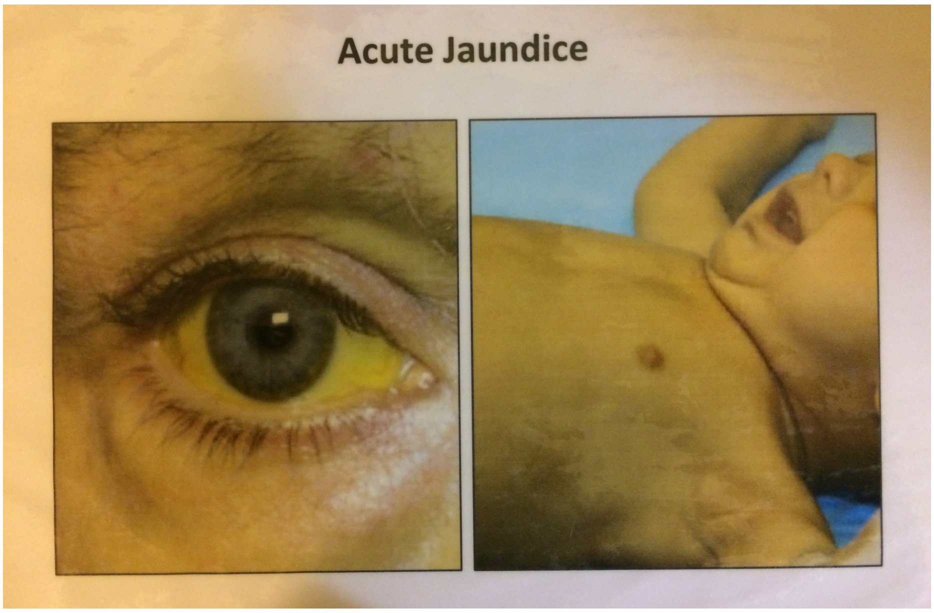
803. Time interview ended (24hr clock: hh-mm)

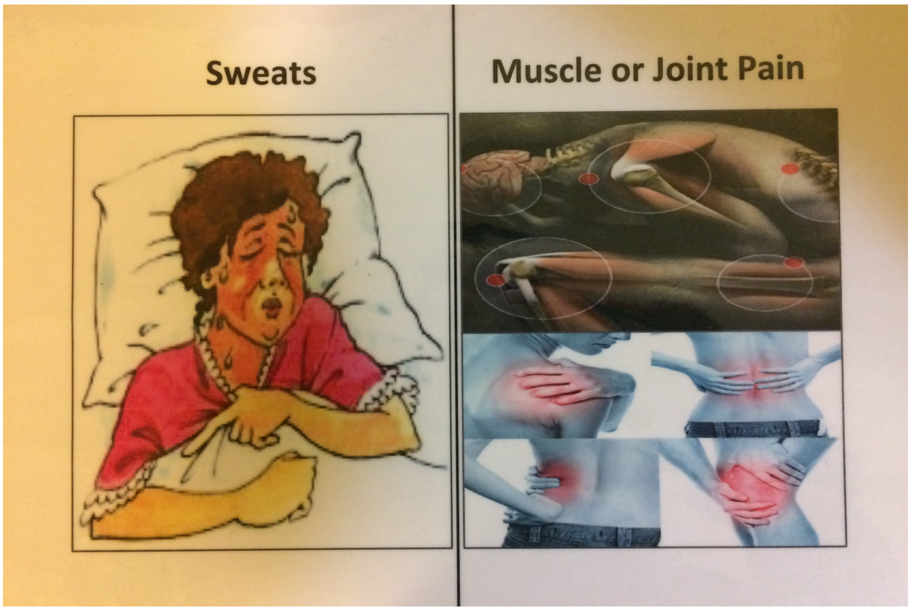
|__|__| - |__|__|

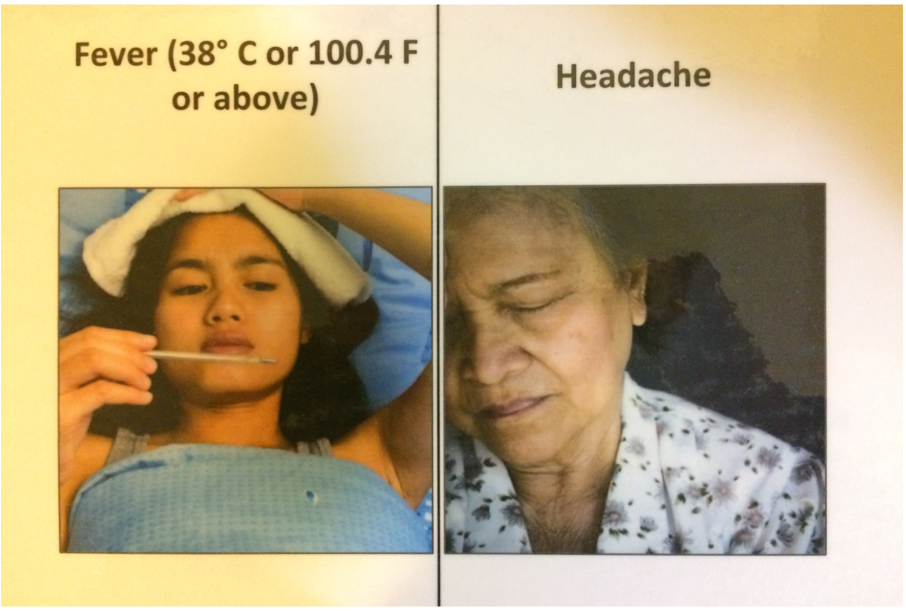
Thank you very much again.

Visual aids for FGDs






Sweats
Muscle or Joint Pain


Fever (38° C or 100.4 F or above)
Headache

ໂຄງການປັບປຸງລະບົບການລ້ຽງໝູຂອງຊາວກະສິກອນ

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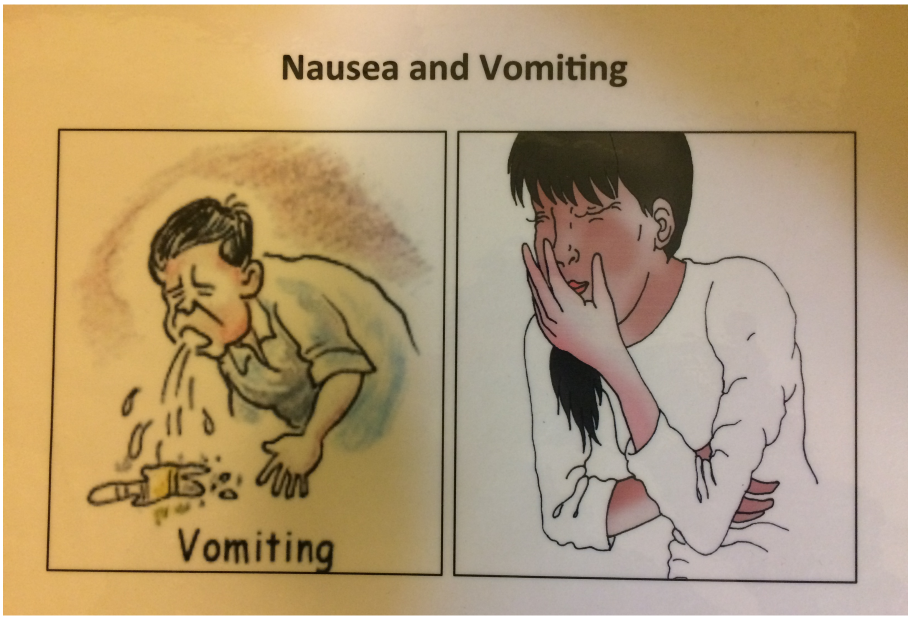

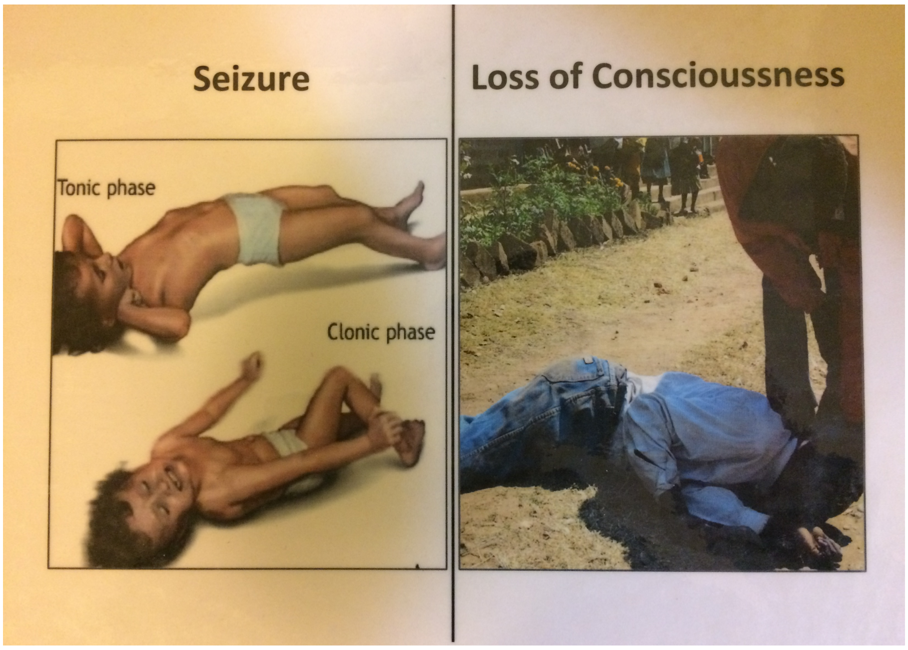

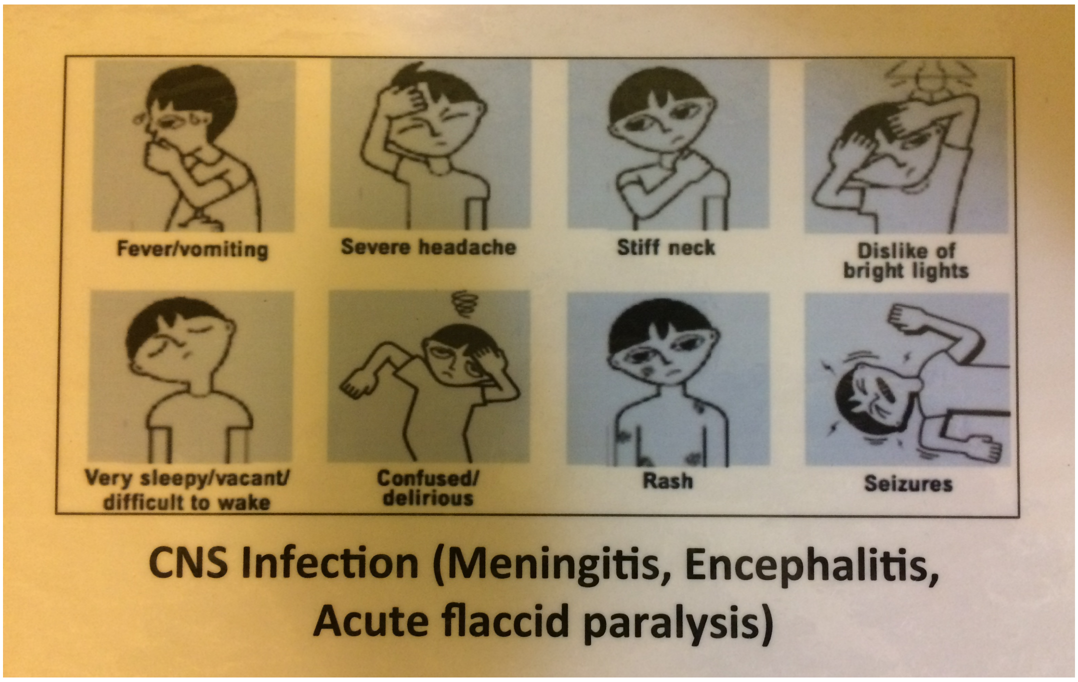
Fever/vomiting
Severe headache
Stiff neck
Dislike of bright lights
Very sleepy/vacant/ difficult to wake
Confused/ delirious
Rash
Seizures
CNS Infection (Meningitis, Encephalitis, Acute flaccid paralysis)

ໂຄງການປັບປຸງລະບົບການລ້ຽງໝູຂອງຊາວກະສິກອນ
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Appendix III

Form 1 - Socio-demographic and Animal factors

Questionnaire

Interviewer instructions:

- Fill in numbers |__|__| - make sure you put a '0' if the answer is 'none' so we know the question has been answered
- Where there are choices, tick the box next to the answer given or fill in 'Other' where relevant
- Write answers on lines ________________________

I. Interview Identification

111. Interview date (mm-dd-yy) |__|__| -- |__|__| -- |__|__|

112. Household/hospital and interview number
|__|__| |__|__|

113. Interviewer's name ____________________________
114. District name and ID ____________________________
115. Village name and ID ____________________________
116. Hospital name (if applicable) __________________________
117. Type of hospital (if applicable)
1. District
2. Provincial
3. Regional/Central
4. Private clinic/hospital
5. Health centre
6. Other, please specify: _____________________

118. GPS reading latitude (north/south) in degree with decimal
|__|__| |__|__|__|__|__|
119. GPS reading longitude (east/west) in degree with decimal
5. |__|__| |__|__|__|__|__|

120. Time interview started (24 hour clock: hh-mm)
|__|__| -- |__|__|

121. What is your position (the person being interviewed) in the household? Are you:
1. Household head
2. Wife, husband, son, daughter, father, mother of household head
3. Other family member
4. Household employee
5. Other: ____________________________

122. Are you comfortable talking about health of people in your household?
2. No *(If answer 'No', skip Form 2/3)*
3. Yes

123. Are you comfortable talking about livestock keeping in your household?
2. No *(If answer 'No', skip questions 222 – 235)*
3. Yes

II. Description of Household

Interviewer explains: We would like to know a bit about who lives in your household and what type of farming, livestock keeping and other types of work your household does.

201. How old is the household head?
|__|__|

202. Is the household head
1. Male
2. Female

203. What is the highest level of education the household head completed
1. None
2. Primary school
3. Secondary school
4. Further education

204. How old is the person being interviewed (years), if not head of household? |__|__|

205. Is the person being interviewed

1. Male
2. Female

206. What is the highest level of education the person being interviewed completed, if not the head of household?

1. None
2. Primary school
3. Secondary school
4. Further education (college, university, etc.)

207. How many people live in your household?

|__|__|

208. What are their ages and sex?

Age (years)	Number of household members	
	Male	Female
0 - 4		
5 - 14		
15 - 64		
65 +		

209. What ethnic group do you belong to?

1. Thai Deng
2. Thai Dam
3. Thai Khao
4. Hmong – Yao
5. Lao Loum
6. Lao Theung
7. Lao Sung

8. Khmou
9. Phou noy
10. Other, please specify: ___________________

210. What is your household's religion?

1. Buddhist
2. Christian
3. Muslim
4. spirit
5. Other____

From which activities is the household's income?

211. What is the main occupation in your household, from which it gets most of its income and food?

1. Livestock keeping |__|
2. Crop farming (rice, coffee) |__|
3. Fishing |__|
4. Business or selling (own business) |__|
5. Paid employment |__|
6. Other ____

212. What is the second most important occupation?

1. Livestock keeping |__|
2. Crop farming |__|
3. Fishing |__|
4. Business or selling |__|
5. Paid employment |__|
6. Other ____
7. None |__|

213. What is the third most important occupation?

1. Livestock keeping |__|
2. Crop farming |__|

3. **Fishing** |__|
4. Business or selling |__|
5. Paid employment |__|
6. Other ____
7. None |__|

214. If livestock keeping is the main income of the household, which livestock species generates most?

1. Cow |__|
2. Buffalo |__|
3. Goats |__|
4. Pigs |__|

215. How many members of your household currently attend school?

|__|__|

216. Are any members of your household in full or part-time paid work?

0. No
1. Yes

217. What kind of work do they do?

____

218. Do any members of your household do any type of business (handicrafts, brewing, building work) or selling (except for your own livestock and farm products)?

0. No
1. Yes

219. What kind of business do they do?

____

____

220. Do you receive money from family members who live away from your home?

0. No
1. Yes

221. If yes, how often do they send you money?

1. About once a month
2. About once every 2 or 3 months
3. About once every 6 months
4. About once a year
5. Never.

How many animals does your household keep?

(*Put 0 if there are none) Be aware, in some areas people do not want to give overall numbers of livestock owned. Skip if answered 'No' to question 113.*

222. Donkeys |__|__|

223. Cow |__|__|__|

224. Buffalo |__|__|__|

225. Goats |__|__|__|

226. Pigs |__|__|

227. Dogs |__|__|

228. Chickens |__|__|

229. Any other animals (specify) ______________________________

230. How many other animals? |__|__|

231. How many animals have been sick or died in the last 30 days? |__|__|__|

232. Do you separate sick animals from animals that are well?

0. No
1. Yes

233. If you have pigs, how are they housed?

1. Penned housing

2. Free range
3. Combination of both (roam free in day, penned at night)

234. Are pigs housed or kept < 100m away from the household?

0. No
1. Yes

235. Does your family/household own a rice field?

0. No
1. Yes

III. Housing Condition and Expenditures

301. How much money do you spend on food for your household per week?

|__|__|__||__|__|__|________________

302. What is your house made of?

1. Double storey with both levels made of wood
2. Double storey with upper storey made of wood and lower made of bamboo lattice
3. Double storey with both storeys made of bamboo
4. Double storey with both storeys made of brick or metal
5. Single storey made of brick or metal
6. Single storey made of wood
7. Single storey made of bamboo
8. Other (specify): ____________________________________

303. How many rooms in your household? |__|__|__|

304. Do you have electricity?

0. No
1. Yes

305. Do you any of own the following: Check all that apply.

1. Television
2. DVD player
3. Mobile phone
4. Radio

5. Bicycle
6. Car/truck
7. Toilet
8. Motorcycle

306. If owned, what is the principle type of toilet used by members of your household?

1. Flush toilet
2. Traditional pit latrine
3. Ventilated improved pit latrine
4. Don't know

307. What is the principle household source of drinking water?

1. Piped drinking water in household
2. Public pump
3. Water from protected well/covered tank
4. Water from unprotected well
5. River
6. Other, please specify: ______________________

IV. Interview conclusion (If not completing Form 2 or 3)

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

804. Are there any questions you have for us?

____

____

805. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

806. Time interview ended (24hr clock: hh-mm)

|__|__| - |__|__|

Thank you very much again.

Form 2 - Impact of Illness & Health Seeking Behaviour Questionnaire – Household survey

I. Human health information for the household

101. Have you or anyone in your family/household experienced any of the following symptoms/conditions in the last 30 days? (Check all that apply)

1. Acute febrile illness (38C (100.4F) or above)
2. Acute jaundice
3. CNS infection (meningitis or encephalitis or acute flaccid paralysis)
4. Fever, headaches, sweats, joint or muscle pain
5. Nausea, vomiting, loss of appetite (anorexia)
6. Enlarged tender liver (hepatomegaly) or acute liver failure
7. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis
8. None. (Please go to interview conclusion)

102. Have you or your family member had this illness before?

0. No
1. Yes
2. Don't know

103. Where did you seek treatment for this illness? More than one answer possible (check all that apply)

1. Self medication (pharmacy/drug-seller)
2. Home remedies
3. Traditional healer ("Mo-Lao"?)
4. Spiritual healer/leader

5. Health centre
6. Private clinic or hospital
7. Hospital (district/provincial/regional)
8. Other, please specify: ______________________
9. Do nothing

104. Where was the first place that you sought care?

1. Self medication (pharmacy/drug-seller)
2. Home remedies
3. Traditional healer ("Mo-Lao"?)
4. Spiritual healer/leader
5. Health centre
6. Private clinic or hospital
7. Hospital (district/provincial/regional)
8. Other, please specify: ______________________

105. If you did nothing, what is the reason?

____

106. How long after onset of illness did you seek treatment? _______________ (days/weeks)

107. How far away is the nearest health centre? |__|__|__|__| *(Specify Km or miles)*

108. How far away is the nearest hospital? |__|__|__|__| *(Specify Km or miles)*

109. If the patient (you or family member) did not go to hospital/health centre, what is the reason?

____

110. Have you or a family member ever been diagnosed with any of the following diseases?

a. Hepatitis E

0. No

1. Yes
2. I don't know

b. Japanese encephalitis
0. No
1. Yes
2. I don't know

c. Coxiella
0. No
1. Yes
2. I don't know

d. Brucellosis
0. No
1. Yes
2. I don't know

II. Impact of the disease on affected patients

If answered "YES" to questions 102 or 106: find out how people diagnosed with the disease are affected by the disease, and if there have been deaths, note age when died and describe course of illness, if possible. (Below)

If answered "NO" to questions 102 or 106: skip to question 314 on health insurance.

201. History of patient's illness

HH member	Sex	Age	Duration of symptoms (days)	Type of diagnosis done	Severity: 1.Mild 2.Moderate 3.Severe	Able to work/ school? Y/N	Did the patient die? If Yes, at what age?	If cured, what is long-term effect?	Where is the patient currently?	Main occupation of patient
Ex.	F	7	4	Clinical(or Lab/ None)	2.	N	N	Neurological deficit	At home	Child (no school)
1.										
2.										
3.										
4.										
5.										
6.										

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III. Patient and patient's family costs – at the hospital/health center

Illness imposes a lot of cost on a family. We would like to ask you about the costs the illness has imposed on your household.

301. If you went to hospital/health centre, how far away from your house did you have to travel? |__|__|__|__| (*Specify Km or miles*)

302. How did you get there?

1. Walking
2. Bicycle
3. Car
4. Bus
5. Tuk tuk
6. Ambulance
7. Other, please specify: ____________________

303. What was the cost of getting there? ______________________

304. What medicine were you given?

____

____

(Prompt: Traditional medicine, Vitamins, Antibiotics, Painkillers, Steroids, Vaccines, Other)

305. What did you have to pay for the medicine?

____

306. Were there any other costs? (What else is paid for out of pocket)? Please specify:

____

____

____

307. How much were these other costs?

____

308. How much does it cost for the patient to stay in hospital?

____

309. How did you get the money to pay for all these costs?

____
____
____

(Prompt: borrow or sell something)

310. Did you have to borrow money to pay for these healthcare costs?

0. No

1. Yes

310. If yes, how much money did you have to borrow?

____

311. While the patient is ill, who does the work that he/she would normally do?

1. Another adult in your household
2. Someone from outside your household came and helped
3. Someone had to be paid to do it
4. Nobody did your work
5. Other; Please specify:

   ____

312. If patient is a child, how much time did you/family member have to take off work to be with the patient? _________ (Days)

313. Who did the work that you would normally do?

1. Another adult in your household
2. Someone from outside your household came and helped
3. Someone had to be paid to do it

4. Nobody did your work
5. Other; Please specify: ____

314. If someone was paid to do your work, how much were they paid and for how long?
_________________ (Amount)
_________________ (days/weeks/months)

315. What have the long-term effects of illness been on the household?
____

316. Do you have health insurance?
0. No
1. Yes
2. I don't know

If answered NO:

317. Do you know that it is available?
0. No
1. Yes

318. If you had health insurance, would it influence how you accessed a hospital or health centre?
0. No
1. Yes

If answered YES:

319. Is the health insurance you have important for you in making the decision to seek care in a hospital or health centre?
0. No
1. Yes

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IV. Interview conclusion

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

401. Are there any questions you have for us?

____

____

402. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

403. Time interview ended (24hr clock: hh-mm)

|__|__| - |__|__|

Thank you very much again.

Form 3 - Impact of Illness & Health Seeking Behaviour Questionnaire – Hospital survey

I. *Patient demographics*

(If not interviewing patient, but the parent/guardian)

101. Patient's age: |__|__|
102. Patient's sex:
1. Male
2. Female
103. Patient's main occupation: ______________________________

II. *Impact of the disease on affected patient*

201. What is patient's diagnosis or reason for admission/presentation to hospital?

____

202. Specimens collected?

0. No

1. Yes, please specify: ________________________________

203. Lab diagnosis?

0. No

1. Yes, specify diagnosis: ________________________

204. Onset of illness (Number of days before coming to hospital)

____

205. Date of admission/presentation: |__|__| -- |__|__| -- |__|__|

206. Clinical characteristics of patient (check all that apply):

1. Acute febrile illness (38C (100.4F) or above)
2. Acute jaundice
3. CNS infection (meningitis or encephalitis or acute flaccid paralysis)

ໂຄງການປັບປຸງລະບົບການລ້ຽງໝູຂອງຊາວກະສິກອນ
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4. Fever, headaches, sweats, joint or muscle pain
5. Nausea, vomiting, loss of appetite (anorexia)
6. Enlarged tender liver (hepatomegaly) or acute liver failure
7. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis
8. None. Please go to interview conclusion.

207. Has the patient had this illness before?

- **0.** No
- **1.** Yes
- **2.** Don't know

208. Where did you first seek care for this illness before coming to hospital/health centre? More than one answer possible (Want to know number of visits elsewhere before correct diagnosis)

- **10.** Self medication (pharmacy/drug-seller)
- **11.** Home remedies
- **12.** Traditional healer ("Mo-Lao"?)
- **13.** Spiritual healer/leader
- **14.** Health centre
- **15.** Other government hospital (district/provincial/regional)
- **16.** Private clinic or hospital
- **17.** Other, please specify: ________________________
- **18.** Do nothing

209. If you did nothing, what is the reason?

____

210. If you did not first go to a hospital or health centre, what is the reason?

____

211. If you had multiple visits to a health centre/hospital before admission, what was diagnosis on first presentation?

____

212. How severe would you describe the patient's current illness?

- **1.** Mild
- **2.** Moderate
- **3.** Severe

213. Has the patient been able to go to work or school during this illness?

- **0.** No
- **1.** Yes

213. How far away is the nearest health centre from your household?
|__|__| *(Specify Km or miles)*

214. How far away is the nearest hospital (district or provincial)? |__|__| *(Specify Km or miles)*

215. Have you or a family member ever been diagnosed with any of the following diseases?

- **1.** Hepatitis E
  - **3.** No
  - **4.** Yes
  - **5.** I don't know
- **e.** Japanese encephalitis
  - **0.** No
  - **1.** Yes
  - **2.** I don't know
- **f.** Coxiella
  - **0.** No
  - **1.** Yes
  - **2.** I don't know
- **g.** Brucellosis
  - **0.** No
  - **1.** Yes
  - **2.** I don't know

216. If interviewing at discharge, what is patient outcome?

1. Cured
2. Died
3. Still sick

217. Duration of symptoms: ___________ (days/weeks/months)

III. Patient and patient's family costs – at the hospital/health center

Illness imposes a lot of cost on a family. We would like to ask you about the costs the illness has imposed on your household.

308. How far away from your house did you have to travel to reach this hospital/ health centre? |__|__| Km

309. How did you get here?

1. Walking
2. Bicycle
3. Car
4. Bus
5. Tuk tuk
6. Other, please specify: ____________________

310. What was the cost of getting here? _____________________

311. What medicine were you given?

____

____

(Prompt: Traditional medicine, Vitamins, Antibiotics, Painkillers, Steroids, Vaccines, Other)

312. What did you have to pay for the medicine?

____

313. How much does it cost for you/your family member to stay in hospital?

____

314. Were there any other costs (what else is paid for out of pocket)? Please specify:

____

____

315. How much were these other costs?

____

311. How did you get the money to pay for all these costs?

____

____

____

(Prompt: borrow or sell something)

310. Did you have to borrow money to pay for these healthcare costs?

2. No

3. Yes

312. If yes, how much money did you have to borrow?

____

313. How much time off work/school has the patient had to take? |__|__| days

314. While you/your family member (the patient) is ill, who does the work the patient would normally do?

6. Another adult in your household

7. Someone from outside your household came and helped

8. Someone had to be paid to do it

9. Nobody did your work

10. Other; Please specify:

____

315. If patient is a child, how much time off work have you (care giver/parent) had to take? _____________ (Days)

316. While you/your family member (the patient) is ill, who does the work that you would normally do?

1. Another adult in your household

2. Someone from outside your household came and helped

3. Someone had to be paid to do it

4. Nobody did your work

5. Other; Please specify:

____

317. If someone was paid to do your work, how much were they paid and for how long?

_______________ (Amount)

_______________ (days/weeks/months)

318. What have the long-term effects of illness been on the household?

____

319. Do you have health insurance?

0. No

1. Yes

If answered NO to question 318:

320. Do you know that it is available?

0. No

1. Yes

321. If you had health insurance, would it influence how you accessed a hospital or health centre?

0. No

1. Yes

If answered YES to question 318:

322. Is the health insurance you have important for you in making the decision to seek care in a hospital or health centre?

0. No
1. Yes

IV. Interview conclusion

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

404. Are there any questions you have for us?

____

____

405. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

406. Time interview ended (24hr clock: hh-mm)

|__|__| - |__|__|

Thank you very much again.

Acknowledgements

Forms 1-3 has been further adapted from socioeconomic questionnaires developed and modified by ICONZ (Integrated Control of Neglected Zoonoses) and DFID-RIU (Department for International Development - Research into Use), Alexandra Shaw, Anna Okello, Dennis Muhanguzi, Marie Ducrotoy, Felix Roth, Esther Schelling, Jakob Zinsstag.

Appendix IV

Health Care Provider Service Delivery Assessment

Interviewer instructions:

- Interview member of staff from health centre – medical in-charge, senior nurse, laboratory technician, or doctor if available
- Fill in numbers |__|__| - make sure you put a '0' if the answer is 'none' so we know the question has been answered
- Where there are choices, circle the number next to the answer given or fill in 'Other' where relevant
- Write answers on lines ________________________

I. Interview Identification

124. Interview date (mm-dd-yy) |__|__| -- |__|__| -- |__|__|

125. Hospital/health centre and interview number
|__|__| |__|__|

126. Interviewer's name ____________________________
127. District name and ID ____________________________
128. Hospital name ____________________________
129. Type of hospital (if applicable)
1. District
2. Provincial
3. Regional/Central
4. Private clinic/hospital
5. Health centre/dispensary
6. Other, please specify: _____________________

130. GPS reading latitude (north/south) in degree with decimal
|__|__| |__|__|__|__|__|
131. GPS reading longitude (east/west) in degree with decimal
|__|__| |__|__|__|__|__|

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132. Time interview started (24 hour clock: hh-mm)

|__|__| -- |__|__|

133. Is the person being interviewed

3. Male

4. Female

134. Interviewee's age: ______ (years)

135. What is your job title/position?

____

136. What area(s) does this health centre cover? (Villages/districts)

____

137. How many medical staff are employed at this health centre?

1. Total ______

2. Doctors ______

3. Nurses ______

4. Lab tech ______

5. Other ______; please specify: ______________________

138. Do you have any inpatient wards at this hospital/health centre?

0. No

1. Yes

116. ***If YES*** – how many inpatient wards are at this hospital/health centre?

1. Total ______

2. For children only ______

117. Estimate how many patients come to this hospital/health centre on a normal day?

1. Less than 20

2. 20 – 50

3. 50 – 100

4. More than 100

118. In your opinion, what are the most common reasons people come to this hospital/health centre?

____

____

____

____

(Prompt if necessary – maternity reasons, trauma, infections, etc)

119. Name the 3 most common infections at this hospital/health centre.

____

____

____

____

120. What are the most commonly given medicines?

1. Painkillers
2. Antibiotics
3. Antimalarial
4. Vitamins
5. Other, please specify:

____

121. In general, how are infections diagnosed?

1. Clinical assessment or examination
2. Laboratory diagnosis
3. Other, please specify:

____

122. What are the 3 most common clinical signs and symptoms of infection that patients present with?

____

____

____

____

(Prompt if necessary – fever, diarrhoea, vomiting, loss of consciousness, etc)
(Tick here _____ if prompt necessary)

123. If different from above (119 & 121), do you see patients presenting with any of the following symptoms or syndromes? (Check all that apply)

1. Acute febrile illness (38C (100.4F) or above)
2. Acute jaundice
3. CNS infection (meningitis or encephalitis or acute flaccid paralysis)
4. Fever, headaches, sweats, joint or muscle pain
5. Nausea, vomiting, loss of appetite (anorexia)
6. Enlarged tender liver (hepatomegaly) or acute liver failure

7. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis
8. None

II. Diagnostic Capacity

234. Does this hospital/health centre have a diagnostic lab?

0. No
1. Yes
2. Don't know

235. ***If YES*** – what diagnostic equipment does this hospital/health centre have? (Check all that apply)

1. Microscope
2. Centrifuge
3. Rapid kit for malaria
4. Any other rapid kit, please specify: ____
5. X – ray
6. Other, please specify: ________________________________

203. How often does this equipment get used?

1. Everyday
2. Sometimes [a) once a week, b) 2-3 times per week]
3. Rarely [a) once a month, b) once every few months]
4. Never

204. If used never, please state the possible reason(s) why.

____

____

205. Do you have electricity supply for the hospital/health centre?

0. No

1. Yes

III. Knowledge and Awareness

306. Have you heard of the following diseases?

1. Hepatitis E
- i. No
- ii. Yes
- iii. Don't know

2. Japanese encephalitis
- iv. No
- v. Yes
- vi. Don't know

3. Coxiella
- vii. No
- viii. Yes
- ix. Don't know

4. Brucellosis
- x. No
- xi. Yes
- xii. Don't know

307. If YES to any of above, do you think these diseases are present in this district?

1. Hepatitis E
- i. No
- ii. Yes
- iii. Don't know

2. Japanese encephalitis
- **0.** No
- **1.** Yes
- **2.** Don't know

3. Coxiella
- **0.** No

1. Yes
2. Don't know

4. Brucellosis
   0. No
   1. Yes
   2. Don't know

303. Have you ever diagnosed a patient with any of the following diseases?

1. Hepatitis E
   0. No
   1. Yes
   2. Don't know
2. Japanese encephalitis
   0. No
   1. Yes
   2. Don't know
3. Coxiella
   0. No
   1. Yes
   2. Don't know
4. Brucellosis
   0. No
   1. Yes
   2. Don't know

304. Are you confident that patients presenting with the following signs and symptoms would be correctly diagnosed at this hospital/health centre?

- **a.** Acute febrile illness (38C (100.4F) or above)
- **b.** Acute jaundice
- **c.** CNS infection (meningitis or encephalitis or acute flaccid paralysis)
- **d.** Fever, headaches, sweats, joint or muscle pain
- **e.** Nausea, vomiting, loss of appetite (anorexia)
- **f.** Enlarged tender liver (hepatomegaly) or acute liver failure
- **g.** Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis

0. No
1. Yes

2. Don’t know

Any comments:

____

____

____

____

9.1 Health Insurance

305. Do you think more patients would seek care in hospital/health centre if they had health insurance?

- **0.** No
- **1.** Yes
- **2.** Don’t know

306. Do you think the health insurance system in Laos has an effect on the quality of service that patients receive (i.e. if they have health insurance they receive better/worse care than if they do not)?

- **0.** No
- **1.** Yes
- **2.** Don’t know

307. For patients that do not have health insurance, how do they normally pay for their treatment and care?

- **1.** Money (cash)
- **2.** Other payment methods, please specify: ____________________

Any comments about health insurance:

____

____

____

____

ໂຄງການປັບປຸງລະບົບການລ້ຽງໝູຂອງຊາວກະສິກອນ
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IV. Interview conclusion

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

807. Are there any questions you have for us?

____

____

808. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

809. Time interview ended (24hr clock: hh-mm)

|__|__| - |__|__|

Thank you very much again.

Pharmacy/Drug Seller Interview

Interviewer instructions:

- Fill in numbers |__|__| - make sure you put a '0' if the answer is 'none' so we know the question has been answered
- Where there are choices, circle the number next to the answer given or fill in 'Other' where relevant
- Write answers on lines ______________________

I. *Interview Identification*

139. Interview date (mm-dd-yy) |__|__| -- |__|__| -- |__|__|
140. Pharmacy and interview number |__|__| |__|__|
141. Interviewer's name ______________________
142. District name and ID ______________________
143. Pharmacy name ______________________
144. GPS reading latitude (north/south) in degree with decimal
|__|__| |__|__|__|__|__|
145. GPS reading longitude (east/west) in degree with decimal
|__|__| |__|__|__|__|__|
146. Time interview started (24 hour clock: hh-mm)
|__|__| -- |__|__|

II. *Demographics*

201. Is the person being interviewed
  5. Male
  6. Female

202. Interviewee's age: _______ (years)
203. What is your job title/position?
____

204. What is your highest level of education you have completed?
  1. Secondary education (high school)
  2. Certificate
  3. Diploma
  4. Bachelor's degree
  5. Masters or PhD

205. Prior to working/owning this pharmacy, did you undertake any specialist training program? (Diploma/degree level)

- **0.** No specialist training
- **1.** Yes, please specify: ______________________________

205. How long have you been working in this pharmacy?
______________________________ (Months/years)

III. Pharmacy Characteristics

301. What area(s) does this pharmacy cover? (Villages/districts)
____

302. How many staff is employed at this health centre? (Total)
____

303. Estimate how many patients come to this pharmacy (seeking treatment) on a normal day?

- **1.** Less than 20
- **2.** 20 – 50
- **3.** 50 – 100
- **4.** More than 100

304. What types of medications/drugs do you sell? (Check all that apply)

- **1.** Traditional medicine
- **2.** Vitamins
- **3.** Antibiotics
- **4.** Anti-malarials
- **5.** Painkillers
- **6.** Paracetamol (fever)
- **7.** Steroids
- **8.** Vaccines
- **9.** Other, please specify:
____
____

305. In your opinion, what are the most common reasons (symptoms) people come to this pharmacy?
____
____
(Prompt if necessary – maternity reasons, trauma, infections, etc)
(Tick here ______ if prompt necessary)

306. Name the 3 most common infections that you see.

____

____

____

307. What are the 3 most common clinical signs and symptoms of infection that patients present with?

____

____

____

(Prompt if necessary – fever, diarrhoea, vomiting, loss of consciousness, etc)
(Tick here _____ if prompt necessary)

308. What is the most commonly given medicines?

1. Traditional medicine
2. Painkillers
3. Paracetamol (fever)
4. Antibiotics
5. Antimalarial
6. Vitamins
7. Vaccines
8. Other, please specify:

____

309. If different from above (305-307), do you see patients presenting with any of the following symptoms or syndromes? (Check all that apply)

9. Acute febrile illness (38C (100.4F) or above)
10. Acute jaundice
11. CNS infection (meningitis or encephalitis or acute flaccid paralysis)
12. Fever, headaches, sweats, joint or muscle pain
13. Nausea, vomiting, loss of appetite (anorexia)
14. Enlarged tender liver (hepatomegaly) or acute liver failure
15. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis

IV. Interview conclusion

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

810. Are there any questions you have for us?

____

____

811. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

812. Time interview ended (24hr clock: hh-mm)

|__|__| - |__|__|

Thank you very much again.

Traditional Healer/Spiritual Healer/Health Volunteer Interview

Interviewer instructions:

- Fill in numbers |__|__| - make sure you put a '0' if the answer is 'none' so we know the question has been answered
- Where there are choices, circle the number next to the answer given or fill in 'Other' where relevant
- Write answers on lines ________________________

I. *Interview Identification*

147. Interview date (mm-dd-yy) |__|__| -- |__|__| -- |__|__|
148. Interview number |__|__|__|__|
149. Interviewer's name ____________________________
150. District name and ID ____________________________
151. GPS reading latitude (north/south) in degree with decimal
|__|__| |__|__|__|__|__|
152. GPS reading longitude (east/west) in degree with decimal
|__|__| |__|__|__|__|__|
153. Time interview started (24 hour clock: hh-mm)
|__|__| -- |__|__|

II. *Demographics*

206. Is the person being interviewed
7. Male
8. Female
207. Interviewee's age: _______ (years)
208. What is your highest level of education you have completed?
1. Primary education
2. Secondary education (high school)
3. Certificate
4. Diploma
5. Bachelor's degree
6. Masters or PhD
206. How long have you been a traditional healer?
__________ (Months/years)

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ONEHEALTH - SMALLHOLDER PIG SYSTEMS PROJECT

THE UNIVERSITY OF EDINBURGH

III. Village Characteristics & Health beliefs

310. What are the most common reasons people come to see you?

____

____

____

____

(Prompt if necessary – maternity reasons, trauma, infections, etc)

(Tick here ______ if prompt necessary)

311. How do people believe they get sick?

____

____

____

____

312. How do people believe they get healed?

____

____

____

____

313. Are there reasons why someone in the community would not seek treatment when they are sick?

____

____

____

____

314. Estimate how many patients come to see you to seek treatment on a normal day?

5. Less than 20
6. 20 – 50
7. 50 – 100
8. More than 100

315. What types of medicine do you prescribe/sell?

____

____

____

____

316. What are the 3 most common infections that you see.

____
____
____
____
____

317. What are the 3 most common clinical signs and symptoms of infection that patients present with?

____
____
____
____
__________________(Prompt if necessary – fever, diarrhoea, vomiting, loss of consciousness, etc)
(Tick here _____ if prompt necessary)

318. If different from above (305-307), do you see patients presenting with any of the following symptoms or syndromes? (Check all that apply)

16. Acute febrile illness (38C (100.4F) or above)
17. Acute jaundice
18. CNS infection (meningitis or encephalitis or acute flaccid paralysis)
19. Fever, headaches, sweats, joint or muscle pain

20. Nausea, vomiting, loss of appetite (anorexia)

21. Enlarged tender liver (hepatomegaly) or acute liver failure

22. Seizures (fits), change in mental state (from confusion to loss of consciousness), uncontrollable shaking of body parts (tremors), stiffness or paralysis

IV. Interview conclusion

We would like to thank you very much for your time and for this useful information. We hope it will help to plan good disease control work both for people and for their livestock.

813. Are there any questions you have for us?

____

____

814. Are there any other comments you would like to make or anything for us to tell the people we are working for?

____

____

815. Time interview ended (24hr clock: hh-mm)

|__|__| - |__|__|

Thank you very much again.