School of Public Health

Risk Factors for Leptospirosis and the Impact of an Intervention to Reduce Exposures

Mateus Sakundarno Adi

This thesis is presented for the Degree of
Doctor of Philosophy
of
Curtin University

October 2013

Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature: …….

Date: ……...

Acknowledgements

I would like to extend my sincere thanks to my supervisor, Associate Professor Dean Bertolatti, and my associate supervisors, Professor Bruce Maycock, Professor Jeffery Spickett, and Professor Satvinder Dhaliwal, for their valuable guidance, advice, and encouragement throughout the process of developing and implementing the research and writing this thesis.

I would also like to express my gratitude to:

- The Directorate General of Higher Education, the Ministry of Education and Culture of the Republic of Indonesia for the post graduate scholarship that has been given.
- The head of Diponegoro University and the dean of Faculty of Public Health Diponegoro University for granting the permission to pursue doctoral study, and providing facilities to conduct the research in Demak district.
- Demak district government for granting the permission to conduct the research in Demak district areas. I am also grateful to the assistance provided by Mr. Solikhin, Ms. Saryati, and Mr. Suyoto in the study location. A special thanks to Mr. Khafidin for the wonderful friendship and loving assistance during planning and implementation of an intervention in Kembangan village.

I wish to thank Mr. Arie Wuryanto, Ms. Praba Ginanjar, Mr. Samsulhuda, Mr. Budiono, Mr. Bagoes Widjanarko, Mr. Suhartono, and other colleagues in the Faculty of Public Health Diponegoro University for their assistance to make this research possible to be undertaken in Demak district.

In preparation of the text, I wish to thank Ms. Ilsa Sharp for assisting with editing and proofreading of this thesis.

Finally, I would like to thank my parents, Moerdjono Tjitrodirdjo and Siti Sudarsih, and my parents in-law, Martin Wauran and Rochnika for their loving encouragement and support throughout my study. Last but not least, my heartfelt thanks to my loving wife,

Martini Adhiningsih Wauran, and my wonderful children, Adhika Ysabel Nindiakirana and Amadeo Dharmestha Tjitrowerdoyo, who have been patiently there for me and giving support throughout the long process in completing this PhD program.

Abstract

Background: Human leptospirosis exists in Indonesia, and the number of cases in humans is increasing. Efforts to prevent or reduce the occurrence of human leptospirosis have been made in Indonesia; however, these activities have suffered from a lack of coordination and integration, and have not been planned systematically, nor objectively evaluated. Among the key information inputs required to support and justify interventions designed to prevent or reduce the occurrence of human leptospirosis is evidence of specific local risk factors. However, in Indonesia, particularly in rural areas where leptospirosis is endemic, there is little or no available information about local leptospirosis risk factors. On the other hand, local and district health institutions are under pressure to take immediate action to prevent or reduce the occurrence of human leptospirosis. Therefore, obtaining rapid information on local leptospirosis risk factors is vital to support any intervention for leptospirosis control in leptospirosis-endemic areas, in the context of a paucity of existing data on local leptospirosis risk factors.

Objectives: The aim of this study was to investigate existing leptospirosis risk factors in order to develop an intervention program in a leptospirosis-endemic area, operating within the context of a paucity of existing leptospirosis risk factor data. This study was conducted in the Demak district of Central Java, one of Indonesia's leptospirosis-endemic districts. The study was designed with two phases. In the first phase, the general objective was to investigate the existing data and identify leptospirosis risk factors in the target endemic area with a paucity of available risk factor data. The general objective of the second phase was to investigate how the identified leptospirosis risk factor data might contribute to the development of an intervention program. Three specific objectives were investigated in the first phase, and two specific objectives were investigated in the second phase.

Methods: In the first phase, the first specific objective was the review and synthesis of available data on leptospirosis risk factors already reported in grey literature and in international peer-reviewed sources. The second specific objective was to undertake in-

depth interviews of key local informants and apply content analysis to the completed interviews. To achieve the third specific objective in this first phase, the study investigated environmental and behavioural factors as related to leptospirosis transmission observations. In the second phase, the first specific objective was to conduct a knowledge, attitude, and practice (KAP) survey of 304 respondents regarding leptospirosis risk factors and prevention. In the final stage of the study, the second specific objective under the second phase was to implement an intervention in the Demak district: the village of Kembangan was selected for the actual intervention , while the village of Bumirejo was chosen as the control site for comparison. The objective of the intervention was to promote knowledge of leptospirosis risk factors and to reduce the risk of exposure in the village of Kembangan.

Results: Specific and non-specific local leptospirosis risk factors in Demak district were identified. Specific local risk factors were: stagnant water in areas surrounding houses; poor home sanitation; the presence of rats; human contact with stagnant water; bathing in rivers or ponds; washing clothes in rivers or ponds, and walking barefoot. Results of the knowledge, attitude, and practice (KAP) study confirmed the presence of some potential local risk factors for human leptospirosis, as reported in a review of previous leptospirosis risk factor studies and in an in-depth interview. Key informants also reported insufficient knowledge about leptospirosis, and community activities entailing human contact with water and animals in the investigated leptospirosis-endemic area of Demak district. The study's observations and findings are consistent with the results of previous leptospirosis risk factor studies in Demak district. However, previous leptospirosis risk factor studies did not record that numerous rats' burrows are found in the paddy fields, that bovine excreta are discharged directly into the village water drains, or that local people give their water buffaloes and goats regular baths. Results of the intervention in Demak district showed increased awareness among people in the target group, of leptospirosis risk factors (+37.5%), of leptospirosis prevention methods (+53.3%), and of the benefits of leptospirosis prevention (+9.8%); they also showed a decrease in the percentage of people failing to check for skin lesions before working in aquatic locations (–34.2%).

Conclusion: In leptospirosis-endemic areas with a paucity of available risk factor data, existing local risk factors for leptospirosis can be identified by implementing a review of previous studies; conducting in-depth interviews with key local informants; observation of local environmental and behavioural factors, and conducting KAP surveys. The local risk factors for leptospirosis and local observations identified during these activities constitute important contributions to the development of an intervention to reduce leptospirosis transmission to humans.

Table of Contents

List of Figures

List of Tables

Abbreviations

CAAT	Cross Agglutination Absorption Test
CFR	Case Fatality Rate
DALY	Disability-Adjusted Life Year
DNA	Deoxyribonucleic acid
ELISA	Enzyme-linked Immunosorbent Assay
EMJH	Ellinghausen-McCullough-Johnson-Harris
IFA	Immunofluorescence assay
Ig	Immunoglobulin
IHA	Indirect Hemagglutination Assay
KAP	Knowledge, attitude, and practice
LERG	Leptospirosis burden epidemiology reference group
LPS	Lipopolysaccharides
MAT	Microscopic Agglutination Test
PCR	Polymerase Chain Reaction
pH	Power of hydrogen
QUALY	Quality-Adjusted Life year
RIA	Radioimmunoassay
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization
YLD	Year lost due to disability
YLL	Year of life lost

CHAPTER 1
INTRODUCTION

This chapter presents a synopsis of the study. It covers the study's background, research objectives, scope and significance, and finally, the organisation of the thesis.

1.1. Background

'Leptospirosis' refers to a group of zoonotic bacterial diseases (zoonosis) caused by pathogenic leptospires that belong to the genus *Leptospira*, falling under the family Leptospiraceae and the order Spirochaetales. [1, 2] Pathogenic *Leptospira* species are subdivided into serovars, of which there are over 250.[1, 3] Leptospires live in natural hosts or in accidental hosts. In natural hosts, pathogenic *Leptospira* reside in the proximal renal tubules of carriers' kidneys and are subsequently excreted in urine; the hosts do not become ill, but the infection is maintained. Accidental hosts often become ill when infected by pathogenic leptospires.[4] Small mammal species (e.g. peridomestic rodents and wild small mammals like racoons,) and domestic animals (cattle, pigs, dogs, etc.) are possible sources of leptospirosis infection in humans.[4] Infection of humans by leptospires is effected primarily through humans' direct and indirect exposure to the urine or tissues of infected animals. Direct transmission occurs when leptospires in the urine, body fluid, or body tissues of infected animals contact and enter new hosts, whether animals or humans. Direct transmission usually occurs among animals, e.g. in the form of transplacental transmission, the suckling of an infected mother's milk, or sexual contact. Indirect transmission occurs when leptospires in contaminated environments such as contaminated water or mud infect animals or humans.[2, 5] In humans, the usual points of entry for leptospires are cuts and abrasions of the skin, mucous membranes, or waterlogged skin.[4]

Clinical manifestations of leptospirosis vary and resemble the clinical manifestations of other diseases, especially tropical diseases.[1, 2, 4] An influenza-like illness is the most frequent clinical manifestation found in the early stage of leptospirosis. In more severe

cases, jaundice, renal failure, meningitis and pulmonary haemorrhage will manifest, and the illness may end with respiratory failure.

As the disease is often characterised by a wide variety of clinical signs, diagnosis of leptospirosis can be difficult. Hence a range of specific microbiological tests is necessary to confirm that a patient is infected. Leptospires can be detected by using several methods: visualisation of the leptospires using a dark field microscope; staining methods; isolation and identification; molecular detection of leptospires, and serological methods.[1, 6] Serological methods include the microscopic agglutination test (MAT); indirect haemagglutination assay (IHA), or immunoenzymatic assay (ELISA). MAT is able to detect leptospire serovars and is considered to be the definitive serological test for leptospirosis.[1, 2, 6] However, specific skills and a particular laboratory facility are required to perform and to interpret this test. Only a few laboratories can perform MAT. Molecular techniques may therefore become the main option for leptospirosis diagnosis in the future.[7, 8]

The variability of clinical manifestations of leptospirosis and the complexity of current serological tests for diagnosing leptospirosis are among the reasons for this disease being overlooked and under-reported in many parts of the world. Additionally, in areas of endemic leptospirosis, most infections are clinically cryptic or too mild to be diagnosed definitively.[9] This may cause many cases to be misdiagnosed. Hence data on the incidence and prevalence of leptospirosis worldwide are insufficient.[10]

Leptospirosis is common in tropical and subtropical areas. Southeast Asia, Oceania, the Caribbean, Central and South America are areas where leptospirosis is endemic.[10] A study by Victoriano et al. (2009), showed the current trend of leptospirosis epidemiology in the Asia-Pacific region. The leading leptospirosis-endemic areas are in Southeast Asia and Oceania. In Australia and New Zealand, leptospirosis is mostly an occupational disease, occurring among agricultural workers exposed to livestock. In Japan, leptospirosis is considered a recreational disease, (i.e. a disease that is transmitted during recreational activities), or one that it is imported from Southeast Asian countries.[11]

Reports from several parts of the world indicate that the leptospirosis case fatality rate (CFR) is in the range of 5%–30%.[4, 12]

The occurrence of leptospirosis in a local area, a country, or in the world is the result of a specific chain of infection that involves many factors: infectious agents, a transmission process, hosts, and environmental factors.[13] For the transmission process to take place, exposure to an infectious agent must occur in a susceptible host. Infectious agents usually present in specific substances or reservoirs.

An infectious agent reservoir can be human or animal. Exposure to leptospires can result from activities that facilitate contact between a susceptible host and the infection reservoir or infected substances. Such activities include washing or bathing in rivers, walking in flooded areas, and cleaning sewers or drains that are known to host substantial rat populations. Host factors are the particular characteristics of a person or an animal that enable or provide a suitable place for the infectious agent to enter and grow. The host's immune system is very important in determining his/her/its reaction to infection.[1, 2] Environmental factors, including physical, biological, chemical and social factors, in turn influence all other factors associated with the chain of infection.[13] In short, the main factors related to the occurrence of infection are agent-related, host-related, and environment-related.[13, 14]

Factors or conditions that increase the chance of a person becoming infected or developing the disease are considered to be risk factors for infection or risk factors for disease in humans.[15] Risk factors for leptospirosis can be grouped into three main categories: animal, environmental, and human.[2, 16] Activities in wet places or occupational contact with water, the existence of skin wounds and the presence of rats in the home are the main risk factors for leptospirosis found in developing countries such as those in Southeast Asia, India and South America.[9, 17-24]. In developed countries, the occurrence of leptospirosis usually is related to occupation or recreation.[10, 11, 25]

1.2 Research issues

Information on the incidence, prevalence, chain of infection, and risk factors of leptospirosis is important for conducting preventive or control actions. In the public health field, such actions mostly deal with the identification of sources of infection and the control of disease transmission; while the clinical field pays more attention to the interaction between infectious agents and humans as hosts.[26] The focus of leptospirosis prevention or control programs is to avoid direct contact or minimise the risk of indirect contact with sources of infection, while adopting control measures that show benefit in reducing leptospirosis transmission to humans.[2, 26]

Information on the sources of infection, risk factors for leptospirosis, and previous control measures that have shown benefit in reducing leptospirosis transmission to humans is mostly obtained from the results of leptospirosis studies. However, few studies of risk factors for leptospirosis infection in humans in developing countries are to be found in international peer-reviewed journals. Possible reasons for this may be that there are few human leptospirosis risk factor studies conducted in developing countries; that few human leptospirosis risk factors studies from developing countries fulfil the requirements for publication in international peer-reviewed journals; that researchers in developing countries have limited or no access to such journals and therefore tend not to submit papers to them for publication; or simply that worldwide there are few published articles focusing on issues related to risk factors for leptospirosis infection in humans in developing countries.

The scarcity of reliable leptospirosis data is likewise an issue in Indonesia, a leptospirosis-endemic country. The annual incidence of leptospirosis in Indonesia is still unknown. The number of human leptospirosis cases reported annually to the Ministry of Health during 2007–2011 was as follows, shown together with the reported case fatality rates.[27, 28]

Table 1.1 Reported Leptospirosis cases in Indonesia

Year	Human leptospirosis cases reported to Ministry of Health	Case fatality rate %
2007	664	8.28
2008	426	5.16
2009	335	6.87
2010	409	10.51
2011	857	9.57

These annual figures were based on data reported by only a few of Indonesia's currently declared 34 provinces.

The actual number of leptospirosis cases in Indonesia is possibly higher than the reported cases, due to under-reporting. Under-reporting leptospirosis cases occurs possibly because leptospirosis is often confused with other endemic diseases, and also because there are few laboratory centres in the country able to perform diagnosis tests for leptospirosis, since current diagnosis tests for leptospirosis involve very costly equipment and require a relatively high microbiological skill set.

The number of studies on leptospirosis in Indonesia can be considered few compared to the number of studies on other communicable diseases such as dengue haemorrhagic fever, malaria, and tuberculosis. Studies of leptospirosis conducted in Indonesia and published internationally deal more with the clinical and laboratory aspects of the disease than public health aspects. Leptospirosis risk factor studies nonetheless are conducted relatively more frequently in Indonesia than other types of public health studies of leptospirosis. However, a number of leptospirosis risk factor studies undertaken in Indonesia lack diagnostic confirmation.[18, 29-36] Just a few risk factor study results have been published in international peer-reviewed journals, and a number of

other study reports focusing on risk factors for leptospirosis infection in humans are found in grey literature. This grey literature is usually found in local university libraries and in libraries housed at local district health institutions.

A small number of local leptospirosis risk factor study reports submitted to the local district health office can be found in the primary health care centres (*puskesmas*—for *Pusat Kesehatan Masyarakat*) located in leptospirosis-endemic areas. These primary health care centres act as front-line health institutions for conducting leptospirosis prevention or control programs in the sub-district area. Many leptospirosis-endemic areas within sub-districts are located in rural or remote areas. Hence data about local leptospirosis risk factors in these endemic areas often are insufficient or inadequate.

Local leptospirosis risk factor data are required for effective leptospirosis prevention and control programs. The Indonesian government and related institutions began to pay more attention to leptospirosis prevention and control after a leptospirosis outbreak in Jakarta in 2002. Activities to prevent and control leptospirosis transmission to humans have been initiated. These activities are generally related to the prevention or reduction of leptospirosis risk factors. National and district health officers, in collaboration with local health centre staff members, have conducted epidemiological investigations in the areas where leptospirosis cases reside, have conducted local intervention programs, and have given information to local communities on the danger of leptospirosis, risk factors for leptospirosis, and leptospirosis prevention.[37, 38] Although it is known that prevention and control of leptospirosis should be a multi-sector activity, in reality these activities still lack multi-sector coordination and integration in the field.[39] In addition, activities or interventions to prevent or control leptospirosis infection in humans in Indonesia have not been systematically planned or evaluated. Although Indonesia's Ministry of Health has published guidelines for diagnosis, case management and control of leptospirosis,[40] the implementation of these guidelines has been variable among provinces and district health offices due to the variable nature of existing human resources and facilities.

Problems arise when the need for action on the control or prevention of leptospirosis transmission in endemic areas is urgent, yet risk factor data in rural or remote leptospirosis-endemic areas are insufficient or inadequate. Such data are needed quickly if an effective intervention programs is to be developed. Consequently, an approach to the provision of leptospirosis risk factor information in endemic areas with insufficient or inadequate leptospirosis risk factor data is required.

To provide sufficient leptospirosis risk factor data for the development of intervention programs in leptospirosis-endemic areas with a paucity of risk factor data, the evidence-based public health approach[41-43] and 'Precede-Proceed' model[44] have been applied during this study, with modifications. Methods investigated and discussed include the identification of local leptospirosis risk factors using available sources of information. Also discussed are the implications of using existing leptospirosis-related risk factor data for the development of a public health intervention to reduce exposure to leptospirosis risk factors in endemic areas where there is a paucity of available risk factor data.

1.3 Research objectives

The main objective of this research has been to investigate available leptospirosis risk factor data for the purpose of developing an intervention program in a leptospirosis-endemic area with a paucity of leptospirosis risk factor data: two general objectives and five specific objectives were proposed.

1.3.1 General objectives

Objective 1:
To investigate the availability of leptospirosis risk factor data and identify social, behavioural, and environmental factors that could be related to the occurrence of leptospirosis in humans.

Objective 2:
To investigate the potential contribution of the available leptospirosis risk factor data to the development of an intervention program by means of designing, implementing, and evaluating an intervention to reduce exposure to leptospirosis risk factors in a leptospirosis-endemic area.

1.3.2 Specific objectives

To investigate the availability of data and identify leptospirosis risk factors in the endemic area with a paucity of risk factor data, three specific objectives were proposed:

Specific objective 1a:
To review and synthesise data associated with leptospirosis risk factors reported in grey literature and in international peer-reviewed sources, and to identify the distribution of similarities and differences in risk factors for leptospirosis in Indonesia and in the Asia-Pacific region.

Specific objective 1b:
To obtain and synthesise information on the social and behavioural characteristics of communities as related to leptospirosis in leptospirosis-endemic areas.

Specific objective 1c:
To obtain and evaluate more detailed information on environmental factors and community behaviour as related to leptospirosis risk factors in leptospirosis-endemic areas

To investigate the suitability of the available leptospirosis risk factor data for the purpose of developing an intervention program, two specific objectives were proposed:

Specific objective 2a:
To identify and evaluate the knowledge, attitudes, and practices of members of the community regarding leptospirosis risk factors and the prevention of leptospirosis in endemic areas.

Specific objective 2b:
To promote knowledge of leptospirosis risk factors, and to reduce risk exposure among people aged 18 years and older living or working in leptospirosis-endemic regions of Demak district in Central Java, Indonesia.

1.4 Scope of the study

The study of leptospirosis is multifaceted, including human, animal, clinical, public health, and laboratory dimensions. This study focuses on leptospirosis in humans and the public health aspects of the disease in developing countries. Furthermore, the specific focus of this study is risk factors for leptospirosis infection in humans as related to the development of an intervention program to reduce exposure to those risk factors in a leptospirosis-endemic area with insufficient or inadequate risk factor data.

This study was conducted in Indonesia, specifically in '*kabupaten* Demak' (the district of Demak), Central Java province. Central Java is an Indonesian province with an increasing number of annually reported leptospirosis cases.[45] Demak district is an area that contributes significantly to the leptospirosis cases recorded in Central Java province.[46]

1.5 Significance of the study

The paucity of leptospirosis risk factor data limits the opportunity to effectively manage leptospirosis in Indonesia. Thus it is important to better understand the leptospirosis risk factors (social, behavioural, and environmental) associated with the continued presence of leptospirosis. This study will contribute new knowledge that will assist in implementing proactive prevention strategies for reducing exposure to the risk factors for leptospirosis.

This study is significant to health programmers working on leptospirosis prevention locally, nationally and internationally. It develops a leptospirosis KAP (knowledge, attitude and practice) survey, a risk factor assessment guide for assessing leptospirosis risk factors in an endemic area with insufficient or inadequate risk factor data, and develops an intervention program to reduce exposure to leptospirosis risk factors. The study tests a leptospirosis KAP survey that can be used for other similar surveys in Central Java province or throughout Indonesia. The local leptospirosis risk factor identification procedure used in this study can also be adopted, modified and used anywhere in the world. The methods used and the results of the intervention program will provide important inputs and basic information for further research and for control methods in the field of leptospirosis prevention or in general infectious diseases prevention.

1.6 Organization of the thesis

This research was conducted in two phases: phase one, the risk factors study entailing identification of local leptospirosis risk factors and phase two, an intervention study encompassing the development and implementation of an intervention program to reduce exposure to leptospirosis risk factors.

The thesis is divided into six chapters. The objectives for each chapter are as follows:

- **Chapter 1**: to introduce the background of the study including research issues, research objectives, the scope of the study, the significance of the study, and the organisation of the thesis;
- **Chapter 2:** to present an overview of the history, causal agents, pathogenesis and clinical manifestations as well as diagnosis of leptospirosis; the epidemiology and transmission of leptospirosis; risk factors for leptospirosis in humans; prevention and control of leptospirosis in humans;
- **Chapter 3:** to describe the methods used in the investigation of the availability of leptospirosis risk factor data, and in the investigation of the suitability of the available risk factor data for the purpose of developing an intervention program to reduce exposure to leptospirosis risk factors in an endemic area of Indonesia
- **Chapter 4:** to present study findings;
- **Chapter 5:** to discuss the identification of local leptospirosis risk factors using available sources of information, the implications of using existing leptospirosis-related risk factor data for developing a public health intervention to reduce exposure to leptospirosis risk factors, and the impact of an intervention to reduce exposure; limitations of the study;
- **Chapter 6:** to present the conclusions and recommendations of the study.

CHAPTER 2
LITERATURE REVIEW

This chapter presents an overview of risk factors for human leptospirosis infection and previous actions or programs to prevent or control those risk factors. The history of leptospirosis and an account of leptospirosis causal agents, pathogenesis and clinical manifestations are presented before describing diagnostics for leptospirosis in humans. The following sections review the epidemiology and transmission of human leptospirosis, together with the risk factors, prevention and control of human leptospirosis. Finally, the study's final conclusions are presented.

2.1 History, causal agents, pathogenesis and clinical manifestations

This section presents a brief history of the discovery of leptospirosis and reviews the literature focusing on Leptospira *as the causal agent of leptospirosis, its pathogenesis and the clinical manifestations of leptospirosis in humans.*

2.1.1 History of leptospirosis

The history of the formal study of leptospirosis began when Adolf Weil published a report in 1886 regarding an acute infectious disease characterised by tumours of the spleen, and by jaundice and nephritis. This disease became known later on as 'Weil's disease'.[47] The connection between this disease and leptospires had already been identified in the early 20th century.

The first search for the causative agent in Weil's disease was conducted by Stimson (1907). He was the first expert to observe and report the organism in a group of spirochaetes found in the kidneys of a patient who had died with jaundice. He suggested naming this organism *Spirochaeta interrogans* because its shape resembled a question mark.[48] Two researchers from Japan, Inada and Ido, published an article in 1915 that announced the causative agent of Weil's disease. They called this causative agent *Spirochaeta ichterohaemorrhagiae*.[47, 49] At the same time but independently, European experts Uhlenhuth and Fromme published findings similar to those of Inada and Ido.[47]

In 1918, H. Noguchi named this bacterium *Leptospira*, and *Leptospira* was then included in the order Spirochaetales. In 1927, Schuffner announced the official confirmation of the name *Leptospira*. Sellar was the first person to announce, in 1940, that Stimson's *Spirochaeta* description corresponded to *Leptospira*.[47]

2.1.2 *Leptospira* spp.

The name *Leptospira* was introduced by Noguchi, in 1918, to differentiate the genus from other genera in the family Leptospiraceae, under the phylum Spirochaetes. The genus *Leptospira* consists of both saprophytic (non-pathogenic) and pathogenic species.[2] Prior to 1989, based on serological classification, *Leptospira* traditionally was classified into two species, *L. interrogans* and *L. biflexa*.[50] Based on their antigenic relatedness (structural heterogeneity in the carbohydrate component of the lipopolysaccharides (LPS) of leptospires), *Leptospira* species have been divided into several serovars using the cross agglutination absorption test. More than 250 serovars of pathogenic species and 60 serovars of non-pathogenic species have been recognised.[3, 50, 51] Serovars with antigens in common are grouped into the same serogroups.

For pathogenic species of *Leptospira* 26 serogroups have been described.[51] Identification of serovars is important for understanding aspects of the epidemiology of the disease, such as host preferences and transmission pathways.[2, 3, 50, 52]

With the development of molecular technology, the use of DNA relatedness to achieve species determination for *Leptospira* is also increasing. Over the past 5 years, at least 20 species of *Leptospira* have been described by means of charting DNA relatedness; they comprise eight pathogenic species, five intermediate species, and seven non-pathogenic species .[3]

Table 2.1 Serological (serogroups) and genotypic (species) classification of *Leptospira* spp.

Serogroup	Species																				
	L. interrogans	*L. kirschneri*	*L. noguchii*	*L. borgpetersenii*	*L. weilii*	*L. santarosai*	*L. alexanderi*	*L. alstonii*[b]	*L. wolffii*[c]	*L. licerasiae*[d]	*L. inadai*	*L. fainei*	*L. broomii*[e]	*L. kmetyi*[f]	*L. wolbachii*	*L. meyeri*	*L. biflexa*	*L. vanthielii*[b]	*L. terpstrae*[b]	*L. yanagawae*[b]
	Pathogens group							Intermediates group						Saprophytes group						
Andaman																1				
Australis	9	1	5	1																
Autumnalis	10	5	1	1		1														
Ballum				6																
Bataviae	5	1	2	1		5														
Canicola	11	3									1									
Celledoni				2	3															
Codice															1					
Cynopteri		1				3														
Djasiman	4	1	1																	
Grippotyphosa	3	4				1														
Hebdomadis	2	2		4	1	7	2													
Holland																		1		
Hurstbridge										1		1								
Icterohaemorrhagiae	14	5			1						1								1	
Javanica				9	3	3	1				1					1				
Lyme											1									
Louisiana	1		3																	
Manhao	1				2		2				2									
Mini	2			1	1	4	1									1				
Panama			2																	
Pyrogenes	8		1	2	1	7														
Pomona	4	3	2			2														
Ranarum	1							1								1				
Sarmin	1				1	3														
Sejroe	12			9	1	6										1				
Semaranga																1	1			1
Shermani			1			3					1									
Tarassovi			1	7	3	12					1			1						
Undesignated								1	1				1							

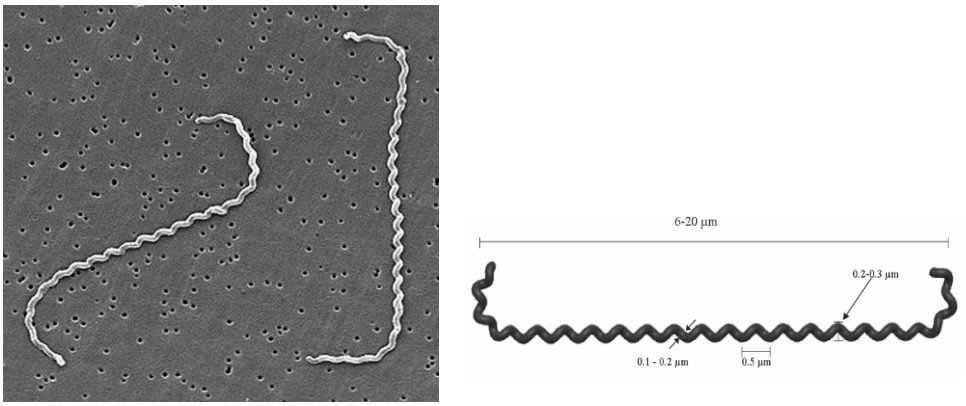
P=pathogens, I=intermediates, S=saprophytes.
[a] Based on Levett (2001).
[b] Recognized nomenclature for genomospecies 1, 3, 4 and 5.
[c] No cross-reaction, based on Slack et al. (2008).
[d] Titre of 1/100. Matthias et al. (2008).
[e] Undetermined, based on Levett et al. (2006).
Numbers represent serovars per serogroup and species. A total of 282 serovars were identified.
[f] Based on DNA hybridization data, Slack et al. (2009).

(adapted from Cerqueira GM, *Infection, Genetic and Evolution* vol.9, 2009, p. 762)

Experts agree that serological classification and genotypic classification do not correlate well; for example, a number of serovars in a given serogroup are found in several *Leptospira* species.[3, 6, 12, 50, 52, 53]

Leptospires are thin, helical, and motile organisms with a diameter of 0.15 micrometres (µm). They are about 10 µm to 20 µm long, and hooked at one or both ends.[1, 2] The main structural components of a leptospire include the outer envelope with the outer peptidoglycan complex, cell contents, and two periplasmic flagella.[50] The outer envelope consists of protein, lipids, and LPS. The LPS are associated with various antigens. The peptidoglycan complex forms a cell wall located beneath the leptospire's outer envelope, separated from that outer envelope by a periplasmic space. The

peptidoglycan stimulates phagocytosis and the production of cytokines in human monocytes. Cell contents include fibrillar material, nuclear material, and mesosomes. Each leptospire has two flagella; these flagella arise at each end of the leptospire, a unique feature of leptospires.



(a) (b)

Figure 2.1 Leptospires

(a: adapted from Levett, *Clinical Microbiology Review,* vol.14, no.2, 2001, p.299; b: adapted from Schreier, *Biol Res 42,* 2009, p. 6)

Optimal growth in leptospires occurs at 28–30°C, in the pH range 7.2–7.6, and in aerobic conditions. Leptospires grow well in a medium enriched with vitamins B1 and B12. Pathogenic leptospires will not grow at 13°C. Leptospires survive in aquatic or wet environments (streams, rivers, ponds, flood water and stagnant water), and in alkaline conditions with pH up to 7.8—7.9, such as alkaline soil, mud, swamps, and the body tissues of live or dead animals. In a protein-containing environment, leptospires are able to survive in temperatures below freezing. They will not survive in dry conditions, in temperatures above 41º–42°C, or at pH 6.8 or lower. Agents that remove the outer envelope of the leptospire, such as lipid detergents or soaps, are lethal to the bacteria.[2]

2.1.3 Pathogenesis and clinical manifestations of leptospirosis

The pathogenesis of a disease is the causal-agent mechanism and process through which that disease is produced.[15] Pathogenesis of leptospirosis in humans begins when leptospires enter human bodies through skin abrasions and mucous membranes. The

leptospires disseminate quickly in the human body by crossing tissue barriers and by travelling through the blood stream (leptospiraemia), to cause a systemic infection. During the leptospiraemia period, the blood of the infected host can be used for bacterial culture or for other methods of examining for leptospires. In the early stage of infection, leptospires evade the host's innate immune response, and indeed pathogenic leptospires are resistant to the innate immune system. Leptospires in the blood stream (leptospiraemia), tissues and organs, are lost after the host's acquired immune response becomes effective, about one to two weeks after exposure to the leptospires.

In maintenance (reservoir) animals, the renal tubule is a favoured place for pathogenic *Leptospira* spp. to congregate; thus pathogenic leptospires have the ability to generate persistent renal carriage. These leptospires are able to suppress the expression of proteins thus avoiding recognition by the humoural immune response of the maintenance host. In contrast, in humans (as incidental hosts), pathogenic *Leptospira* spp. do not induce a carrier state.[52] In humans, it is when the human host's antibodies appear and leptospires have been cleared from the blood stream that the clinical manifestations of the disease usually emerge.

The disease's clinical manifestations arise after an incubation period of 5–14 days on average, with a range of 2–30 days.[2] The incubation period is related to and indicative of the degree of pathogenicity in *Leptospire* spp. The pathogenicity of *Leptospire* spp. is related to host susceptibility factors, the dose of leptospires entering the host, and the virulence of the infecting species and serovars. Certain pathogenic species and serovars are found to cause more severe disease in humans than others.[2, 52-55]

In the early phase of the disease, an influenza-like illness is the most frequent clinical manifestation, characterised by fever, headache and myalgia, especially in the calf muscles. It is often difficult to differentiate leptospirosis in this phase from other acute fever diseases such as dengue hemorrhagic fever and malaria. In most cases (about 90%), the symptoms of this phase last about a week; the remaining 5–15% of cases fall into the category of late-phase manifestations of the disease, often with severe

manifestations such as conjunctival suffusion, cardiac arrhythmia, skin rash, jaundice, renal failure, meningitis and pulmonary haemorrhage. This phase may end with respiratory failure.[2, 52]

In short, the spectrum of leptospirosis infection manifestations includes subclinical or very mild illness with no clinical manifestation, mild illness with flu-like symptoms, and severe illness with severe manifestations.[50]

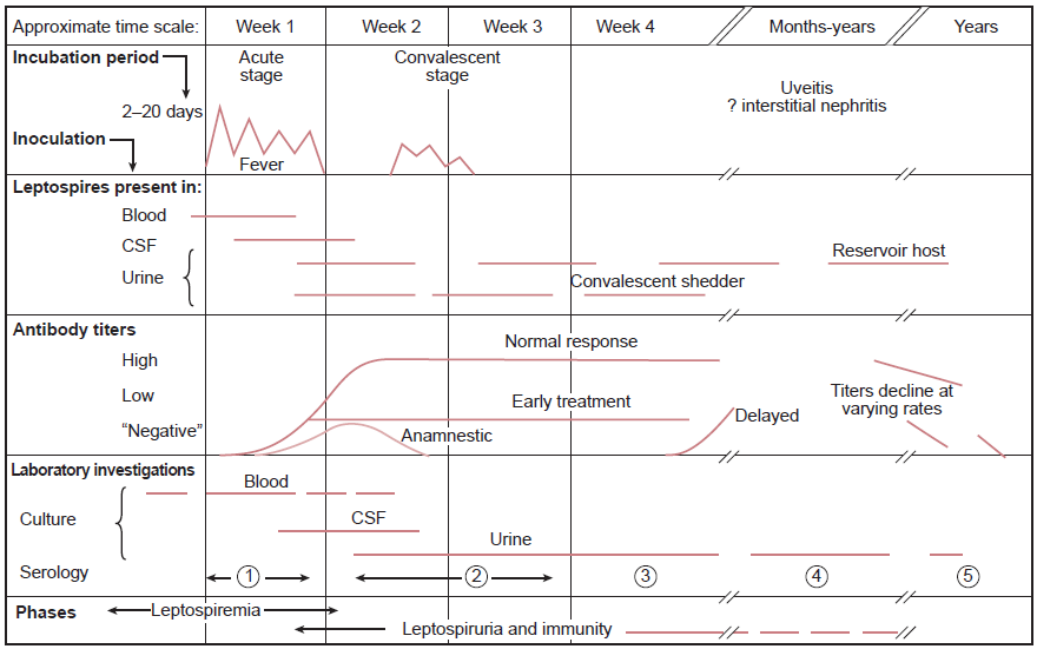


Figure 2.2 Natural history, host antibody and laboratory investigations of leptospirosis (adapted from Levett, *Clinical Microbiology Review*, vol.14, no.2, 2001, p.303)

2.2 Diagnosis

This section presents a variety of laboratory methods for confirmation of human leptospirosis infection. Criteria for diagnosing human leptospirosis infection and disease are presented in the diagnosis sub-section.

2.2.1 Diagnostic methods

As leptospirosis is often difficult to differentiate from other diseases due to a wide variety of clinical signs or symptoms especially in the early phase, specific

microbiological tests are necessary to confirm that a patient is infected by *Leptospira* spp.

Several laboratory-based methods are available for the detection of *Leptospira* spp. in humans. These methods include direct examination, culture, serological and molecular methods.

Detection of leptospire infection in humans can be achieved by observing leptospires in clinical materials such as blood, cerebrospinal fluid, urine, and tissues. Leptospires can be observed by direct observation using a dark field microscope. However, this method offers low sensitivity: hence false interpretations due to the presence of fibrin or other proteins that are misclassified as leptospires often occur. Furthermore, this method is affected by the timing of the sample collection: leptospires can be detected in the blood only during the leptospiraemia phase of the disease, hence the examination should be performed during that phase.[2, 51]

Direct observation using a dark field microscope is also the method for examining the result of leptospire cultures. Leptospires can be isolated from blood during leptospiraemia for blood culture, or from urine for urine culture. Suitable culture media for leptospires are the Ellinghausen-McCullough-Johnson-Harris medium and a modified Korthof medium. The culture should be incubated at 30°C for a minimum of 6–8 weeks. Leptospires grow very slowly in the medium.[2, 50, 53] Hence, although isolation of leptospires through culture is recognised as yielding a definitive diagnosis of leptospirosis, this method is not recommended for early diagnosis of leptospirosis, due to the slow growth of leptospires in cultures.[51] Serology and molecular methods are usually preferred to the culture method, in order to achieve an early diagnosis.

The principle of serological methods is the detection of an antigen-antibody reaction. This method requires the presence of antibodies and antigens from infected human bodies. Human antibodies for leptospire infection can be detected in the blood about 3–10 days after the symptoms appear.[2]

However, leptospires (antigens) in the blood stream (leptospiraemia) are lost about a week after the symptoms appear. A variety of serological tests have been applied for detecting the antibodies and antigens for leptospirosis in humans: for example, the microscopic agglutination test (MAT);[2, 56] the indirect haemagglutination assay (IHA);[57] the immunofluorescence assay (IFA);[58, 59] IgM-ELISA;[60, 61] IgM dipstick;[62] the lateral flow assay;[63, 64] complement fixation;[65] radioimmunoassay (RIA);[66] the enzyme-linked immunosorbent assay (dot-ELISA),[67] and counterimmunoelectrophoresis.[68]

Table 2.2 Laboratory methods used to detect *Leptospira* spp.

Test	Sensitivity[a,b,c]	Specificity[a,b]	Costs[d]	Advantages	Disadvantages[e]
Culture	5–50%	100%	€20[f]	Provides evidence. Veterinary and human applicability	Too slow and difficult
Dark-Field Microscopy (DFM)	10^4 bacteria/ml	Low; confusion with protein fibres	<€1	Quick and early diagnosis. Veterinary and human applicability	Unreliable, requires confirmation
Microscopic Agglutination Test (MAT)	90%	>90%	€160[f,g]	Gold standard. Veterinary and human applicability	Requires a panel of life antigens, difficult (expertise), laborious (3 h), serology. Problems with seronegative carrier animals
IgM-ELISA[h]	84%	99%	€48[f,g]	Cost effective, can be done without ELISA Reader	Laborious (4 h), serology Limited veterinary use
IgM-ELISA[i]	>90%	88–95%	€9–16[g,j]	Cost effective and relatively rapid (1–2 h)	Serology
IgG-ELISA for cattle	ca.90%	95%	€6[j]	1 h	Misses early immune response
DriDot test	82%	95%	€5–7[g,j]	Easy, quick (30 s), cost effective	Serology, needs confirmation by MAT. No veterinary use
Lateral flow test	81%	96%	€2–5[g,j]	Easy, quick (10 min), finger prick blood, cost effective	Serology, needs confirmation by MAT
Real-time PCR	100%	93%	€100[f]	Early diagnosis. Veterinary and human applicability	Few tests validated (ref 56, 57), sophisticated expensive equipment, expertise

a Several studies indicate different percentages.
b Sensitivity and specificity largely depends on a number of factors; stage of illness, type and producer of test and panel of clinical materials used for testing [6,57].
c Sensitivity of culture depends mainly on the route and transport time to the laboratory. MAT is the gold standard and should be 100%. However, when comparing with culture this gold standard appears not optimal. Sensitivities of other serological tests are compared with MAT.
d Excluding costs for equipment.
e Serology has the disadvantage that it detects antibodies 7–10 days after the onset of the disease. This is too late for antibiotic treatment, which should start within the first 4 days.
f Includes personnel costs for execution of test based on costs formally recognised by the health assurance authority in the Netherlands (2011).
g Based on performance of one test. Please notice that serological confirmation requires testing of both acute and convalescence serum samples for seroconversion or significant titre rise.
h In-house ELISA.
i Commercial ELISA.
j Costs may vary, amongst other factors, due to the subjection to different import taxes raised in distinct countries.

(adapted from Hartskeerl, *Clin Microbiol Infect*, vol.17, 2011, p. 496)

MAT is considered to be the 'gold standard' of leptospirosis serodiagnosis and currently it is still the most widely used confirmatory leptospirosis diagnosis test.[1, 4] The test provides indication of infecting serovars or serogroups. Information regarding infecting serovars or serogroups in a population is important for epidemiological investigation; this information guides the identification of reservoirs and the development of prevention and control strategies.[2, 53, 69] However, the procedures needed for conducting MAT are complex, time-consuming, and laborious, while the materials and equipment needed are also troublesome to source and expensive to acquire; therefore, to detect leptospire infection in the early phase of the disease, faster serological screening tests are the usual choice, particularly in developing countries: these include IgM-ELISA, IgM-dipstick, and lateral flow.[51, 62-64, 70] Although these tests cannot detect the details of infecting serovars or serogroups, the fact that they can be performed rapidly makes them easier to use.

Furthermore, MAT has relatively low sensitivity when it is used to test serum from patients in the acute phase, i.e. those who have had clinical signs or symptoms for five days or less.[2, 71] Thus, paired sera, with a collection-date difference of 10–14 days between them, should be provided for a definitive diagnosis of leptospirosis by MAT, and at least a fourfold increase in titre concentration has to be observed between the first and second serum samples.

Serological tests have relatively low sensitivity in the acute phase of the disease, and early diagnosis is crucial in the acute phase, to enable disease management that can prevent severe cases. There is a need for laboratory-based tests with high sensitivity in the acute early phase of the disease.

Molecular methods are sensitive for detecting leptospires in the acute early phase of the disease. A molecular method usually used for diagnosing leptospirosis is polymerase chain reaction (PCR); this method has been developed and applied over the last two decades.[12, 51, 53] PCR is known as a rapid and sensitive tool for leptospire detection, and

is useful for early diagnosis of leptospirosis. However, the limitations of PCR-based diagnosis of leptospirosis are its inability to identify infecting serovars, and the fact that it requires sophisticated and expensive equipment. In addition, PCR testing is unavailable at most health service centres in developing countries.[51]

2.2.2 Diagnosis

Diagnosis of human leptospirosis is divided into laboratory-based classification and case-based classification. Laboratory criteria for leptospirosis diagnosis include presumptive and confirmatory diagnosis. Presumptive diagnosis of leptospirosis is established when a rapid screening test shows a positive result. Rapid screening tests include IgM-ELISA, lateral flow, dipstick and the latex agglutination test, etc. Confirmatory diagnosis is confirmed when 1) pathogenic leptospires can be isolated from blood or other clinical materials through culture, 2) the PCR result is positive, and 3) MAT shows a fourfold or greater rise in titre, or seroconversion is detected on paired samples. MAT is applied using *Leptospira* spp. that are representative of the local serovars for pathogenic leptospires. [72-75]

The World Health Organisation's (WHO) recommended surveillance standard classifies diagnosis of leptospirosis cases in humans into suspected cases and confirmed cases.[72] A suspected case is a patient whose symptoms have been matched with the clinical description of leptospirosis and who also has a presumptive laboratory diagnosis. A confirmed case is a suspected case with a confirmatory laboratory diagnosis.

The clinical description of leptospirosis according to this standard is acute fever accompanied by headache, myalgia, and prostration; these main symptoms can be followed by any other symptoms such as conjunctival suffusion, meningeal irritation, anuria, oliguria, and/or proteinuria, jaundice, haemorrhages, cardiac arrhythmia, and skin rash. In addition, a history of contact with infected animals or contaminated environments will have been reported by the suspected case. [72, 74, 76]

In Indonesia, direct examination, culture, serological and molecular methods are performed.[21, 63, 77-81] However, only a limited number of laboratories are able to perform leptospire culture, MAT or PCR testing, due to the complexity of these procedures, the limited skills of laboratory staff, and the requirement for expensive equipment. The rapid tests frequently used for diagnosing suspected cases in the primary health care centres (*puskesmas*) are the lateral-flow test and Dri-dot test. IgM-ELISA is usually used for patients admitted to hospital. MAT (for confirmatory diagnosis) and PCR are performed only at a limited number of laboratories. Not all patients with a positive result from a rapid test, most of them being from rural areas, are further tested for confirmatory diagnosis using MAT or PCR; these tests are performed only for certain patients, such as those who are willing to pay the expensive cost of the test, and patients who are under study in formal leptospirosis investigations. A number of leptospirosis risk factor studies in Indonesia did not conduct further tests such as MAT or PCR for diagnosis confirmation, due to their limited funding, and the limited availability or accessibility of laboratories able to perform such confirmatory testing.[18, 32, 35, 36, 82, 83]

2.3 Epidemiology, burden and transmission of leptospirosis

This section presents the frequency, distribution, and impact of leptospirosis. Information on sources of infection, indirect and direct transmission and cycles of leptospirosis infection is presented as a base for understanding the ensuing sections.

2.3.1 Frequency and distribution

The epidemiological pattern of human leptospirosis is related to the interaction among leptospires, animal reservoirs, humans, and environment.[50] In rural areas, human leptospirosis infections are usually associated with farming and livestock; in urban areas, specifically in urban slum areas in developing countries, infection is usually associated with overcrowding, poor hygiene and sanitation standards, and poverty; in developed countries, infection is usually related to recreational exposure and international travel.[2, 50, 84]

Leptospirosis is ubiquitous in countries with tropical and temperate climates. The number of leptospirosis cases is higher in tropical-climate countries than in temperate-climate countries. In tropical climates, leptospirosis cases peak in the rainy season, while in temperate climates the peak occurs in summer or autumn.[6, 50]

Data on the incidence and prevalence of human leptospirosis worldwide are still insufficient as the disease is overlooked and under-reported in many parts of the world.[10] A number of leptospirosis cases are overlooked due to symptoms in the early phase of this disease being similar to the symptoms of other acute-fever diseases. Among other possible reasons for overlooked cases is the lack of accessible and affordable laboratory facilities that can perform presumptive diagnosis tests for leptospirosis.

Under-reporting can be attributed to mild and even severe cases seeking treatment only at local health care centres; additionally, the majority of infected people do not seek treatment at health care centres since their leptospirosis symptoms are clinically cryptic or else they are only very mildly ill.[50]

Incidence of leptospirosis is in the range of 0.1–1 per 100 000 per year in temperate climates and 10–100 per 100 000 per year in the tropics. The incidence of leptospirosis may be over 100 per 100 000 during outbreaks.[4] The estimated world annual median incidence of leptospirosis as reported by the Leptospirosis Burden Epidemiology Reference Group (LERG) is 5.1 per 100 000 people.[59] The WHO's listed geographical regions with high annual median incidence of leptospirosis are Africa (95.5/100 000) and Western Pacific (66.4/100 000). The median incidence for the Americas and Southeast Asia regions is 12.5/100 000 and 4.8/10 000 respectively.[59] Victoriano[85] classified the annual incidence of leptospirosis for countries in the Asia-Pacific region into three groups: low (<1 per 100 000), moderate (1–10 per 100 000) and high (>10 per 100 000). Countries in the Asia-Pacific region with high annual incidence include India, Sri Lanka, Thailand and New Caledonia. Countries with moderate annual incidence include Indonesia, Malaysia, the Philippines, China, and New Zealand. Japan, Taiwan,

South Korea and Australia, are countries with a low annual incidence of leptospirosis.[10, 84, 85] The mortality among severe leptospirosis cases is in the range of 5%–40%.[2]

In Indonesia, the number of human leptospirosis cases reported annually to the Ministry of Health in 2007–2011 indicates an increasing trend (see table 1.1, page 5).
The actual number of leptospirosis cases in Indonesia is possibly higher than that reported. The under-reporting is often due to the infection being clinically cryptic, too mild to be diagnosed definitively, or misdiagnosed as dengue fever or other endemic diseases. Under-reporting also occurs because of the lack of laboratory centres able to perform confirmatory tests.

2.3.2 Leptospirosis burden

The term disease burden means the impact of a disease in a population. It is usually expressed as a single indicator, such as Healthy Life Years (HeaLYs), Disability-Adjusted Life Years (DALYs), or Quality-Adjusted Life Years (QUALYs).[15] These indicators provide a comprehensive measurement encompassing mortality and morbidity data, and also enable burden comparison based on various disease or risk factors.

The global burden of leptospirosis is not yet known. Experts working in the WHO's LERG unit are still working hard to estimate this global burden. They have decided to use DALYs as the single measure to indicate the burden of leptospirosis.[86]

In the case of leptospirosis DALYs equates with the sum of the year of life lost due to premature death in a population and the year lost due to disability for each incident of the disease. One DALY is a gap measure that equates to one year of healthy life lost.[87]

The parameters for calculating DALYs for leptospirosis include:

1. Number of deaths from leptospirosis and all sequelae (complications)
2. Age at onset of leptospirosis and all sequelae
3. Average duration of leptospirosis and all sequelae

4. Remission rates of leptospirosis and all sequelae
5. Disability burden for leptospirosis and all sequelae (assess the severity of disease on a scale from 0 (perfect health) to 1 (equivalent to death).[86]

These parameters have to be collected from the relevant locations in countries across the world, but a number of countries, mostly developing countries, do not have the data for these required parameters. This situation makes LERG's work of estimating DALYs as an indicator of the global burden of leptospirosis challenging.[59, 86, 88, 89]

Although the global burden of leptospirosis is not known, the economic consequences of human leptospirosis have been reported. A study in the US has reported that the average length of hospitalisation for leptospirosis patients is 7.1 days, with the average cost standing at US$ 38 521.[90] In the US, the average per capita annual income in 2011 was US$ 41 560.[91] Abela-Ridder and colleagues reported the average medical cost for a patient seeking treatment in a Thai community hospital: a patient with a mild or severe case of leptospirosis spent about 45 € or 250 € (about US$ 56 or US$ 312), respectively.[92] Monthly income per person in Thailand (urban areas) was about 615 € (US$ 768), and it was lower for the rural areas.[93]

A recent leptospirosis study in the urban setting of Metro Manila in the Philippines showed that the average total cost per hospitalised patient was US$ 473, and the minimum income of Metro Manilans per month was US$ 217.[94] These reports suggest that leptospirosis treatment is expensive when compared with average monthly incomes. Another economic consequence of leptospirosis in humans is the patient's loss of income while unable to work. The high hospital costs and reduced incomes resulting from human leptospirosis together present a powerful argument for the need to prevent and control human leptospirosis as early as possible.

In Indonesia, to the best of this writer's knowledge, no studies on the economic impact of human leptospirosis have been published in international peer-reviewed journals.

Similarly, no accounts of the economic impact and the national burden of human leptospirosis were found in Indonesian grey literature.

2.3.3 Transmission

2.3.3.1 Source of infection

Leptospirosis infection occurs primarily in animals. Animals infected by pathogenic leptospires are considered as animal reservoirs of leptospirosis, and these animals can be categorised either as maintenance hosts or accidental (incidental) hosts.[2, 4, 16, 50] A maintenance host is a particular vertebrate animal species that has a commensal relationship with pathogenic leptospires. These pathogenic leptospires usually do little or no harm to the host, but they still maintain the infection. This infection maintenance period in the maintenance host is lengthy because the leptospire carriers equally are long-lived. An accidental (incidental) host is a host that is accidentally or incidentally infected with pathogenic leptospires from a host (animal) that is not a maintenance host. Clinical manifestations of leptospirosis in accidental hosts vary from acute to sub-acute, and chronic.

Leptospires in an accidental (incidental) host are only temporary carriers, for a few months to years. In animals, the natural habitat of pathogenic leptospires is in the renal tubules, whence they spread to the general environment with the animal's urine.[2, 4, 16] It is not always possible to determine whether an animal is a maintenance or accidental host of leptospires: an animal can be a maintenance host for a certain serovar yet also an accidental host for other leptospire serovars. For example, cattle are a maintenance host for serovar Hardjo-bovis and also an accidental host for serovar Pomona.[2, 16]

Animal maintenance hosts are the main source of leptospire infection in other animals and humans; animal accidental hosts can also be a source of leptospire infection in humans. However, pathogenic leptospires in humans do not become carriers. Thus, humans are an accidental host, and constitute a 'dead end' for the pathogenic leptospires' life cycle.[2, 4, 52]

2.3.3.2 Mode of transmission

Humans acquire infection from infected animals through direct or indirect transmission.[2, 50]

a. Direct transmission

Direct transmission occurs when leptospires in the urine, body fluids or body tissues of an infected animal contact and enter new hosts, animal or human. Direct transmission usually occurs among animals, and it can be in the form of transplacental or sexual contact, and from suckling milk from an infected mother.[2, 5] Artificial insemination using infected semen[95] and embryos used for the in vitro fertilisation of animals are also routes for direct leptospirosis transmission among animals.[96]

Direct transmission from animal to human usually occurs as an occupational disease among people whose work involves contact with animals or animal tissues, for example butchers, veterinarians, abattoir workers, meat inspectors, and rodent control workers.[2, 5, 50] Human to human transmission is possible but very rare.[4]

b. Indirect transmission

Indirect transmission occurs when leptospires in contaminated environments infect an animal or a human.[2] Indirect transmission among animals occurs when leptospires in the environment infect susceptible animals. Examples of environments contaminated by leptospires are surface water bodies (ponds, rivers, and lakes), sewage, slaughterhouse drainage water, mud or moist soil. Leptospirosis infection in humans usually occurs by indirect transmission.[2, 4, 5] Human activities involving contact with contaminated water or soil enable the transmission of leptospires to the human body.

The usual transmission portals for leptospires entering the human body are skin abrasions, skin cuts, and mucous membranes including the conjunctiva. Even intact skin can also act as a transmission portal after the human host's prolonged immersion in water.[2, 50]

2.3.3.3 Transmission cycle

The transmission cycle of leptospires involves three key 'players': animal reservoirs, humans as the 'victims' and the 'dead end' of leptospire infection, and the environment as the medium enabling leptospires to make contact with humans. Understanding the interaction among these key players will help to identify the risk factors for human leptospirosis and to plan strategies for the prevention and control of human leptospirosis.

The crux of leptospire transmission to humans is the presence of pathogenic leptospires in the renal tubules of infected animals (whether maintenance or accidental hosts). These leptospires are excreted from the renal tubules into the environment along with the host animal's urine. The extent to which leptospires spread in the environment depends on many factors, such as urine volume; the concentration of leptospires in the urine; the range of the animal's movements; the acidity, temperature, moisture, and chemical composition of the soil, mud, and water where the animal host's urine is passed.[2] In a favourable environment leptospires can live longer, 32–74 days, and they can then infect other susceptible animals or humans through indirect transmission. Leptospires from infected animals (maintenance or accidental hosts) can also be transmitted directly to other susceptible animals or humans through direct contact with the urine or tissues of infected animals.[2, 16]

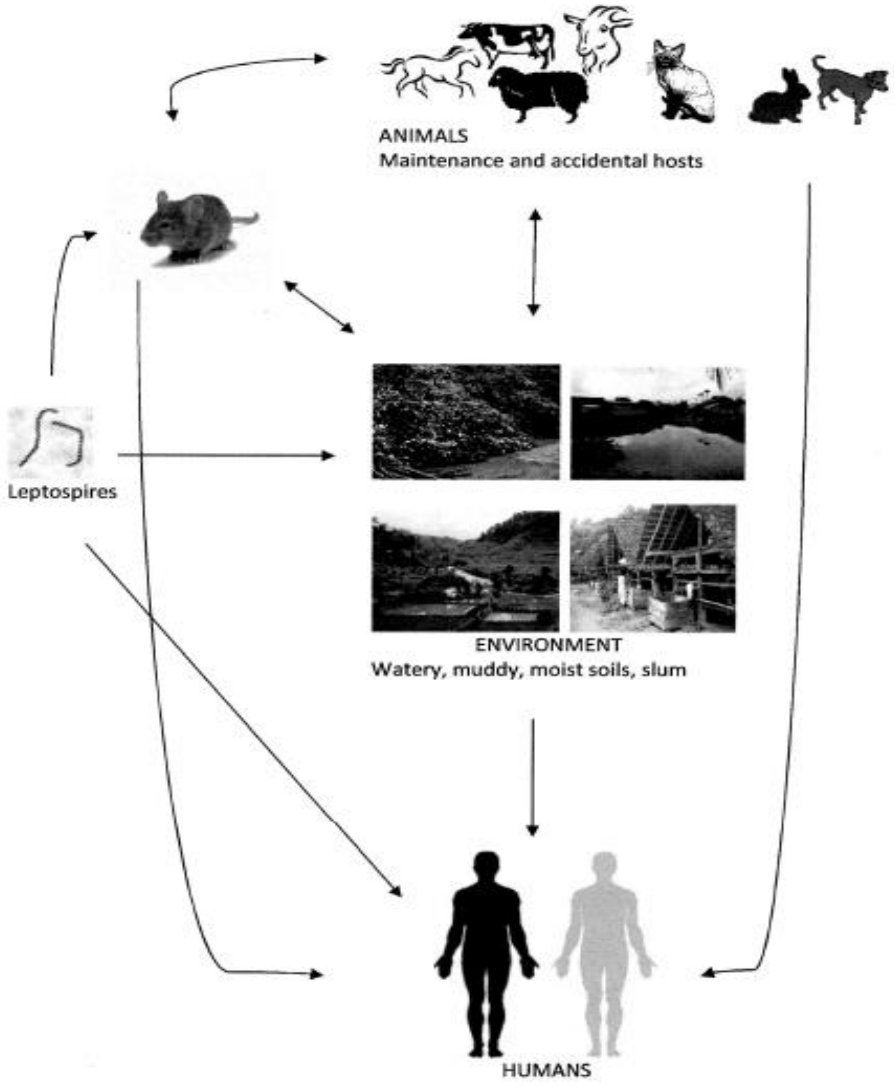


Figure 2.3 Transmission cycle of leptospirosis

2.4 Risk factors for leptospirosis in humans

This section presents risk factors for leptospirosis infection and leptospirosis mortality in humans. Risk factors for leptospirosis infection include animal, environmental, and human factors. Risk factors for leptospirosis mortality are presented in the last part of this section.

A risk factor is an aspect of personal behaviour or lifestyle, an environmental exposure, or an inborn or inherited characteristic that, on the basis of scientific evidence, is known to be meaningfully associated with health-related condition(s).[15] In other definitions, a risk factor is a variable with a significant statistical association with a clinical outcome;[97] a factor associated with the increase in probability of developing a disease (a factor such as socio-demographic characteristics, occupational, environmental or other types of exposures), and the factor or exposure must be present before the disease occurs.[98] Exposure is a variable whose causal effect is to be estimated, or the process by which an agent comes into contact with a person or animal in such a way that the person or animal may develop the relevant outcome, such as a disease.[15] The risk factor definition used in this study is a combination of the above definitions, as reported by Beck.[99]

> Risk factor: an environmental, behavioral, or biologic factor confirmed by temporal sequence, usually in longitudinal studies, which if present directly increases the probability of a disease occurring, and if absent or removed reduces the probability. Risk factors are part of the causal chain, or expose the host to the causal chain. Once disease occurs, removal of a risk factor may not result in a cure.

Risk factors for human leptospirosis are divided into three main groups: animal, environmental, and human factors.[2, 16] Animal factors entail a variety of animal species and leptospire serovars as sources of infection.[6]

Environments that are potentially related to leptospirosis infection in humans include any physical environment that a) assists pathogenic leptospires to live outside the maintenance or accidental hosts, such as a wet or humid environment (surface water, mud, moist soils),[2, 4, 55, 100] or b) either attracts maintenance or accidental-host animals, such as rodents or wild animals, into human habitat;[101, 102] or supports conditions enabling infected animals to live in human habitat—for example, a densely-populated slum area is conducive to rodents' living and breeding there.[103-105] Human factors include particular characteristics, behaviour, occupations, hobbies, and other individual conditions (for example, the level of immunity, the existence of wounds) that permit leptospires to enter and grow in the human body.[2, 16]

2.4.1 Animal factors

All mammals are susceptible to leptospire infection. The most important animal reservoirs are small mammal species (peridomestic rodents, wild small mammals) and domestic animals (cattle, pigs, dogs, goats, horses, etc.).[2, 4, 50] Besides domestic animals, wild animals are also possible leptospire hosts[106, 107] and leptospires have been isolated from reptiles and amphibians.[2, 108, 109]

Table 2.3 Typical maintenance hosts of common leptospire serovars

Maintenance host	**Serovar(s)**
Pigs	*Pomona, Tarassovi*
Cattle	*Hardjo, Pomona*
Horses	*Bratislava*
Dogs	*Canicola*
Sheep	*Hardjo*
Raccoon	*Grippotyphosa*
Rats	*Ichterohaemorrhagiae, Copenhageni*
Mice	*Ballum, Arborea, Bim*
Marsupials	*Grippotyphosa*
Bats	*Cynopteri, Wolffi*

(adapted from Bharti, *Lancet Infect Dis*, vol.3, p.759)

An animal can be a maintenance host for certain leptospire serovars and an accidental host for other leptospire serovars. The maintenance hosts for certain serovars are presented in Table 2.4 [6, 50, 53]

In different parts of the world, the animals acting as leptospire reservoirs or as specific serovar hosts may vary greatly. [107]

In Barbados, the majority of positive leptospirosis tests occur in horses, cattle, rats, mongooses and dogs. The predominant serogroup for horses is Pyrogenes; for cattle, Autumnalis, Hebdomadis, Ballum and Pyrogenes; for rats, Ichterohaemorrhagiae and Autumnalis; for mongooses, Autumnalis, and for mice, Ballum.[110]

In Europe, the majority of livestock infected by leptospires are pigs, cattle, horses, and sheep. Cattle are the animals most frequently infected by serovars Hardjo, Pomona and Ichterohaemorrhagiae; pigs are usually infected by serovars Pomona and Tarassovi.[111]
In the Pacific islands, the majority of MAT-positive animals are rats and dogs, and the dominant serogroup is Ichterohaemorrhagiae.[112, 113]
In Australia, the majority of animals infected by leptospires are cattle, pigs, sheep, horses and dogs. The predominant serovars found in cattle are Hardjo, Pomona and Zanoni; in pigs, Pomona, Tarassovi and Bratislava; in sheep, Hardjo; in horses, Pomona, and in dogs, Copenhageni and Australis.[114]
In Korea, the majority of MAT-positive animals are rats, and the predominant serogroup is Canicola.[115]

In India, on the Andaman Islands, the majority of animals infected by leptospires are goats, cows, buffaloes, pigs, bullocks, dogs and rats. The serogroups found to be the most common cause of infection in these animal populations are Grippotyphosa, Australis, Canicola and Pomona.[116] In North Andaman Island, dogs are carriers of Grippotyphosa, while cattle are carriers of Australis.[117]
In South India, the majority of MAT-positive animals are cattle, dogs, cats and rats; the predominant serogroups are Autumnalis and Ichterohaemorrhagiae. Rats are the source of infection for domestic animals.[118]
In Thailand, more than 50% of cattle, buffalo and swine in the epidemic provinces, provinces in which the occurrence of leptospirosis in the community is in excess of normal expectancy, are MAT-positive; the predominant serogroups found in cattle and buffalo are Sarmin, Ranarum, Sejroe and Castellonis; predominant serogroups in swine are Sarmin, Ranarum, Bratislava and Pomona. The leptospirosis infection rate among rodents in Thailand is 14.5%, and Pyrogenes is the main serogroup infecting the common Brown Rat (*Rattus norvegicus*); the Greater Bandicoot Rat (*Bandicota indica*) is mostly infected by the Autumnalis, Bataviae, Pyrogenes, Javanica and Australis serogroups.[119]

In Malaysia, rats are the most common maintenance host for serogroup Ichterohaemorrhagiae. Besides Ichterohaemorrhagiae, other serovars such as Pomona, Pyrogenes and Sejroe also infect rats.[120]

In Indonesia, information regarding infected animals is limited. No routine laboratory examination of animals in leptospirosis-endemic areas is conducted, and only certain animals are tested for leptospire infection. The proportion of MAT-positive results for animal sera sent to the Indonesian Research Center for Veterinary Science (Balitvet) in 2004 was 48.0% for rats, 33.33% for dogs, and 17.38% for cattle. The predominant serovars found in cattle were Hardjo, Tarassovi, Pomona, Australis, Rachmati and Bataviae.(81) The predominant serogroups found in rats in Central Java Province were Bataviae, Ichterohaemorrhagiae and Autumnalis. [121, 122]

The association between the occurrence of leptospirosis in humans and the role of animals as either maintenance or accidental hosts has been studied. Significant associations between the presence of rats and human leptospirosis infection have been shown in leptospirosis risk factor studies conducted in Indonesia[18, 31, 78, 123, 124] and also in other countries. [105, 125-127] Surprisingly, no studies in Indonesia have shown any significant association between human leptospirosis and the presence of domestic animals/livestock close to residential premises. In contrast, risk factor studies from other countries have shown that the presence of domestic animals is significantly associated with human leptospirosis.[22, 105, 128, 129]

2.4.2 Environmental factors

Leptospirosis is known to be a disease that is related to environmental factors. The survival of leptospires depends on an environment that provides them with ideal living conditions. They survive in aquatic or wet environments, in alkaline conditions with a pH of 7.8–7.9, in alkaline soil, mud, swamps, streams or rivers, and in the tissues of live or dead animals. In a protein-containing environment, leptospires are able to survive in temperatures below freezing.[2] They die in dry conditions and also in environments containing any agents that can remove their outer envelope, such as lipid detergents or soaps. Certain environmental conditions in human habitats can also attract infected wild

and domestic animals to come and breed in the vicinity of human settlements. Such conditions include poor home sanitation, uncovered and overflowing garbage containers, and the presence of solid waste accumulation.[101, 102, 104]

Leptospires can be detected in the environment with laboratory tests of samples from suspect contaminated environments, such as water from rivers or ponds, stagnant water, mud or wet soils. Methods used for identification of *Leptospira* in the environment include culture [130] and molecular assays.[55, 131-133] The existence of leptospires in aquatic or wet environments such as streams, rivers, ponds, mud or clay, and stagnant water, has been reported.[55, 100, 133, 134]

A number of peer-reviewed articles on leptospirosis risk factor studies have reported significant associations between human leptospirosis and flooding,[20, 129] stagnant water,[129, 135] poor home sanitation,[103, 135] and living close to accumulated garbage.[105, 125] In Indonesia, no Indonesian articles regarding the relationship between human leptospirosis and environmental factors were found in peer-reviewed international journals. A number of reports of studies on human leptospirosis and environmental factors in Indonesia were however found in Indonesian grey literature. Flooding, stagnant water surrounding the house, poor sewerage, poor sanitary conditions in homes and their surroundings are among the potential environmental risk factors usually included in Indonesian studies.[18, 21, 32, 35, 36, 78, 82, 83, 123, 124, 136-138] No significant association between human leptospirosis and flooding has been reported in the Indonesian studies that have offered multivariate analysis. Conversely, multivariate analysis has shown that the presence of stagnant water around homes is significantly related to human leptospirosis in Indonesia.[21, 83] Similarly, poor sewerage [18, 124] and poor home sanitation[18, 123] are conditions that are significantly associated with human leptospirosis in Indonesia.

2.4.3 Human factors

2.4.3.1 Behavioural risk factors

The term behavioural risk factors refers to behaviour that increases the probability of a specified outcome (disease).[15] In a leptospirosis study, those factors include activities that put humans into contact with sources of leptospirosis infection, such as walking through stagnant water, flood water, or muddy areas, swimming in streams or rivers, taking a bath or washing clothes in rivers or ponds.

A number of studies published in international peer-reviewed journals have reported significant associations between behavioural factors and human leptospirosis. The behavioural factors reported include walking through stagnant water,[19, 117, 129, 139-141] walking through flooding or muddy areas, [125, 126, 140, 142-144] swimming in a stream or river, [125, 128, 129, 140, 143, 145, 146] taking a bath in a river, [9, 103, 117, 125, 135, 142, 147] washing in a river or pond, [9, 125, 135, 143, 147] contact with a suspected infected animal or its urine/ tissues,[128, 129, 135, 144, 148-153] walking barefoot, [20, 22, 125, 129, 140, 147] not wearing waterproof protection for hands or feet,[103, 127, 129, 141] and using streams as a source of drinking water. [9, 22] In Thailand, wearing long trousers or long skirts instead of shorts, in aquatic or wet locations has been shown to reduce the risk of contracting leptospirosis infections during pond-cleaning activities.[154] However, another study by Stern and colleagues found no significant association between wearing shorts and leptospirosis infection among adventure race participants.[145]

In Indonesia, reports of leptospirosis risk factor studies have shown no significant association or weak significant associations between human leptospirosis and contact with stagnant or flood water.[21, 78, 82, 83] Similarly, studies have shown no significant association between human leptospirosis and swimming in the river or contact with domestic animals. However, studies in Indonesia on the association between leptospirosis infection in humans and taking a bath or washing clothes in a river or stream have shown significant association. This significant association only occurs in bivariate analyses.[18, 31, 83]

2.4.3.2 Occupational risk factors

The term occupational risk factor in this study refers to an occupation that is related to contact with sources of leptospirosis infection. Examples of higher risk occupations for leptospirosis transmission are soldiers, miners, sewer workers, rice-planters or harvesters, abattoir workers, dairy farmers, and veterinarians.[2, 4]

Many leptospirosis risk factor studies combine several categories of work related to contact with suspected contaminated water or substances into one variable, such as outdoor labour,[117] work standing in water,[22] risk occupation,[83, 123] manual labourer,[135] workplace exposure to contamination,[126] or activities in aquatic or wet locations.[21] Occupational factors significantly associated with leptospirosis infection in humans include workers in contact with contaminated surface water or animal tissues/ specimens;[22, 126, 129, 144, 148, 150, 155] activities in paddy fields,[19, 22, 117] collecting wood in the forest;[9, 20]) and clearing up garbage.[22]

In Indonesia, workers in contact with contaminated surface water or animal tissues/ specimens represent the occupations most frequently reported to have significant association with leptospirosis infection in humans.[18, 21, 35, 78, 124] However, despite Indonesia's being a heavily forested country, association between working in a forest and human leptospirosis has not been reported.

2.4.3.3 Recreational, hobby, or sport risk factors

Recreational risk factors include all forms of recreation, sport or hobby that are related to contact with a source of infection. These activities include water-related sport (kayaking, canoeing, swimming, etc.), cross-country activities, and water-based recreation.

The incidence of human leptospirosis attributable to recreational exposure is increasing, especially in developed countries.[10, 156] Nardone and colleagues[128] reported that canoeing was a significant factor in leptospirosis among patients hospitalised in France 1999–2000. Investigation of a leptospirosis outbreak in Japan's Yaeyama islands [157]

and the northern part of Okinawa [158] indicated that aquatic recreational activities were the main cause of exposure. Several studies have reported that swallowing river water during sporting activities in leptospirosis-endemic areas has a significant association with human leptospirosis. [145, 146, 159]

Indonesia offers an abundance of water bodies (e.g. rivers and lakes), and also mountainous rain forests that are ideal for aquatic recreational or sporting activities. Indonesia's Ministry of Tourism and Creative Economy has nominated sporting and recreational activities as one of seven special focus areas for the Indonesian tourism industry.[160] However, studies of recreation-related risk factors for leptospirosis in Indonesia are rare.

A leptospirosis study by Murtiningsih in Yogyakarta province showed that recreational river fishing had a significant association with leptospirosis infection in humans.[31]

2.4.3.4 Personal hygiene

Personal hygiene practices include washing or showering with soap after contact with a source of leptospirosis infection, covering wounds or skin lesions with a waterproof dressing and wearing protective devices to avoid direct contact with sources of leptospirosis infection.[4] The association between personal hygiene and leptospirosis infection in humans has been reported.[127, 161]

In Indonesia, about 43% of leptospirosis risk factor studies included personal hygiene as a studied potential risk factor for human leptospirosis.[162] Several studies support the association between personal hygiene and leptospirosis.[21, 78, 137]

2.4.3.5 Skin wounds

Leptospires enter the human body through cuts, abrasions or scratches to the skin.[2, 4] A number of studies of leptospirosis risk factors reported in international peer-reviewed journals show significant associations between skin wounds and human leptospirosis.[19, 22, 125, 128, 129, 147, 163, 164]

In Indonesia, a number of studies that included skin wounds as a studied potential risk factor for human leptospirosis have shown significant associations in their multivariate analysis.[21, 78, 124]

2.4.3.6 Immunity

Humans are susceptible to leptospire infection. However, the human body has its own defence mechanism against such infections. The first line of host defence against leptospire infection is the innate immune system. Saprophytic or non-pathogenic leptospires are easily killed by this immune system. By contrast, pathogenic leptospires, specifically virulent leptospires, can survive and are more resistant to the innate immunity system.[2, 165]

The host's immune response to pathogenic leptospires in the early stages of infection usually depends on the humoural mechanism; immunity is specific to leptospire types with closely related agglutinating antigens or closely similar serovars.[2] The agglutinating antigen in leptospires is LPS and these lipopolysaccharides are specific to each serovar. It is the leptospires' LPS that is the main target for the potential host's protective antibody response (humoural response).[2, 52] In other words, specific antibodies produced by the host (animal or human) target the specific LPS of individual leptospire serovars. Consequently, passive immunisation with specific anti-LPS antibodies can only protect against the relevant leptospire serovars.

Besides passive immunisation, vaccination is another way to build host immunity against leptospire infection. Currently available vaccines for leptospirosis contain inactivated leptospires or outer-membrane fractions of leptospires. However, concerns about the use these vaccines have been identified: the vaccines do not have cross-protection against leptospire serovars that are not included in the specific vaccine preparation; annual revaccinations are needed; the use of whole-leptospire vaccines correlates with high rates of adverse reaction.[2, 52, 165] The development of vaccines that have cross-protection against many kinds of leptospire serovar is in progress; efforts

have been focused first on the identification of surface-associated proteins that are stored by leptospire serovars, so that they can be targeted by the host's (animal or human) immune response.[52, 165, 166]

2.4.3.7 Socio-demographic characteristics

The socio-demographic characteristics of individuals are not directly related to the occurrence of leptospirosis, but are indirectly relevant. These personal characteristics include age, gender, education level, knowledge and income. Age is usually related to the individual's level of immunity, level of education, and to the extent of knowledge and experience of leptospirosis. Gender is usually connected with types of occupations or activities.[167]

People in developing countries, specifically in rural areas or urban slum areas, are usually more vulnerable to leptospirosis infection than people in developed countries. Rural areas in developing countries are usually characterised by the presence of farming or agricultural areas and livestock, as well as low income and low education levels; urban slum areas are usually characterised by overcrowding, poor hygiene and sanitation, and poverty.[84, 166] Thus, most leptospirosis risk factors are found in these areas of developing countries rather than in developed countries.

Socio-demographic studies of leptospirosis show a significant relationship between leptospirosis and low education levels, [32, 105, 168] insufficient knowledge of leptospirosis [18, 32, 35, 148] and low incomes, [105, 168] especially in developing countries. Adults are also more likely to suffer from severe leptospirosis.[105, 144] Some studies of the association between leptospirosis and gender have indicated that gender is significantly associated with leptospirosis occurrence, with males more likely to contract the disease.[12, 20, 105, 117, 129, 144, 150] However, other studies[9, 154, 163, 164] have reported that there is no significant association between gender and leptospirosis occurrence. The influence of gender on the occurrence of leptospirosis infection in humans, other than the fact that males may experience a greater frequency or duration of exposure to infected or contaminated environments, is still unclear.[167]

In Indonesia, the majority of the country can be classified as rural, and many urban slum areas also exist. People in such areas usually have low incomes, poor hygiene and sanitation, low levels of education, and inadequate knowledge of leptospirosis. Living conditions in the urban slum areas are overcrowded, with poor environmental sanitation, and characterised by poverty. The socio-demographic characteristics of rural areas and urban slums in Indonesia contribute to the existence of local leptospirosis risk factors.

2.4.4 Risk factors for leptospirosis mortality

After entering the human body, pathogenic leptospires will disseminate and invade tissues and organs, leading to a very broad spectrum of severity. The clinical manifestations of leptospirosis can range from subclinical illness, to mild or flu-like illness with self-limited systemic illness, and severe, potentially fatal illness.[1, 2, 50, 71]

The severity of leptospirosis in humans is related to the specific infecting leptospire serovar, human factors, and health provider factors.[1, 2, 169] Leptospire factors include pathogenicity, the virulence of the infecting serovar, and the bacterial load.[1, 2, 165] The virulence of a leptospire correlates with its ability to survive in the host. Virulent leptospires have mechanisms to evade the host's immune response.[52, 165] Such virulence factors include LPS, haemolysins, outer membrane proteins, and adhesion molecules.[52, 166] The patient's response factors include the patient's age,[170-173] immunological status,[1, 2] whether there has been any delay in seeking medical treatment,[150, 174] the presence or otherwise of severe complications,[171, 173-181] and the severity of the disease at the time of admission to hospital as indicated by clinical and laboratory or radiographic data.[176, 181] Health provider factors include the availability of diagnostic and treatment facilities and [4, 172, 182] the availability of experts and skilled workers experienced in leptospirosis patient management. [172]

2.5 Prevention and control of leptospirosis in humans

This section presents the principles of public health action to prevent and control human leptospirosis, what action has already been taken to prevent and control human leptospirosis, and the identification of what necessary immediate action should be taken in the public health field to reduce exposure to leptospirosis risk factors in Indonesia.

'Prevention' covers not only action to prevent the occurrence of disease, but also action that includes eradicating, eliminating, or minimising the impact of a disease and resulting disability. Several levels of prevention were defined: primordial prevention (to inhibit the emergence or establishment of risk factors); primary prevention (to reduce new occurrences of the infection or disease); secondary prevention (to reduce the duration or severity of the disease); tertiary prevention (to reduce complications or disabilities), and quaternary prevention (to prevent iatrogenesis).[15, 183]

'Control' refers to actions or programs to reduce the incidence and/or prevalence of a disease or infection to a locally agreed level.[15, 26] Leptospirosis prevention and control mostly deal with the identification of sources of infection and the control of the transmission of the disease; the clinical field pays more attention to the interaction between the infectious agent and the human host.[26] The focus of leptospirosis prevention or control programs in public health is to cut the chain of infection by avoiding direct contact or minimising the risk of indirect contact with sources of infection, and adopting control measures that show benefit in reducing leptospirosis transmission to humans.[2] All factors related to the chain of infection for leptospirosis can be classified as risk factors, preventive factors or contributing factors for leptospirosis disease or infection. Information on leptospirosis risk factors is crucial to the prevention and control of leptospirosis in humans.

Information on local leptospirosis risk factors can be obtained from surveillance or from incidental surveys conducted by local or national health offices, universities or other relevant institutions. The obtained leptospirosis risk factor data constitute important

information when conducting public health programs for leptospirosis prevention and control intervention.

There are many kinds of public health intervention for leptospirosis prevention and control that can be undertaken. Keller and colleagues discussed 17 kinds of public health interventions, and they divided them into five focuses for actions: 1) Surveillance, disease and other health event investigation, outreach, screening, and case finding; 2) Referral and follow-up, case management, and delegated functions; 3) Health teaching, counselling, and consultation; 4) Collaboration, coalition building, and community organising; 5) Advocacy, social marketing, and policy development and enforcement.[184]

Public health leptospirosis interventions require community involvement; the interventions will not achieve their purposes without support from people in the communities involved.

Leptospirosis prevention and control interventions will obtain more support from the community if people in the community are aware of the disease and its risk factors.[185, 186] To achieve better community awareness of leptospirosis itself, as well as risk factors and prevention, education is vital. [2, 4, 187] Bipin and colleagues reported, and emphasised, the importance of providing regular community education sessions in order to maintain high awareness levels about leptospirosis.[188]

Few studies published in international peer-reviewed journals have reported any evidence on the effectiveness of public health strategies or interventions for leptospirosis prevention and control, beyond the limited use of chemoprophylaxis and vaccines. Chemoprophylaxis using the doxycycline antibiotic has been reported to protect humans by reducing the incidence of the disease, as well as the clinical illness and mortality arising from leptospirosis during outbreaks; it has also been shown to protect exposed persons in areas of high exposure.[189, 190] However, a systematic review conducted by Brett-Major and Lipnick [191] concluded that the benefit of using doxycycline to reduce

leptospire seroconversion or the clinical consequences of infection, was unclear. Victoriano and colleagues[85] reported that doxycycline as chemoprophylaxis for leptospirosis was only useful for cases where exposures were obvious and short-term. In addition, routine use of doxycycline as chemoprophylaxis and across whole communities was not recommended. Vaccines for preventing human leptospirosis are available, but have not been applied worldwide; they have been used only in some countries.[1, 2, 50, 53]

Bracho et al.[192] introduced homeoprophylactic intervention to control leptospirosis epidemics in Cuba. In this study of Bracho's, four highly-diluted strains of inactivated leptospires were administered orally to people living in a high-risk region for epidemic leptospirosis after a natural disaster. Although results of the study indicated an association between homeoprophylactic intervention and reduction of leptospirosis incidence, further studies were recommended.

Leptospirosis prevention and control in Indonesia drew more attention from the government and related institutions after an outbreak of the disease in Jakarta in 2002. Public health and clinical activities related to leptospirosis have increased since. In 2012, leptospirosis was established as one of six national priority diseases transmitted by animals (zoonoses) in Indonesia.[39] The Indonesian Ministry of Health provided formal guidelines for the diagnosis, case management and control of leptospirosis.[40] Efforts to improve leptospirosis prevention and control in Indonesia have been initiated. They include the establishment of a Commission on Integrated Zoonosis Control at the national, provincial and district levels, to coordinate and integrate zoonosis control,[193] and the establishment of a diagnostic zoonosis laboratory network to improve laboratory diagnosis and to provide integrated and comprehensive surveillance information on zoonoses including leptospirosis. National and district health officers, in collaboration with local health centre staff members, have conducted epidemiological investigations as well as local intervention programs, and have provided leptospirosis education to the local high-risk community. However, quite apart from funding limitations, activities or interventions conducted to prevent and control human

leptospirosis in Indonesia are not systematically planned and evaluated, due to the lack of coordination and integration among the relevant sectors.[39]

In addition, leptospirosis prevention and control programs or interventions in Indonesia are more challenging due to the shortage of laboratories and skilled people to perform diagnostic tests, the absence of standard equipment for collecting information on potential risk factors, and insufficient or inadequate information on local leptospirosis risk factors, especially in rural or remote leptospirosis-endemic areas.

Insufficient or inadequate information on local leptospirosis risk factors in Indonesia can be attributed to various reasons, such as the paucity of studies on leptospirosis risk factors published in peer-review journals; very little local grey literature on leptospirosis risk factors; only a few study reports regarding local leptospirosis risk factors to be found in the relevant primary health care centres (*puskesmas*); a lack of confirmatory diagnosis, and inadequate methodology in a number of available risk factor studies. Indonesian grey literature is usually found in local university libraries and in local district or provincial health institution libraries. For researchers from outside the relevant institutions, accessing this grey literature, especially literature that is not digitised or available online, requires negotiation of a time-consuming bureaucratic process. A number of risk factor studies for human leptospirosis disease or infection in Indonesia lack diagnostic confirmation: [18, 29-36, 194] most cases of leptospirosis in humans are still determined based on clinical characteristics and the results of rapid tests, rather than on the more definitive MAT or PCR assays. Comprehensive reviews of existing studies on leptospirosis risk factors in humans at the district and sub-district levels have not been done. Such reviews are however important to identify local risk factors for leptospirosis disease or infection in humans.

2.6 Conclusion

Human leptospirosis is a zoonosis, and it is also considered an occupational, environmental, and a recreational disease. This disease is ubiquitous, with the Asia-Pacific region being the region with the highest incidence in the world. Specific laboratory-test confirmation for leptospirosis diagnosis is required due to the disease's clinical characteristics, which are similar to those of other infectious diseases at the early stages of infection.

In general, risk factors for leptospirosis disease or infection in humans are grouped under animal factors, environmental factors, and human factors. Rats and domestic animals are the predominant animals with *Leptospira* infection in developing countries; livestock constitute the majority of animals infected by *Leptospira* in developed countries. Environment-related factors that are related to human leptospirosis are flooding, stagnant water, poor home sanitation, and living close to accumulated refuse. Human behavioural factors related to leptospirosis disease or infection are walking through stagnant water, flooded or muddy areas; swimming, washing, taking a bath in a river; walking barefoot; and using streams as a source of drinking water. A number of leptospirosis risk factor studies have reported a significant association between leptospirosis disease or infection in humans, and workers in contact with contaminated surface water or substances. The majority of leptospirosis risk factor studies that include skin wounds as a potential risk factor show a significant association between such wounds and leptospirosis disease or infection in humans. Low education levels and insufficient knowledge of leptospirosis are also reported to have a significant association with leptospirosis infection in humans.

Indonesia is one of the Asia-Pacific region's leptospirosis-endemic countries; leptospirosis risk factor studies have been done there. However, the number of studies is relatively few, and many of them do not use confirmatory tests for case diagnosis due to the lack of, or inaccessibility of, proper testing laboratories. No standard equipment for collecting information on potential risk factors for leptospirosis disease or infection in

humans is found in Indonesia. Efforts to improve leptospirosis prevention and control in the country have been initiated; however, activities or intervention programs undertaken to prevent and control leptospirosis disease or infection in humans in Indonesia are not systematically planned and evaluated due to the lack of coordination and integration among the relevant sectors.

A few leptospirosis risk factor studies in Indonesia have been published in international peer-reviewed journals. The majority of reports of human leptospirosis risk factor studies are found in the grey literature stored in local university and local health office libraries. Only a little grey literature containing information on local risk factors for human leptospirosis is accessed and used by health programmers from local primary health care centres in leptospirosis-endemic areas. These conditions indicate that information on risk factors for leptospirosis disease or infection in humans in the leptospirosis-endemic areas of Indonesia is still insufficient and inadequate.

Information on risk factors for leptospirosis disease or infection in humans is crucial to conducting leptospirosis preventive and control interventions. Investigation of possible risk factor information is required in order to develop intervention programs in leptospirosis-endemic areas where there is a paucity of risk factor data.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the methods used to achieve the aims of the research. The general objectives of the study were to investigate the availability of leptospirosis risk factor data, and to investigate the suitability of the available risk factor data for the purpose of developing an intervention program to reduce exposure to leptospirosis risk factors in a leptospirosis-endemic area of Indonesia.

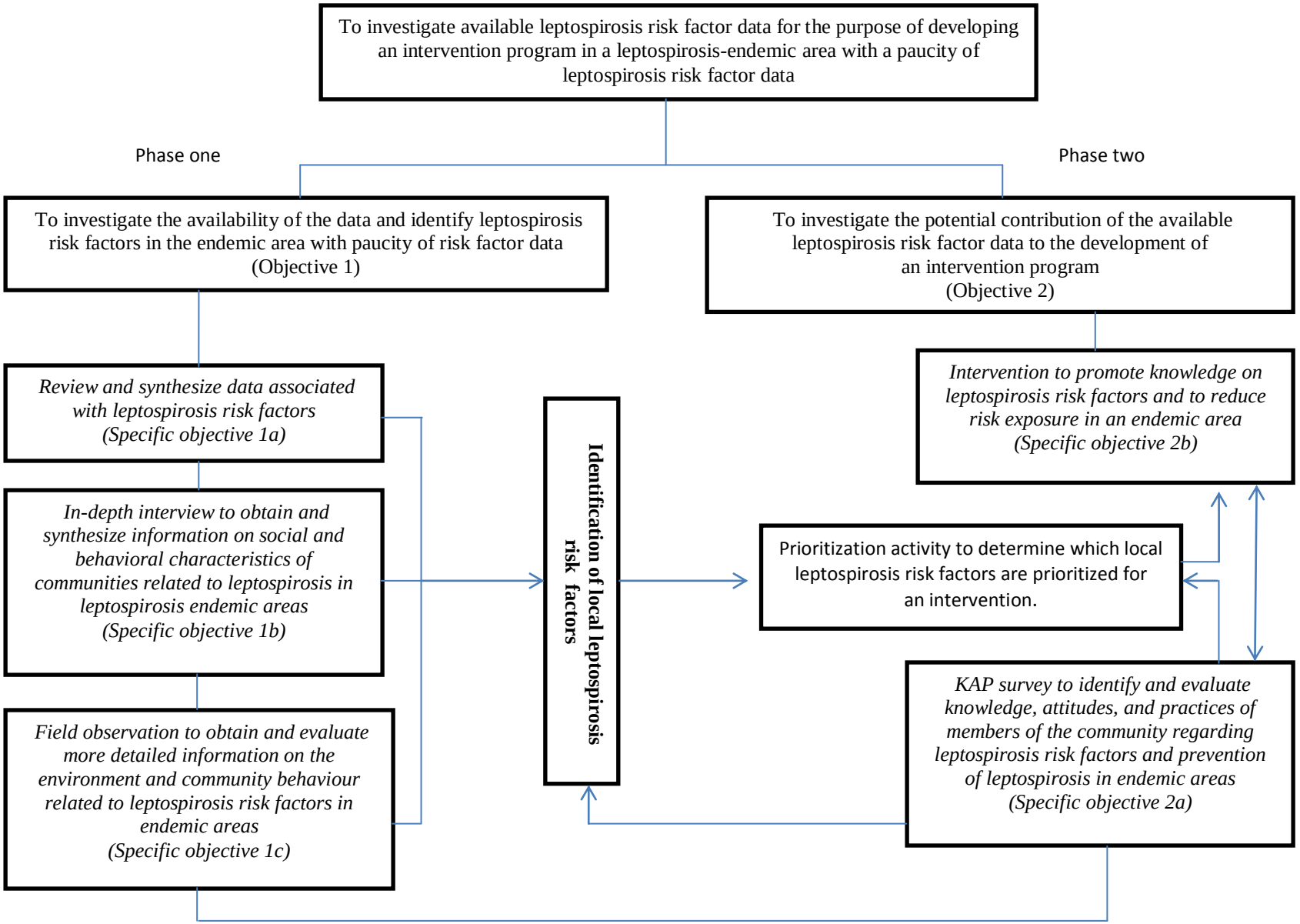
This research was conducted in two phases: identification of local leptospirosis risk factors and the development and implementation of an intervention to reduce exposure to leptospirosis risk factors (intervention study).

The first phase of the research, the risk factor study, comprises three parts: a review of previous leptospirosis risk factor studies, a socio-behavioural study relevant to leptospirosis risk factors and prevention, and field observations of leptospirosis risk factors. The second phase of the research, an intervention study, consists of two parts: a survey of knowledge, attitude, and practice (KAP) related to leptospirosis risk factors (before and after an intervention); and an actual intervention to reduce exposure to leptospirosis risk factors. (See figure 3.1)

This study was conducted in Demak district, Central Java province, Indonesia (figure 3.2 and 3.3). Demak district was selected because it is: 1) a prime area for leptospirosis cases (a leptospirosis-endemic area), 2) rural, 3) geographically and politically accessible.

A rural locality was selected because the majority of Indonesians live in rural areas and the majority of leptospirosis cases in Indonesia also occur in rural communities. Demak district is largely rural, with agriculture the district's main source of income.

Figure 3.1 Essential components of the research



The district is geographically accessible in that all villages in Demak district can be reached by vehicle. Certain areas of Demak district cannot be reached by car, especially in the rainy season; however, these can still be reached using other motor vehicles. Paths to these areas are mainly mud tracks or else roughly cobbled, and they are inundated during the rainy season. Political accessibility was assured because the government of Demak district has a legal collaboration agreement with Diponegoro University in Semarang. This agreement made it easier for researchers (staff from Diponegoro University) to legally access Demak district to conduct research.

Demak district is located on 6° 43' 23"–7° 09' 43" S (South) latitude and 110° 27' 58"–110° 48' 47" E (East) longitude, with an elevation of 0–100 metres (m) above sea level. The total area of Demak district is 89 743 hectares (ha), of which 48 947 ha are paddy fields. Demak district is divided into 14 *kecamatan* (sub-districts) and 249 villages (*desa*). Each sub-district has a population of 37 000–141 000. Each sub-district has 12–21 villages and each village has 1500–15 000 inhabitants. Demak district has a tropical climate with two distinct seasons, the dry and rainy seasons. The dry season usually extends from June–September, the rainy season from December–March.

The majority of people in Demak district are employed in the farming sector.[195, 196] The predominant types of farming are rice paddy, corn, cassava, and soy cultivation.

INDONESIA

Central-Java Province

Figure 3.2 Indonesia and Demak district

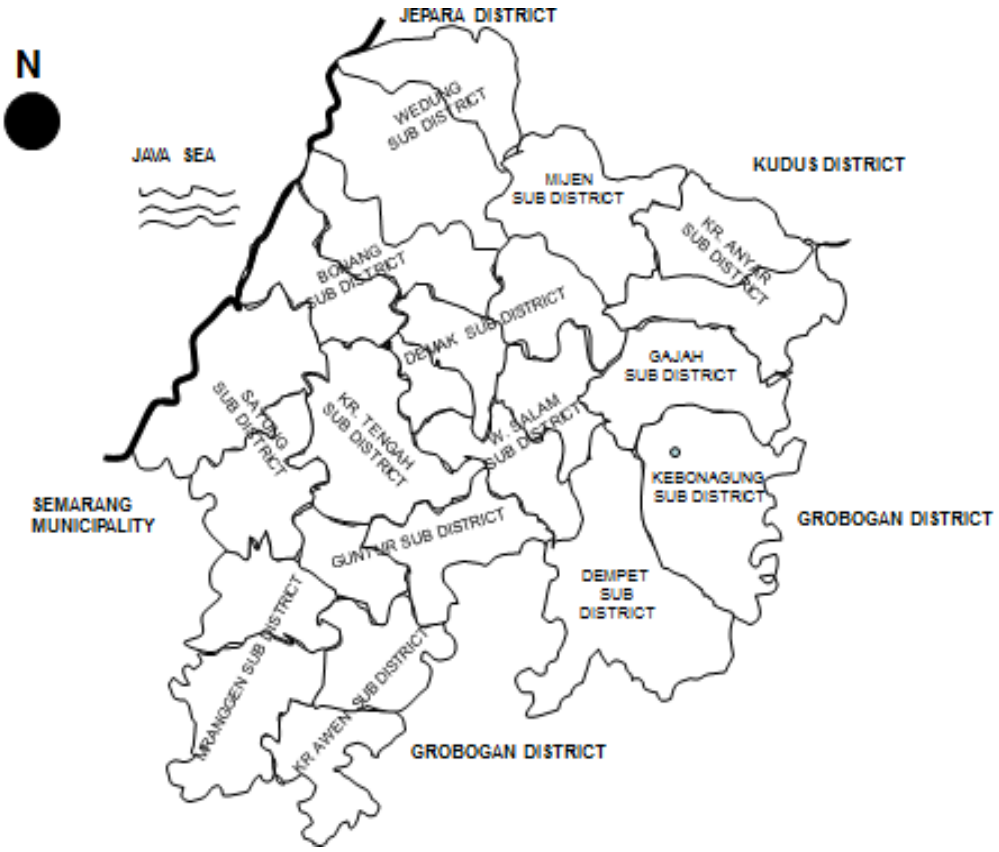


Figure 3.3 Demak district and 14 sub-districts

3.2 Identification of local leptospirosis risk factors

Objective 1:
To investigate the availability of leptospirosis risk factor data and identify social, behavioural, and environmental factors that could be related to the occurrence of leptospirosis in humans.

3.2.1 Review of previous studies on risk factors for leptospirosis infection in humans

3.2.1.1

Specific objective 1a:
To review and synthesise data associated with leptospirosis risk factors reported in grey literature and in international peer-reviewed sources, and to identify the distribution of similarities and differences in risk factors for leptospirosis in Indonesia and in the Asia-Pacific region.

3.2.1.2 Literature search strategy

The review question for this activity was 'what do previous studies tell us about human leptospirosis risk factors in Demak district?' A search strategy was developed by applying selection criteria. The keywords arising from these criteria were used to research the required information via website search engines, publication databases, and online libraries. Internet-accessible journal articles and other electronic publications that met the search criteria were downloaded; journal articles that could not be accessed via the internet were found in the library or ordered via interlibrary loan.

Peer-reviewed articles on leptospirosis risk factor studies were searched in the Medline, PubMed and Scopus databases. Selection of the articles was guided by defined criteria: 1) articles in English published before January 2012, 2) studies of leptospirosis in humans, 3) compliance with the study objective, which was to assess risk factors for

leptospirosis infection or disease in humans, 4) the strength of association (between risk factors and infection or disease) was measured and presented in the material searched, 5) the study site was located within the Asia-Pacific region. Terms entered for searching were 'leptospirosis, risk' and they were separated by the Boolean word 'AND'. Indonesian grey literature was searched for leptospirosis risk factor studies in Indonesia published prior to January 2012. The search for Indonesian studies was conducted through local university library websites and local government health office websites. The search for articles or grey literature on leptospirosis risk factor studies in Demak district and in Central Java province was conducted by visiting local district health offices and related institutions.

3.2.1.3 Synthesising the data

Available local leptospirosis risk factor data for Demak district were synthesised and compared with available leptospirosis risk factor data from other endemic districts of Indonesia. These Indonesian data were then compared with synthesised data from previous leptospirosis risk factor studies in other Asia-Pacific region locations, to compare and contrast the similarities and differences among risk factors for human leptospirosis.

3.2.2 Socio-behavioural study related to leptospirosis risk factors and prevention

3.2.2.1

Specific objective 1b:
To obtain and synthesise information on the social and behavioural characteristics of communities as related to leptospirosis in leptospirosis-endemic areas.

3.2.2.2 Recruitment of key informants

For the purpose of this study, Demak district was classified into three geographical sectors: the coastal sector, the middle sector and the inner sector. The coastal sector consists of sub-districts that have a seashore topography; the middle sector comprises

sub-districts that are located between the coastal sector and the inner sector; the inner sector consists of sub-districts that are distant from the coastline. From each of these groups, two sub-districts were selected, based on those showing the highest number of reported leptospirosis cases over the last four years. In each selected sub-district, two key informants were selected. The total number of key informants for this study was therefore 12 (three geographical groups x two sub-districts x two key informants).

The key informants were individuals with knowledge of and access to information about the social and behavioural characteristics of communities in Demak district. The selection of key informants from participating sub-districts was based on advice and recommendations given by the heads of local community health centres and the heads of sub-district administration offices.

If more than two key informants were proposed for a sub-district, two were selected based on the following criteria: how long they had known or operated in the community, their knowledge of local society and behaviour, and their willingness to participate as a key informant in this study.

3.2.2.3 Data collection

Selected key informants were given information on the purpose of the study and their role in the study. They were offered the opportunity to ask questions regarding the study. After the study research team had obtained their written consent, the informants completed an open-ended questionnaire that was returned within three days. The time lag enabled them to familiarise themselves with the topic at hand and with the scope of information required to participate in in-depth interviews. It also provided them with an opportunity to reflect on the important social and behavioural characteristics of their communities before they underwent in-depth interviews. Questions in the questionnaire covered: local practices related to contact with water and animals; community beliefs regarding leptospirosis; how the community prevented the disease and sought treatment;

what the community knew about leptospirosis (local names for the disease, perceived causes, signs and symptoms, severity, transmission, prevention).

Interviews were conducted a week after the informants had returned the completed questionnaires. This one-week time interval permitted the interviewer to review the completed questionnaires and to become familiar with the terms used by the informants when answering questions. The researcher and the informants then mutually agreed on the times and locations for conducting interviews.

3.2.2.4 Data analysis

Interviews were recorded, transcribed, and analysed using the content analysis method as described by Ryan (2000), Taylor-Powell (2003) and Graneheim (2004).[197-199] The purpose of this content analysis was to ascertain major/consistent themes and contexts that the informants had identified as relevant and important to discussions of leptospirosis disease. Coding and theme construction were validated by the research supervisor, and a summary of key information/findings was compiled.

3.2.3 Field observations on leptospirosis risk factors

3.2.3.1

Specific objective 1c:

To obtain and evaluate more detailed information on environmental factors and community behaviour as related to leptospirosis risk factors in leptospirosis-endemic areas.

3.2.3.2 Location

This study was conducted in Demak district, Central Java province, Indonesia.

Observations were conducted in selected villages within Demak district. A village (*desa*) is an administrative territory with 1500–15 000 inhabitants that falls within a sub-district (*kecamatan*). In each geographical sector, as described in section 3.2.2.2, a sub-district with the highest number of reported leptospirosis cases within the last four years was selected. The selected sub-districts were Bonang, Demak, and Karangawen (The Demak sub-district is one of 14 sub-districts within Demak district). In each selected sub-district, a village with the highest number of leptospirosis cases reported over the last four years was then selected. A total of three villages was selected for the field observations phase of the study.

3.2.3.3 Observations of environmental factors related to human leptospirosis

Observation of the environment focused on observing places or animals in the village or its surroundings that were acknowledged as potential sources for leptospirosis infection (rivers, flood-prone areas, ponds, paddy fields, sewers, solid-waste dumping places, rats, livestock and pets). A check list for leptospirosis-related environmental observations was developed (see appendix A). Environmental observations in each village were conducted by two teams consisting of two observers each (one researcher or research assistant and one local person). The purpose of using two teams with two observers in each team was to generate and collate collaborative findings, in order to obtain more comprehensive and appropriate data. Photographic or video evidence was also collected during the observations.

3.2.3.4 Observations of behaviour related to human leptospirosis

Observations of behaviour related to leptospirosis were collected by observing peoples' activities related to leptospirosis infection, such as contact with water or animals (pets, livestock). Following discussions with village heads a list was compiled detailing potential leptospirosis-related risks associated with the activities of selected village inhabitants. This activities list was classified into two locations to distinguish between private (houses) and public places. Researchers conducted both covert and open observations of the relevant behaviour. Covert observation was used for observing

people in public areas, while open observation was used for observing people in private places.

An observations record form was used (see appendix B). Items to be observed in this form included fields covering: 'Who' (the personal characteristics of people who were engaging in risky activities, such as their age, gender); 'What' (the kinds of suspected infected materials such as river water, pond water, paddy field water/mud, the bodies or tissues of infected animals, and the protection devices used); 'Where' (the main locations for risky activity); 'When' (the time when risky activities were undertaken, and also the weather conditions at that time); and 'How' (the exact way the observed risky activities occurred, in what steps or sequence). If observers required further information or clarification relative to an observed activity, this was followed up with the individual after the observation study had been completed.

Both the observation check lists and record forms were pre-tested to assess their usability in terms of enabling respondents to follow the required processes by providing clear instructions on how to use the list or form, ensuring that all necessary items were comprehensively listed, and that the observation time-frames were appropriate. Assistant researchers were trained (in both the theory and practice of the process) before conducting field observations.

3.2.3.5 Data analysis

Findings from the environmental observations were described in terms of the locations or animal species at risk of contamination or infection by leptospires. Findings from the observations of activities or behaviour related to contact with water or animals likely to entail local leptospirosis risk factors were described according to the who, what, where, when and how aspects of the exposure observed.

3.3 Intervention study

Objective 2:

To investigate the potential contribution of the available leptospirosis risk factor data to the development of an intervention program by means of designing, implementing, and evaluating an intervention to reduce exposure to leptospirosis risk factors in a leptospirosis-endemic area.

3.3.1 Knowledge, attitude, and practice survey

3.3.1.1

Specific objective 2a:

To identify and evaluate the knowledge, attitudes, and practices of members of the community regarding leptospirosis risk factors and prevention of leptospirosis in endemic areas.

3.3.1.2 Design of study

A KAP investigation was conducted by collecting data using survey methodology and a cross-sectional approach. A survey is an investigation for the purpose of collecting information, using non-experimental methods.[15] A cross-sectional survey investigates the relationship between diseases or other health-related elements and other selected variables of interest at one point in time.[13-15]

3.3.1.3 Study population and sample

This study formed part of an intervention study; therefore, the study population was similar to that of the intervention study (see sub-section 3.3.2.2). The study population comprised residents of Demak district, specifically from Kembangan village in Bonang sub-district and from Bumirejo village in Karangawen sub-district, aged 18–60 years old.

The minimum number of respondents required for this study was 288. This estimate of the sample size was calculated with a 95% level of confidence, 5% precision, and it was estimated that 75% of the respondents did work involving contact with water or animals.(200-202) A total of 304 respondents was recruited, 150 from Kembangan village and 154 from Bumirejo village. Respondents were randomly selected from the list and researchers visited them; if selected respondents were not at home or they did not want to participate, they were replaced by neighbours who met the study's inclusion criteria, i.e. that they were residents of Kembangan village or Bumirejo village, aged 18–60, and willing to participate.

3.3.1.4 Data collection

Interviews were conducted only after obtaining written consent from the respondents. Interviewers then visited selected respondents. Before conducting an interview, the interviewer explained the purpose of the survey and the interview process. Respondents were then given the opportunity to ask questions about their involvement and the overall study. Respondents had the right to refuse to be interviewed. Interviewers were recruited from the School of Public Health at Diponegoro University, Semarang, Indonesia. They were recruited based on fixed criteria: mastery of the local language in the study area, past experience of interviewing people in the community, and willingness to live in the study area. Six interviewers were recruited.

The interviewers received two days' training on how to use the questionnaire. Discussion of the questionnaire content and how to use the questionnaire was covered on the first day of training. On the second day, the interviewers did a trial simulation of actual use of the questionnaire in mock interviews. The questionnaire contained closed and open-ended questions to elicit responses that would gauge basic knowledge of leptospirosis risk factors and prevention, attitudes towards leptospirosis prevention, and practices aimed at reducing exposure to leptospirosis risk factors.

Questions on knowledge, attitude and practice relevant to leptospirosis and the reduction of exposure to leptospirosis risk factors were formulated based on

leptospirosis theory, [1, 2] leptospirosis guidelines' [4, 203] a literature review of previous articles or studies of leptospirosis risk factor studies, [19, 21, 22, 83, 123, 124, 204-208] and the results of in-depth interviews and field observations from the first phase of this study. Health belief model theory [209] and also KAP survey guidelines [210, 211] were used to guide the development of this leptospirosis KAP questionnaire.

The structure of the questionnaire comprised a profile of the respondent, their knowledge of leptospirosis, their attitude towards activities that may reduce exposure to leptospirosis risk factors, and practices aimed at reducing exposure to leptospirosis risk factors (see appendix C). The questionnaire was trialed and pre-tested (n= 40) with respondents resident in villages within Demak district other than the villages already selected for the actual interview process.

Each respondent was interviewed for the KAP survey twice, first before an intervention was begun (KAP-1 survey) and then after the intervention had been completed (KAP-2 survey).

3.3.1.5 Data analysis

For each KAP survey (KAP-1 or KAP-2) data were entered, checked, validated, and analysed using Statistical Package for Social Sciences for Windows software (version 16.0, SPSS Inc.). Descriptive statistics were computed for all variables. The Chi-square test or Fisher's exact test (if appropriate) were applied to compare the proportions of categorical variables. Results of the tests were considered statistically significant if p-values < 0.05.

3.3.2 Intervention

Based on the results of the review of previous studies (sub-chapter 4.1), the socio-behavioural study (sub-chapter 4.2), the field observations (sub-chapter 4.3), and the KAP-1 survey (sub-chapter 4.5), a pilot intervention program to reduce exposure to leptospirosis risk factors was developed.

A quasi-experimental approach was applied in this intervention study. Two villages were selected for this study; an intervention village and a control village (see sub section 3.3.2.2). The intervention comprised educational programs containing information on leptospirosis risk factors and prevention.

Local risk factors were prioritised to determine what should be the focus of an intervention to reduce exposure to leptospirosis risk factors. The information obtained from the first phase of this study and the results of the KAP-1 survey were used as sources of evidence-based data related to local leptospirosis risk factors.

A local panel was formed to discuss and determine the local risk factors that should be prioritised in an intervention. This panel discussion was important because it promoted open communication, trusting relationships and collaboration among community, local health provider, and local experts to elucidate local leptospirosis-related problems. The members of this local panel consisted of a staffer in charge of the communicable disease control program at the local primary health care centre (Puskesmas Bonang-1), a village midwife who resided in Kembangan village, two local key persons: - a head of Kembangan village and a leader of local hamlet- and an epidemiologist from the local university (Diponegoro University).

To prioritise local leptospirosis risk factors, the study adopted and modified a problem prioritisation tool developed by the Family Health Outcome Project at the University of California, San Francisco.[212] The process of prioritising local leptospirosis risk factors in this study included forming a local panel; selection of prioritisation criteria for the ranking of leptospirosis risk factors; developing criteria rating scales; weighting of the

prioritisation criteria; review, discussion and agreement on the local leptospirosis risk factors list; the use of weighted criteria to rank local leptospirosis risk factors; a summing up of participants' scores, with ranking of leptospirosis risk factors, discussion, and confirmation of results. The criteria rating scales used in this process were prevalence of the leptospirosis risk factor, contact possibility, and changeability. Each criterion was assigned a scoring or ranking scale. Each member of the panel assessed the selected local leptospirosis risk factors using this criterion scale. The score for each leptospirosis risk factor and from each of the panel members was added up to get the total score for each leptospirosis risk factor. Finally, the leptospirosis risk factors were ranked in order of score (see Appendix D).

The results of the prioritisation process confirmed that promoting knowledge of leptospirosis risk factors and checking the presence of skin wounds before working in aquatic or wet environments should be the key areas of focus for the intervention program.

3.3.2.1

Specific objective 2b:

To promote knowledge of leptospirosis risk factors, and to reduce risk exposure among people aged 18 years and older living or working in leptospirosis-endemic regions of Demak district in Central Java, Indonesia.

Program objectives:

1. To increase the proportion of people in the target group that can identify leptospirosis risk factors (animal, environment, and human) by at least 20% by the end of the program.
2. To increase the proportion of people in the target group that can identify ways to prevent or reduce exposure to leptospirosis risk factors by at least 20% by the end of the program.

3. To increase the proportion of people in the target group that can identify the benefit of preventing or reducing exposure to leptospirosis risk factors by at least 20% by the end of the program.
4. To reduce the proportion of people in the target group who do not take action to reduce exposure to a modifiable risk factor for leptospirosis by at least 20% by the end of program.

3.3.2.2 Target group and control group

One village in Demak district was selected as the intervention village and another Demak district village with similar characteristics was selected as the control village. This selection was based on which villages had a history of the highest number of leptospirosis cases reported over the last four years. Identification of the similarities between the intervention and control villages was based on the number of inhabitants, geographical characteristics, per capita income and levels of education. To avoid contamination bias, the study team ensured that the location of the control village was distant from the intervention village so that there would be limited communication between the two villages. These villages were also used for the field observation study in phase one (section 3.2.3).

Previous studies had indicated that leptospirosis patients were mostly adults. Indonesian law defines an adult as a person who is 18 years of age or above. Based on this parameter and also the need to assure participants' better understanding of this intervention program, the primary target group selected for this study comprised adults aged 18–60 who were living in the selected villages.

Previous investigations for this study, a review of previous studies (sub-chapter 4.1) and the socio-behavioural study (sub-chapter 4.2) had identified that cases of leptospirosis mostly occurred in the area of Bonang sub-district, and among farmers. Based on those findings, Bonang sub-district was the area selected for implementing the pilot intervention program. Kembangan, a village within Bonang sub-district, was selected as

the intervention village, because:1) leptospirosis cases occurred there, 2) the majority of people in Kembangan village are farmers and 3) the inhabitants of Kembangan village were more cooperative than people in other Bonang sub-district villages.
Bumirejo village, in the sub-district of Karangawen, was selected as a control village, i.e. the inhabitants of Bumirejo village did not experience the pilot intervention program. This control village was about 30 kilometres (km) distant from Kembangan village, consequently the direct communication between the inhabitants of the two villages was highly unlikely. Additionally, most people in Bumirejo village are farmers, and leptospirosis cases are found in this village. The education level attained by the majority of people in both villages is junior high school or lower.

A total of 94 subjects was recruited for each of the two groups (intervention and control), to enable the detection of differences of at least 20% among subjects who were exposed to modifiable risk factors for leptospirosis, at 80% power and 5% level of significance. Allowing for a 20% dropout, 120 subjects were initially recruited for each group at the start of the study. The total number of respondents needed for the intervention study was 240.

Participants in this study were farmers, selected from among the respondents in the KAP-1 survey. The selection of the sample from each village was based on a *dukuh* where leptospirosis cases occurred. A *dukuh* or hamlet is a geographical area, part of a village, with about 800 adult inhabitants. The selection of the sample was finalised by simple random sampling from the list of eligible people.

3.3.2.3 Program description

This program provided information on leptospirosis risk factors and prevention to the target group. Two main activities were conducted in order to maximise the delivery of knowledge to the target group and its educational impact on the group: an introductory session and a group session. The introductory session consisted of an overview of program activities, followed by general information about leptospirosis and the burden

of disease associated with leptospirosis infection. The group session consisted of an interactive lecturing session and a demonstration-simulation session.

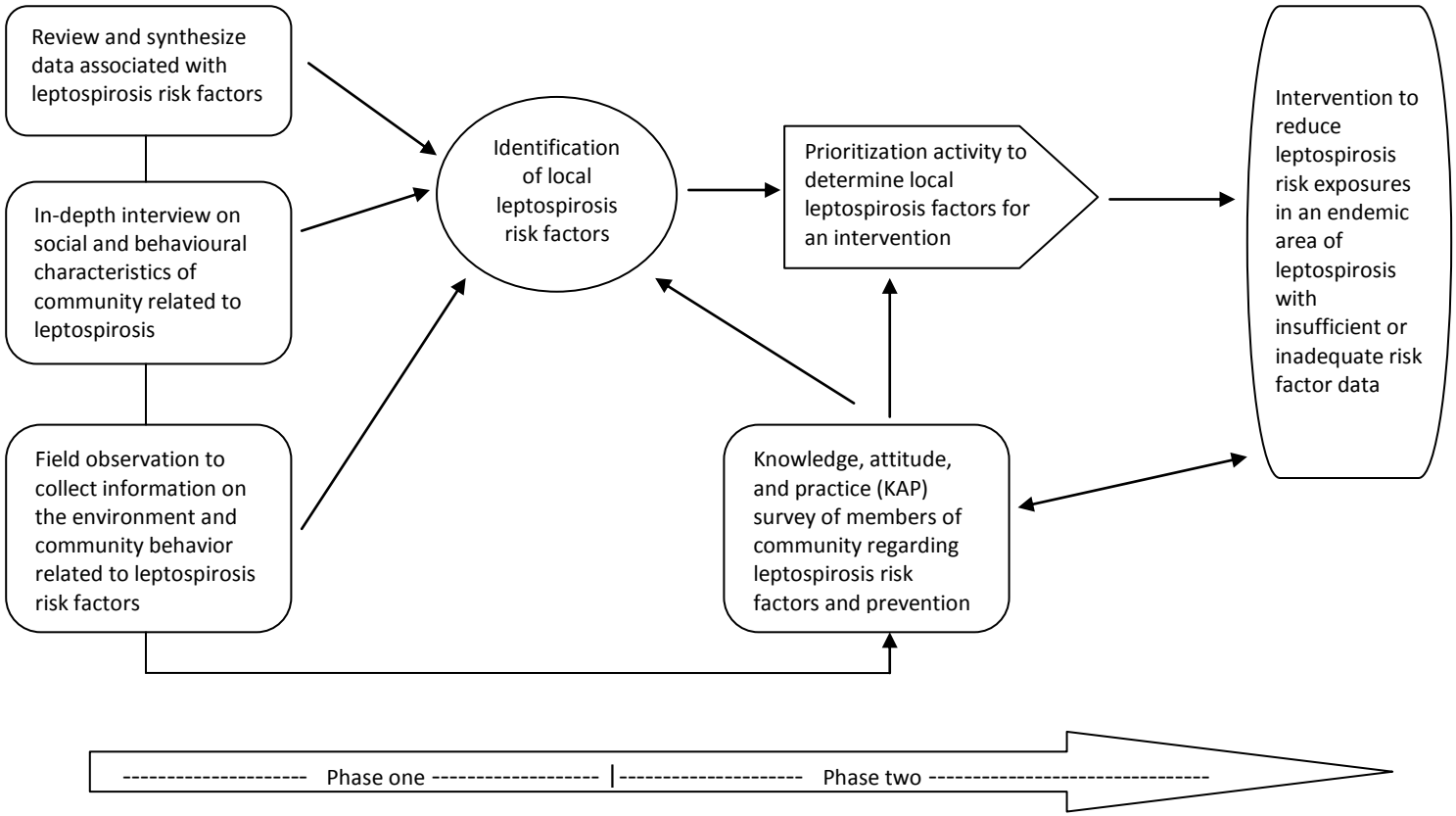
The introductory session provided valuable information to the target group regarding the goals of the program, the objectives of each session, and why participants should know about and take action to prevent the transmission of leptospirosis (see appendix E). The group interactive lecturing session helped the target group to learn about leptospirosis risk factors and identify local factors related to leptospirosis. In addition, the target group also discussed ways to prevent or reduce exposure to local leptospirosis risk factors. Facilitators gave a demonstration of how to prevent or reduce exposure to key local leptospirosis risk factors. Each of the participants was involved in a simulation of how to implement the correct measures to prevent or reduce exposure to leptospirosis risk factors (see appendix F). Finally, participants were advised to practise these measures to prevent or reduce exposure to leptospirosis risk factors in their daily work.

A week after the intervention, a sample of participants was randomly selected and visited to obtain information about what measures they had put into practice to prevent or reduce exposure to leptospirosis risk factors before working in aquatic or wet environments, and to check whether they still remembered the steps for checking on the presence of skin wounds, and whether they covered these skin wounds before working in aquatic or wet environments.

3.3.2.4 Program evaluation

Evaluation was focused on formative evaluation (evaluation conducted during the development stages of the program), process evaluation (tracking the progress of the intervention's implementation), and impact evaluation (evaluating changes in the levels of knowledge of leptospirosis risk factors and actions performed to reduce exposure).

Figure 3.4 Study Framework



CHAPTER 4
RESEARCH FINDINGS

The results for each of the studies undertaken are presented chronologically in accordance with the specific objectives listed for the research: 1a, 1b, 1c, 2a, and 2b.

4.1 Review of previous studies of risk factors for leptospirosis infection in humans

Specific objective 1a:

To review and synthesise data associated with leptospirosis risk factors reported in grey literature and in international peer-reviewed sources, and to identify the distribution of similarities and differences in risk factors for leptospirosis in Indonesia and in the Asia-Pacific region.

Some of results from this review have been accepted for publication as an article in the *Asia-Pacific Journal of Public Health*.[213]

4.1.1 Introduction

This is the first of the three sub-chapters addressing the first objective of the research. The first objective of the research was to identify social, behavioural, and environmental characteristics that could be related to the occurrence of leptospirosis in humans. The purpose of this sub-chapter is to report the availability of information relevant to local leptospirosis risk factors in leptospirosis-endemic areas of Indonesia, and to compare the pattern of human leptospirosis risk factors in Indonesia with the pattern in other Asia-Pacific countries.

Available local leptospirosis risk factor data for Demak district have been synthesised and compared with available leptospirosis risk factor data from other endemic districts in Indonesia. Then, these Indonesian data have been compared with synthesised data from previous leptospirosis risk factor studies in other Asia-Pacific locations, to compare and contrast the similarities and differences in risk factors for human leptospirosis.

4.1.2 **Characteristics of selected studies**

A total of 737 English articles relating to human leptospirosis risk factors was identified from Medline, PubMed, and Scopus databases. After removing repeated articles, 363 articles were assessed in relation to the extent they provided information on risk factors for leptospirosis infection in humans.

Ninety-six selected articles were evaluated for their presentation of strength of association values: odds ratio, risk ratio, or prevalence ratio. A total of 36 articles was found to present the strength of association values. Because their study sites were not within the Asia-Pacific region, 17 articles were excluded. One relevant study[103] found in the references list appended to a selected article, but not included in the original list of selected articles, was added as it fulfilled the inclusion criteria. The final number of international peer-reviewed articles included totalled 20 articles. No Indonesian studies of human leptospirosis risk factors fulfilling the inclusion criteria were found in the databases searched. However, articles on Indonesian studies of human leptospirosis risk factors were sourced from Indonesian grey literature published prior to January 2012. Included in the study were 14 studies of leptospirosis risk factors in Indonesia that fulfilled inclusion criteria 2, 3, and 4 (see page no 51). Ultimately, a total of 34 peer-reviewed and other publications was included in the review.

Table 4.1 presents the characteristics of the 34 selected studies. The main approaches used in the studies were case-control (21; 61.8%) and cross-sectional (13; 38.2%). The majority of the Indonesian leptospirosis risk factor studies (13; 92.9%) were conducted by Indonesian university researchers. In contrast, government agencies in the other Asia-Pacific countries were the leading contributors for the majority of studies that investigated leptospirosis risk factors (14; 70.0%). A number of the leptospirosis risk factor studies in Indonesia lacked diagnostic confirmation for cases cited (9; 64.3%), as only rapid test results and the clinical characteristics of respondents were relied on to support the diagnosis. By contrast, leptospirosis risk factor studies from other Asia-Pacific countries used MAT (13; 65.0%) and ELISA (7; 35.5%) for diagnostic confirmation of leptospirosis disease or infection. More specific leptospirosis laboratory tests had been required for diagnostic confirmation of cases cited in Indonesia.

4.1.3 **Leptospirosis risk factors in Demak district and other districts of Indonesia**

Five studies in Demak district and nine studies in other leptospirosis-endemic districts of Indonesia that fulfilled the inclusion criteria were included in this study. The potential risk factors for human leptospirosis that were frequently included in leptospirosis risk factor studies in Indonesia were: the presence of rats (13; 92.9%); the presence of domestic animals or livestock (11; 78.6%); poor home sanitation (11; 78.6%); work-related contact with contaminated surface water (10; 71.4%); low education levels (10; 71.4%); poor sewerage (9; 64.3%), and stagnant water in areas immediately surrounding houses (8; 57.1%).

Table 4.1 Characteristics of the selected studies

	STUDIES	Study design	CHARACTERISTICS			Total number of samples
			Institution	Study sites	Population for comparison group	
INDONESIA	Handayani and Ristiyanto, 2008 (36)	CS	Indonesia-Gov	Indonesia- Demak	General population	101
	Priyanto, 2008 (18)	CC	Indonesia-Univ	Indonesia-Demak	Hospital patients	123
	Putri, 2009 (136)	CC	Indonesia-Univ	Indonesia-Demak	Neighbourhood of the cases	120
	Ikawati, 2010 (82)	CC	Indonesia-Univ	Indonesia-Demak	Neighbourhood of the cases	88
	Anies et al., 2009 (83)	CC	Indonesia-Univ	Indonesia-Demak	Hospital patients	120
	Wiharyadi, 2004 (21)	CC	Indonesia-Univ	Indonesia-Semarang	Hospital patients	86
	Sarwani, 2005 (123)	CC	Indonesia-Univ	Indonesia-Semarang	Hospital patients	126
	Suratman, 2008 (124)	CC	Indonesia-Univ	Indonesia-Semarang	Neighbourhood of the cases	114
	Murtiningsih, 2005 (31)	CC	Indonesia-Univ	Indonesia-Yogyakarta	Neighbourhood of the cases	106
	Okatini et al., 2007 (32)	CC	Indonesia-Univ	Indonesia-Jakarta	Hospital patients	190
	Hasanah, 2007 (35)	CS	Indonesia-Univ	Indonesia-Klaten	General population	50
	Prasetyo, 2006 (78)	CC	Indonesia-Univ	Indonesia-Semarang	Hospital patients	154
	Hernowo, 2002 (137)	CC	Indonesia-Univ	Indonesia-Jakarta	General population	180
	Suprapto, 1997 (138)	CC	Indonesia-Univ	Indonesia-Semarang	Neighbourhood of the cases	70
OTHER COUNTRIES	Sulong et al., 2011 (127)	CS	Malaysia-Univ	Malaysia	Town service workers	296
	Stern et al., 2010 (145)	CC	USA-Gov	USA	Adventure race participants	192
	Sugunan et al., 2009 (22)	CC	India-Gov	India	Neighbourhood of the cases	156
	Bhardwaj et al., 2008 (125)	CC	India-Univ	India	People visiting the hospital	315
	Kawaguchi et al., 2008 (20)	CS	Japan-Univ	Lao PDR	General population	406
	Thai et al., 2006 (143)	CS	Netherlands-Univ	Vietnam	Schoolchildren	961
	Vijayachari et al., 2004 (142)	CS	India-Gov	India	Schoolchildren	341
	Johnson et al., 2004 (103)	CS	Peru-Gov & USA-Univ	Peru	General population	195
	Leal-Castellanos et al., 2003(129)	CS	Mexico-Gov	Mexico	General population	1169
	Sehgal et al., 2003 (135)	CS	India-Gov	India	Hospital patients	3682
	Sejvar et al., 2003 (146)	CC	USA-Gov	Malaysia	Eco-challenge athletes	189
	Phraisuwan et al., 2002 (154)	CS	Thailand-Gov	Thailand	Pond cleaning participants	104
	Morgan et al., 2002 (159)	CC	USA-Gov	USA	Triathlon participants	834
	Tangkanakul et al., 2001 (139)	CC	Thailand-Gov	Thailand	Neighbourhood of the cases	201
	Ashford et al., 2000 (9)	CS	USA-Gov & Nicaragua-Gov	Nicaragua	El Sauce town community	566
	Tangkanakul et al., 2000 (19)	CC	Thailand-Gov	Thailand	Neighbourhood of the cases	177
	Campagnolo et al., 2000 (161)	CS	USA-Gov	USA	People exposed to UMC swine herd	163
	Murhekar et al., 1998 (117)	CC	India-Gov	India	General population	1014
	Sasaki et al., 1993 (151)	CC	USA-Gov	Hawaii	Hospital patients	110
	Childs et al., 1992 (152)	CS	USA-Univ	USA	People visiting the clinic	200

CS= Cross sectional study CC= Case control study Gov= Government Univ= University
(Adapted from Sakundarno,M, *Asia Pac J Public Healh 1010539513498768.* 2013)

4.1.3.1 Animal factors

Animal-related risk factors and leptospirosis risk factor studies in Demak district and in other districts of Indonesia are presented in Table 4.2. Studies in Demak district (3; 60%) and in other districts of Indonesia (5; 62.5%) showed a significant association between the presence of rats in houses, or in close proximity to human habitation, and leptospirosis infection in humans. Out of a total of 14 such studies, 11 (78.6%) Indonesian leptospirosis risk factor studies examined the association between the presence of domestic animals/livestock close to residential premises and leptospirosis infection in humans. Surprisingly, none of them showed a significant association.

4.1.3.2 Environmental factors

Environmental risk factors and leptospirosis risk factor studies in Demak district and in other districts of Indonesia are presented in Table 4.2. The potential environmental risks or modifiable determinants for leptospirosis infection in humans that are usually examined in Indonesian studies were found to be: flooding (7; 50%); stagnant water surrounding the house (9; 64.3%); poor sewerage, such as clogged sewers or sewers with water overflow (9; 64.3%); poor home sanitation and insanitary surroundings, such as houses with plentiful scattered rubbish both inside and outside (11; 78.6%).

No studies in Demak district, but four out of five (80%) studies in other districts of Indonesia showed a significant association between flooding within the last 14 days and leptospirosis infection in humans. Two out of five studies in Demak district (40%) and three out of four studies in other districts of Indonesia (75%) showed a significant association between stagnant water in areas immediately surrounding homes and leptospirosis infection in humans. One out of three studies in Demak district (33.3%) and, in contrast, four out of six studies in other districts of Indonesia (66.7%) showed a significant association between poor sewerage and leptospirosis infection in humans. Three out of four studies in Demak district (75.0%) and five out of seven studies in other districts of Indonesia (71.4%) showed a significant association between poor home sanitation and leptospirosis infection in humans.

Table 4.2 Animal and environmental risk factors and leptospirosis risk factor studies in Demak district and other districts in Indonesia

Study Sites	STUDIES	Environmental and animal related factors					
		Flooding within the last 14 days	Stagnant water in the area surrounding the house	Poor sewerage	Poor home sanitation	Presence of rats	Presence of domestic animals/ livestock
Demak district	Handayani and Ristiyanto, 2008 (36)	o	~	o	**X**	**X**	^
	Priyanto, 2008 (18)	o	**X**	**XX**	**XX**	**XX**	^
	Putri, 2009 (136)	^	^	o	**X**	**X**	^
	Ikawati, 2010 (82)	^	^	^	^	^	o
	Anies et al., 2009 (83)	o	**XX**	^	o	^	^
Other District in Indonesia	Wiharyadi, 2004 (21)	**X**	**XX**	^	**X**	**X**	^
	Sarwani, 2005 (123)	o	**X**	**X**	**XX**	**XX**	^
	Suratman, 2008 (124)	**X**	o	**XX**	^	**XX**	^
	Murtiningsih, 2005 (31)	o	o	o	o	**XX**	^
	Okatini et al., 2007 (32)	o	o	**X**	**X**	^	o
	Hasanah, 2007 (35)	~	o	o	**X**	^	^
	Prasetyo, 2006 (78)	**X**	**X**	**X**	**X**	**XX**	^
	Hernowo, 2002 (137)	**X**	o	o	o	o	^
	Suprapto, 1997 (138)	o	^	^	^	^	o
	Number of studies with significant association/number of studies examined the association	4/6	5/8	5/9	8/11	8/13	0/11

X = Significant (p<0.05) in bivariate analysis XX= Significant (p<0.05) in multivariate analysis
o = Factor was not examined ^ = Factor was examined, no significant association ~ = Factor was examined, no information regarding association test
- = no information provided
(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

4.1.3.3 Human factors

Human behavioural factors and leptospirosis risk factor studies in Demak district and in other districts of Indonesia are presented in Table 4.3. The human behaviour cited in Indonesian leptospirosis risk factor studies included: contact with stagnant water (4; 28.6%); contact with river or flood water, or muddy areas (4; 28.6%); swimming in rivers or streams (2; 14.3%); bathing in rivers (6; 42.9%); washing in rivers (6; 42.9%); contact with animal urine or tissues (4; 28.6%); not wearing personal protection equipment (4; 28.6%); walking barefoot (2; 14.3%), and using streams as a source of drinking water (2; 14.3%).

Table 4.3 Human-related risk factors: Behavioural factors and leptospirosis risk factor studies in Demak district and other districts of Indonesia

	STUDIES	Behaviour-related factors									
		Contact with stagnant water	Contact with flood water/ rivers/ muddy area	Swimming in streams/ rivers/ flood	Bathing in rivers/ ponds/ flood water	Washing in or using rivers/ ponds/ flood water	Contact with rats' bodies/ urine/ tissues	Contact with domestic animals' bodies /urine	Not wearing personal protection	Walking barefoot	Using streams as source of drinking water
Demak district	Handayani and Ristiyanto, 2008 (36)	o	o	^	^	^	o	o	o	o	o
	Priyanto, 2008 (18)	o	o	o	**X**	**X**	o	o	o	**XX**	o
	Putri, 2009 (136)	o	o	o	o	o	o	o	o	o	^
	Ikawati, 2010 (82)	^	^	o	o	o	^	o	o	o	o
	Anies et al., 2009 (83)	**X**	^	o	**X**	**X**	^	^	^	o	o
Other districts of Indonesia	Wiharyadi, 2004 (21)	**X**	**X**	o	o	o	o	o	o	o	o
	Sarwani, 2005 (123)	o	o	o	^	^	o	o	^	^	o
	Suratman, 2008 (124)	o	o	o	^	^	**XX**	o	^	o	^
	Murtiningsih, 2005 (31)	o	o	^	**X**	**X**	o	o	o	o	o
	Okatini et al., 2007 (32)	o	o	o	o	o	o	o	o	o	o
	Hasanah, 2007 (35)	o	o	o	o	o	o	o	o	o	o
	Prasetyo, 2006 (78)	**X**	**X**	o	o	o	o	o	o	o	o
	Hernowo, 2002 (137)	o	o	o	o	o	^	^	**XX**	o	o
	Suprapto, 1997 (138)	o	o	o	o	o	o	o	o	o	o
	Number of studies with significant association/number of studies examined the association	3/4	2/4	0/2	3/6	3/6	1/4	0/2	1/4	1/2	0/2

X = Significant (p<0.05) in bivariate analysis XX= Significant (p<0.05) in multivariate analysis o = Factor was not examined
^ = Factor was examined, no significant association
~ = Factor was examined, no information regarding association test
- = no information provided
(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

A significant association between contact with stagnant water and leptospirosis infection in humans has been shown in one out of two studies in Demak district (50.0%) and, in contrast, by two out of two studies in other districts of Indonesia (100%). None of two studies in Demak district (0%) and, in contrast, two out of two studies in other districts of Indonesia (100%) showed a significant association between contact with river or flood water and leptospirosis infection in humans. Surprisingly, a study in Demak district (1; 20.0%) and in other districts of Indonesia (1; 11.1%) did not show a significant association between swimming in streams or rivers and leptospirosis infection in humans.

Two out of three studies in Demak district (66.7%) and one out of three studies in other districts of Indonesia (33.3%) showed a significant association between bathing or

washing clothes in rivers and leptospirosis infection in humans. None out of two studies in Demak district (0.0%) and one out of two studies (50.0%) showed a significant association between direct contact with rats' bodies, tissues or urine and leptospirosis infection in humans. Among two Indonesian studies of the association between contact with domestic animals/ livestock and leptospirosis infection in humans, none reported a significant association. No study in Demak district and only one among three studies in other districts of Indonesia (1; 33.3%) reported a significant association between not wearing personal protection and leptospirosis infection. Among five studies in Demak district, only one study examined an association between walking barefoot and leptospirosis infection in humans, and this study did show a significant association. Only one of nine studies in other districts of Indonesia showed no significant association. Both studies, one from Demak district and one from other districts of Indonesia that examined the association between using stream water as a source of drinking water and leptospirosis infection in humans reported no significant association.

Table 4.4 shows findings from Indonesian leptospirosis risk factor studies in relation to occupational factors. Work involving contact with contaminated surface water or substances was the main type of occupation included in the leptospirosis risk factor studies in Indonesia (10; 71.4%). One out of three studies in Demak district (33.3%) and four out of seven studies in other districts of Indonesia (57.1%) showed a significant association between work involving contact with contaminated surface water and leptospirosis infection in humans.

Activities in paddy fields and fishing or catching fish in rivers or ponds are also occupations included in the leptospirosis risk factor studies in Indonesia. Surprisingly, neither of two studies in Indonesia showed a significant association between fishing or catching fish in rivers or ponds and leptospirosis infection in humans. None of the selected studies examined an association between leptospirosis infection in humans and activities in agricultural fields other than paddy fields, nor during activities in the forest, or while cleaning up sewage or garbage.

Table 4.4 Human-related risk factors: Occupational factors and leptospirosis risk factor studies in Demak district and other districts of Indonesia

	STUDIES	Occupational related factors						
		Work -related contact with contaminated surface water or substance	Activities in paddy fields	Activities in agricultural fields other than paddy fields	Catching fish in rivers/ ponds/ irrigation waterways	Collect-ing wood/ work activity in the forest	Cleaning up sewage	Clearing garbage
Demak district	Handayani and Ristiyanto, 2008 (36)	o	^	o	^	o	o	o
	Priyanto, 2008 (18)	**XX**	o	o	o	o	o	o
	Putri, 2009 (136)	^	o	o	o	o	o	o
	Ikawati, 2010 (82)	o	o	o	o	o	o	o
	Anies et al., 2009 (83)	^	o	o	o	o	o	o
Other districts of Indonesia	Wiharyadi, 2004 (21)	**XX**	o	o	o	o	o	o
	Sarwani, 2005 (123)	^	o	o	o	o	o	o
	Suratman, 2008 (124)	**X**	o	o	o	o	o	o
	Murtiningsih, 2005 (31)	o	**XX**	o	^	o	o	o
	Okatini et al., 2007 (32)	^	o	o	o	o	o	o
	Hasanah, 2007 (35)	**X**	o	o	o	o	o	o
	Prasetyo, 2006 (78)	**XX**	o	o	o	o	o	o
	Hernowo, 2002 (137)	^	o	o	o	o	o	o
	Suprapto, 1997 (138)	o	o	o	o	o	o	o
	Number of studies with significant association/number of studies examined the association	5/10	1/2	0/0	0/2	0/0	0/0	0/0

X = Significant (p<0.05)in bivariate analysis XX= Significant (p<0.05) in multivariate analysis
o = Factor was not examined ^ = Factor was examined, no significant association
~ = Factor was examined, no information regarding association test - = no information provided
(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

Leptospirosis risk factor studies and human-related risk factors specific to recreational activities, personal hygiene, the presence of skin wounds, and socio-demographic characteristics are presented in Table 4.5. Indonesian studies on the potential association between leptospirosis infection in humans and recreational activities, including swallowing river water during water sport activities, are rare. Only one of the nine selected Indonesian studies examined this association, and the study did show a significant association.

The one study in Demak district that examined unhealthy personal hygiene and leptospirosis infection in humans showed no significant association, but three out of five studies in other districts of Indonesia (60.0%) showed a significant association. One study in Demak district (20.0%) and four studies in other districts of Indonesia (44.4%)

examined a relationship between leptospirosis infection in humans and the presence of skin wounds.

Table 4.5. Human-related risk factors: Recreational, personal hygiene, skin wounds, socio-demographic factors and leptospirosis risk factor studies in Demak district and other districts

	STUDIES	Recreational, personal hygiene, skin wound and socio-demographic related factors					
		Swallowing water (river)	Leisure/ hobby activities	Unhealthy personal hygiene	Presence of wounds on the limbs	Low education levels	Lack of knowledge of or education on leptospirosis
Demak district	Handayani and Ristiyanto, 2008 (36)	O	O	o	O	^	o
	Priyanto, 2008 (18)	O	O	o	O	^	**XX**
	Putri, 2009 (136)	O	O	^	O	^	o
	Ikawati, 2010 (82)	O	O	o	O	^	^
	Anies et al., 2009 (83)	O	O	o	^	^	^
Other districts of Indonesia	Wiharyadi, 2004 (21)	O	O	**XX**	**XX**	**X**	o
	Sarwani, 2005 (123)	O	O	o	O	o	o
	Suratman, 2008 (124)	O	O	^	**XX**	^	o
	Murtiningsih, 2005 (31)	O	**X**	o	O	o	o
	Okatini et al., 2007 (32)	O	O	o	O	**XX**	**XX**
	Hasanah, 2007 (35)	O	O	o	O	~	**X**
	Prasetyo, 2006 (78)	O	O	**X**	**XX**	**X**	o
	Hernowo, 2002 (137)	O	O	**XX**	O	o	o
	Suprapto, 1997 (138)	O	O	^	**X**	^	o
	Number of studies with significant association/number of studies examined the association	0/0	1/1	3/6	4/5	3/10	4/7

X = Significant (p<0.05) in bivariate analysis XX= Significant (p<0.05) in multivariate analysis
o = Factor was not examined ^ = Factor was examined, no significant association
~ = Factor was examined, no information regarding association test - = no information provided
(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

All four studies in other districts of Indonesia (4; 100.0%) showed a significant association between the presence of skin wounds and leptospirosis infection in humans; in contrast, no significant association was shown by the study in Demak district.

Education levels was a variable that was frequently included in all leptospirosis studies in Demak district (5; 100%) and in five studies in other districts of Indonesia (5; 55.6%). Surprisingly, none of the five studies in Demak district showed a significant association between low education levels and leptospirosis infection in humans. In contrast, three out of five studies in other districts of Indonesia (60.0%) showed that this association was significant. One out of three studies in Demak district (33.3%) and two out of two

studies in other districts of Indonesia (100%) showed a significant association between lack of knowledge of leptospirosis and leptospirosis infection in humans.

4.1.4 **Leptospirosis risk factors in Indonesia and other Asia-Pacific countries**

This study has taken into account 14 selected Indonesian studies and 20 selected studies in other Asia-Pacific countries. Potential risk factors for human leptospirosis that were frequently examined in leptospirosis risk factor studies in other Asia-Pacific countries included: the presence of domestic animals or livestock close to residential premises (14; 70.0%); the presence of rats (12; 60.0%); the presence of skin wounds (11; 55.0%), and swimming in streams or rivers (10; 50.0%).

4.1.4.1 Animal factors

Animal-related risk factors and leptospirosis risk factor studies in Indonesia and in other Asia-Pacific countries are presented in Table 4.6. Studies in Indonesia (8; 61.5%) and in other Asia-Pacific countries (3; 25.0%) have reported a significant association between the presence of rats in homes and leptospirosis infection in humans.

Six out of 14 studies in other Asia-Pacific countries showed a significant association between the presence of domestic animals or livestock close to homes and leptospirosis infection in humans. In contrast, none of the 11 Indonesian studies that examined the association between the presence of domestic animals or livestock close to homes and leptospirosis infection in humans showed a significant association.

4.1.4.2 Environmental factors

Environmental risk factors and leptospirosis risk factor studies in Indonesia and in other Asia-Pacific countries are presented in Table 4.6. Flooding, stagnant water in the immediate surroundings of homes, poor sewerage, and poor home sanitation were potential environmental risk factors for leptospirosis infection that were reported in 13 of the 14 Indonesian studies (92.9%). In contrast, only seven of 20 studies (35.0%) in other Asia-Pacific countries reported these potential environmental risk factors.

4.1.4.3 Human factors

Behavioural factors and leptospirosis risk factor studies in Indonesia and in other Asia-Pacific countries are presented in Table 4.7. Human behaviour examined in other Asia-Pacific studies included: contact with stagnant water (5; 25.0%); contact with river or flood water and muddy areas (6; 30.0%); swimming in rivers or streams (10; 50.0%), bathing in rivers (6; 30.0%); washing in rivers (5; 25.0%); contact with animals' urine, bodies or tissues (5; 25.0%); not wearing personal protection equipment (5; 20.0%); walking barefoot (7; 35.0%); wearing shorts in aquatic or wet locations (2; 10.0%); and using streams as a source of drinking water (8; 40.0%).

Studies in other Asia-Pacific countries of the association between leptospirosis infection in humans and contact with stagnant water (2; 40.0%) or contact with flood or river water (2; 33.3%) showed a significant association in a multivariate analysis.[19, 125, 139, 143] In contrast, studies in Indonesia showed significant associations in bivariate analysis but no significant association in multivariate analysis.[21, 78, 82, 83] Two out of 14 Indonesian studies (14.3%) examined the association between leptospirosis in humans and swimming in rivers, and both studies showed no significant association. However, studies in other Asia-Pacific countries (4; 40.0%) showed a significant association between swimming in river water and human leptospirosis infection.[125, 129, 143, 146]

Three out of six studies in Indonesia (50.0%)[18, 31, 83] and six out of six studies in other Asia-Pacific countries (100.0%)[9, 103, 117, 125, 135, 142] showed a significant association in bivariate analysis between bathing in rivers and leptospirosis infection in humans. Similarly, three out of six studies in Indonesia (50.0%)[18, 31, 83] and four out of five studies in other Asia-Pacific countries (80.0%)[9, 125, 143, 214] showed a significant association in bivariate analysis between washing clothes in rivers and leptospirosis infection in humans.

A significant association between direct contact with rats and leptospirosis infection in humans was shown in multivariate analysis by one out of four studies in Indonesia (25.0%) and by one out of five studies in other Asia-Pacific countries (20.0%).[124, 152]

Three out of eight studies in other Asia-Pacific countries (37.5%)[117, 129, 135] and, surprisingly, none of two studies in Indonesia showed a significant association between contact with domestic animals or livestock and leptospirosis infection in humans. Three out of five studies in other Asia-Pacific countries (60.0%)[103, 127, 129] and one out of four studies in Indonesia (25.0%)[137] showed a significant association between not wearing personal protective equipment and leptospirosis infection in humans.

Four out of seven studies in other Asia-Pacific countries (57.1%)[20, 22, 125, 129] and one out of two studies in Indonesia (50.0%)[18] showed a significant association between walking barefoot and leptospirosis infection in humans. People who work in wet areas, specifically in rural areas of developing countries, prefer to wear long trousers. But the association between wearing shorts and human leptospirosis infection is still unclear. One study has shown that people in Thailand who wear shorts instead of long trousers or long skirts when cleaning ponds have a higher risk of getting leptospirosis infections.[154] However, the authors of this study have given no explanation regarding the possible reasons for this finding. In contrast with that study in Thailand, findings from Stern and colleagues showed no significant association between wearing shorts and leptospirosis infection among participants in an adventure race in Florida.[145] No Indonesian studies examined or reported an association between wearing shorts when working in aquatic or wet environments and the occurrence of leptospirosis infection in humans.

A significant association between using stream or river water as a source of drinking water and leptospirosis infection in humans has been shown by two out of eight studies in other Asia-Pacific countries (25.0%) but by neither of two Indonesian studies.

Table 4.6. Animal-related and environmental risk factors and leptospirosis risk factor studies in Indonesia and other Asia-Pacific countries

	STUDIES	Environmental and vector-related factors					
		Flooding within the last 14 days	Stagnant water in the immediate surroundings of homes	Poor sewerage	Poor home sanitation	Presence of rats	Presence of/ owned domestic animals
INDONESIA	Handayani and Ristiyanto, 2008 (36)	o	~	o	**X**	**X**	^
	Priyanto, 2008 (18)	o	**X**	**XX**	**XX**	**XX**	^
	Putri, 2009 (136)	^	^	o	**X**	**X**	^
	Ikawati, 2010 (82)	^	^	^	^	^	o
	Anies et al., 2009 (83)	o	**XX**	^	o	^	^
	Wiharyadi, 2004 (21)	**X**	**XX**	^	**X**	**X**	^
	Sarwani, 2005 (123)	o	**X**	**X**	**XX**	**XX**	^
	Suratman, 2006 (124)	**X**	o	**XX**	^	**XX**	^
	Murtiningsih, 2005 (31)	o	o	o	o	**XX**	^
	Okatini et al., 2007 (32)	o	o	**X**	**X**	^	o
	Hasanah, 2007 (35)	~	o	o	**X**	^	^
	Prasetyo, 2006 (78)	**X**	**X**	**X**	**X**	**XX**	^
	Hernowo, 2002 (137)	**X**	o	o	o	o	^
	Suprapto, 1997 (138)	o	^	^	^	^	o
OTHER COUNTRIES	Sulong et al., 2011 (127)	^	o	o	^	**XX**	^
	Stern et al., 2010 (145) #	o	o	o	o	o	o
	Sugunan et al., 2009 (22)	o	o	o	o	^	**XX**
	Bhardwaj et al., 2008 (125)	o	o	o	o	**XX**	o
	Kawaguchi et al., 2008 (20)	**XX**	o	o	o	^	^
	Thai et al., 2006 (143) *	o	o	o	o	o	^
	Vijayachari et al., 2004 (142) *	-	-	-	-	-	**X**
	Johnson et al., 2004 (103)	o	o	o	**X**	^	^
	Leal-Castellanos et al., 2003 (129)	**X**	**X**	o	o	^	**XX**
	Sehgal et al., 2003 (135)	o	**X**	o	**X**	**X**	**X**
	Sejvar et al., 2003 (146) #	o	o	o	o	o	o
	Phraisuwan et al., 2002 (154)	o	o	o	o	o	o
	Morgan et al., 2002 (159) #	o	o	o	o	o	o
	Tangkanakul et al., 2001 (139)	o	o	o	^	^	^
	Ashford et al., 2000 (9)	o	o	o	o	^	^
	Tangkanakul et al., 2000 (19)	o	o	o	o	o	**X**
	Campagnolo et al., 2000 (161)	o	o	o	o	o	o
	Murhekar et al., 1998 (117)	o	^	o	o	^	^
	Sasaki et al., 1993 (151)	o	o	o	o	^	^
	Childs et al., 1992 (152)	o	o	o	o	^	**X**
	Number of studies with significant association/number of studies examined the association	6/10	7/12	5/9	10/15	11/25	6/25

X = Significant (p<0.05) in bivariate analysis XX= Significant (p<0.05) in multivariate analysis

*= Study among children #= Study among adventure race participants o = Factor was not examined

^ = Factor was examined, no significant association ~ = Factor was examined, no information regarding association test

- = no information provided

(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

Table 4.7 Behavioural factors and leptospirosis risk factor studies in Indonesia and in other Asia-Pacific countries

	STUDIES	Behavioural related factors										
		Contact with stagnant water	Contact with flood water/ rivers/ muddy areas	Swimming in streams/ rivers/ flood	Bathing in rivers/ ponds / flood water	Washing in or using rivers/ ponds / flood water	Contact with rats ' bodies/ urine/ tissues	Contact with domestic animals' bodies, urine	Not wearing personal protection	Walking barefoot	Wearing shorts in wet places	Using streams as a source of drinking water
INDONESIA	Handayani and Ristiyanto, 2008 (36)	o	o	^	^	^	o	o	o	o	o	o
	Priyanto, 2008 (18)	o	o	o	**X**	**X**	o	o	o	**XX**	o	o
	Putri, 2009 (136)	o	o	o	o	o	o	o	o	o	o	^
	Ikawati, 2010 (82)	^	^	o	o	o	^	o	o	o	o	o
	Anies et al., 2009 (83)	**X**	^	o	**X**	**X**	^	^	^	o	o	o
	Wiharyadi, 2004 (21)	**X**	**X**	o	o	o	o	o	o	o	o	o
	Sarwani, 2005 (123)	o	o	o	^	^	o	o	^	^	o	o
	Suratman, 2008 (124)	o	o	o	^	^	**XX**	o	^	o	o	^
	Murtiningsih, 2005 (31)	o	o	^	**X**	**X**	o	o	o	o	o	o
	Okatini et al., 2007 (32)	o	o	o	o	o	o	o	o	o	o	o
	Hasanah, 2007 (35)	o	o	o	o	o	o	o	o	o	o	o
	Prasetyo, 2006 (78)	**X**	**X**	o	o	o	o	o	o	o	o	o
	Hernowo, 2002 (137)	o	o	o	o	o	^	^	**XX**	o	o	o
	Suprapto, 1997 (138)	o	o	o	o	o	o	o	o	o	o	o
OTHER COUNTRIES	Sulong et al., 2011 (127)	o	o	o	o	o	^	^	**XX**	o	o	o
	Stern et al., 2010 (145) #	o	o	^	o	o	o	o	o	o	^	o
	Sugunan et al., 2009 (22)	^	o	^	o	^	^	^	o	**XX**	o	**XX**
	Bhardwaj et al., 2008 (125)	o	**XX**[a)]	**X**	**X**	**X**	^	^	o	**XX**	o	^
	Kawaguchi et al., 2008 (20)	o	^	^	o	o	o	o	o	**X**	o	^
	Thai et al., 2006 (143) *	o	**XX**	**X**	o	**X**	o	o	o	^	o	^
	Vijayachari et al., 2004 (142) *	-	**X**[b)]	-	**X**	-	-	-	-	-	-	-
	Johnson et al., 2004 (103)	o	o	o	**X**	o	o	o	**XX**	o	o	^
	Leal-Castellanos et al., 2003 (129)	**X**	o	**X**	o	o	o	**XX**[c)]	**XX**[c)]	**X**	o	o
	Sehgal et al., 2003 (135)	o	o	o	**X**	**X**	o	**X**	o	o	o	o
	Sejvar et al., 2003 (146) #	o	o	**XX**	o	o	o	o	o	o	o	o
	Phraisuwan et al., 2002 (154)	o	o	o	o	o	o	o	o	o	**XX**	o
	Morgan et al., 2002 (159) #	o	o	^	o	o	o	o	o	o	o	o
	Tangkanakul et al., 2001 (139)	**XX**	o	o	o	o	o	o	o	o	o	o
	Ashford et al., 2000 (9)	o	^	^	**X**	**X**	o	o	o	^	o	**XX**
	Tangkanakul et al., 2000 (19)	**XX**	o	o	o	o	o	o	^	o	o	o
	Campagnolo et al., 2000 (161)	o	o	o	o	o	o	^	^	o	o	o
	Murhekar et al., 1998 (117)	**X**	o	o	**X**	o	o	^	o	^	o	^
	Sasaki et al., 1993 (151)	o	^	^	o	o	^	**X**	o	o	o	^
	Childs et al., 1992 (152)	o	o	o	o	o	**XX**	o	o	o	o	o
	Number of studies with significant association/number of studies examined the association	7/9	5/10	4/12	9/12	7/11	2/9	3/10	4/9	5/ 9	1/2	2/10

X = Significant (p<0.05) in bivariate analysis XX= Significant (p<0.05) in multivariate analysis [a)] Contact of injured part with flood water [b)] Contact with muddy floor in the house [c)] Contact with animal excreta with no protection and with skin cut *= Study among children

#= Study among adventure race participants o = Factor was not examined ^ = Factor was examined, no significant association

~ = Factor was examined, no information regarding association test

- = no information provided

(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

Table 4.8 shows occupational factors and leptospirosis risk factor studies in Indonesia and other Asia-Pacific countries. Twelve out of 14 Indonesian studies (85.7%) and 10 out of 20 studies in other Asia-Pacific countries (50.0%) included occupational factors as investigated variables. Work involving contact with contaminated surface water was the occupational factor most frequently included in Indonesian studies (10; 71.4%) and in other Asia-Pacific countries' studies (6; 30.0%). Activities in paddy fields were included as an investigated variable by two out of 14 studies in Indonesia (14.3%) and by four out of 20 studies in other Asia-Pacific countries (20.0%). Other occupational factors included in leptospirosis risk factor studies in other Asia-Pacific countries were: activities in agricultural fields other than paddy fields (5; 25.0%); fishing in rivers or ponds (6; 30.0%); collecting wood in forests (3; 15.0%); cleaning up sewage (2; 10.0%), and clearing garbage from local collection points (3; 15.0%). Surprisingly, no studies in Indonesia investigated activities in agricultural fields other than paddy fields, collecting wood in forests, cleaning sewage or clearing garbage from a local collection point.

Five out of 10 studies in Indonesia (50.0%) and four out of six studies in other Asia-Pacific countries (66.7%) showed a significant association between work involving contact with contaminated water or substances and leptospirosis infection in humans.[18, 21, 22, 35, 78, 117, 124, 129, 135] Similarly, one out of two studies in Indonesia (50.0%) and three out of four studies in other Asia-Pacific countries (75.0%) showed a significant association between activities in paddy fields and leptospirosis infection in humans.[19, 22, 31, 117] Only two out of 14 studies in Indonesia (14.3%) examined an association between fishing in rivers or ponds and leptospirosis infection in humans, and none of these showed a significant association.[31, 36]

Table 4.8 Occupational factors and leptospirosis risk factor studies in Indonesia and other Asia-Pacific countries

	STUDIES	Occupational related factors						
		Work involving contact with contaminated surface water or substance	Activities in paddy fields	Activities in agricultural fields other than paddy fields	Catching fish in rivers/ ponds/ irrigation waterways	Collecting wood/ work activity in forests	Cleaning up sewage	Clearing garbage
INDONESIA@	Handayani and Ristiyanto, 2008 (36)	o	^	o	^	o	o	o
	Priyanto, 2008 (18)	**XX**	o	o	o	o	o	o
	Putri, 2009 (136)	^	o	o	o	o	o	o
	Ikawati, 2010 (82)	o	o	o	o	o	o	o
	Anies et al., 2009 (83)	^	o	o	o	o	o	o
	Wiharyadi, 2004 (21)	**XX**	o	o	o	o	o	o
	Sarwani, 2005 (123)	^	o	o	o	o	o	o
	Suratman, 2008 (124)	**X**	o	o	o	o	o	o
	Murtiningsih, 2005 (31)	o	**XX**	o	^	o	o	o
	Okatini et al., 2007 (32)	^	o	o	o	o	o	o
	Hasanah, 2007 (35)	**X**	o	o	o	o	o	o
	Prasetyo, 2006 (78)	**XX**	o	o	o	o	o	o
	Hernowo, 2002 (137)	^	o	o	o	o	o	o
	Suprapto, 1997 (138)	o	o	o	o	o	o	o
OTHER COUNTRIES$	Sulong et al., 2011 (127)	o	o	o	o	o	o	o
	Stern et al., 2010 (145) #	o	o	o	o	o	o	o
	Sugunan et al., 2009 (22)	**XX**	**X**	^	^	o	**X**	**XX**
	Bhardwaj et al., 2008 (125)	o	o	o	o	o	o	o
	Kawaguchi et al., 2008 (20)	o	^	^	^	**XX**	o	o
	Thai et al., 2006 (143) *	o	o	o	o	o	o	o
	Vijayachari et al., 2004 (142) *	-	-	**X**[d)]	-	-	-	-
	Johnson et al., 2004 (103)	o	o	o	^	o	o	o
	Leal-Castellanos et al., 2003 (129)	**XX**	o	o	o	o	o	o
	Sehgal et al., 2003 (135)	**X**	o	o	o	o	o	o
	Sejvar et al., 2003 (146) #	o	o	o	o	o	o	o
	Phraisuwan et al., 2002 (154)	o	o	o	o	o	o	o
	Morgan et al., 2002 (159) #	o	o	o	o	o	o	o
	Tangkanakul et al., 2001 (139)	o	o	o	o	o	o	o
	Ashford et al., 2000 (9)	^	o	**X**	o	**XX**	^	^
	Tangkanakul et al., 2000 (19)	o	**XX**	o	^	o	o	o
	Campagnolo et al., 2000 (161)	o	o	o	o	o	o	o
	Murhekar et al., 1998 (117)	**X**	**X**	**X**	**X**	**X**	o	o
	Sasaki et al., 1993 (151)	^	o	o	^	o	o	^
	Childs et al., 1992 (152)	o	o	o	o	o	o	o
	Number of studies with significant association/number of studies examined the association	9/16	4/6	3/5	1/8	3/3	1/2	1/3

X = Significant (p<0.05)in bivariate analysis XX= Significant (p<0.05) in multivariate analysis
[d)] No information whether or not activity in paddy fields was included *= Study among children
#= Study among adventure race participants o = Factor was not examined ^ = Factor was examined, no significant association
~ = Factor was examined, no information regarding association test - = no information provided
@ = Grey literature $ = International peer-reviewed literature
(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

However, one out of six studies in other Asia-Pacific countries (16.7%) showed a significant association between fishing in rivers or ponds and leptospirosis infection in humans.(117) Studies in other Asia-Pacific countries showed that activities in forests (3; 100.0%), cleaning up sewage (1; 50.0%), and clearing garbage (1; 33.3%) had a significant association with leptospirosis infection in humans.[9, 20, 22, 117]

Table 4.9 shows recreational, personal hygiene, socio-demographic factors and leptospirosis risk factor studies in Indonesia and other Asia-Pacific countries. Recreational risk factors for leptospirosis infection in humans include all leisure activities that potentially expose participants to a source of leptospirosis infection, such as contaminated water, animals' bodies or tissues. One out of 14 studies in Indonesia (7.1%) and five out of 20 studies in other Asia-Pacific countries (25.0%) examined an association between leisure activities, including hobby sports leading to swallowing water, and leptospirosis infection in humans. One out of one Indonesian study (100.0%) and one out of two studies in other Asia-Pacific countries (50.0%) showed a significant association between leisure activities and leptospirosis infection in humans.[31, 127] All three studies in other Asia-Pacific countries that examined an association between swallowing river water during sporting competitions in leptospirosis-endemic areas and leptospirosis infection in humans showed a significant association.[145, 146, 159] A greater number of studies in Indonesia (6; 42.9%) than in other Asia-Pacific countries (2; 10.0%) examined the association between personal hygiene and leptospirosis infection in humans. A significant association was reported by three out of six studies in Indonesia (50.0%) and two out of two studies in other Asia-Pacific countries (100.0%).[21, 78, 127, 137, 161]

A greater number of studies in other Asia-Pacific countries (11; 55.0%) than in Indonesia (5; 35.7%) included the presence of skin wounds as a studied potential risk factor for leptospirosis infection in humans. However, a greater proportion of studies in Indonesia (4; 80.0%) than in other Asia-Pacific countries (6; 54.5%) showed a significant association between the presence of skin wounds and leptospirosis infection in humans.[19, 21, 22, 78, 124, 129, 138, 151, 154]

Similarly, a greater proportion of studies in Indonesia (10; 90.9%) than in other Asia-Pacific countries (2; 18.2%) examined the association between a person's educational attainment level and leptospirosis infection in humans. Three out of 10 studies in Indonesia (33.3%) and none of two studies in other Asia-Pacific countries showed a significant association between a person's educational attainment level and leptospirosis infection in humans.[21, 32, 78] The association between lack of knowledge of leptospirosis and leptospirosis infection in humans was examined by five out of 14 studies in Indonesia (35.7%) and by two out of 20 studies in other Asia-Pacific countries (10.0%). A significant association between lack of knowledge of leptospirosis and leptospirosis infection in humans has been shown in three out of five studies in Indonesia (60.0%) and in one out of two studies in other Asia-Pacific countries (50.0%).[18, 32, 35, 139]

Table 4.9 Recreational, personal hygiene, and socio-demographic factors and leptospirosis risk factor studies in Indonesia and other Asia-Pacific countries

	STUDIES	Recreational, personal hygiene, skin wounds and socio-demographic factors					
		Swallowing water (river)	Leisure/ hobby activities	Unhealthy personal hygiene	Existence of wounds on the limbs	Low education levels	Lack of knowledge or education on leptospirosis
INDONESIA	Handayani and Ristiyanto, 2008 (36)	o	o	o	o	^	o
	Priyanto, 2008 (18)	o	o	o	o	^	**XX**
	Putri, 2009 (136)	o	o	^	o	^	o
	Ikawati, 2010 (82)	o	o	o	o	^	^
	Anies et al., 2009 (83)	o	o	o	^	^	^
	Wiharyadi, 2004 (21)	o	o	**XX**	**XX**	**X**	o
	Sarwani, 2005 (123)	o	o	o	o	o	o
	Suratman, 2008 (124)	o	o	^	**XX**	^	o
	Murtiningsih, 2005 (31)	o	**X**	o	o	o	o
	Okatini et al., 2007 (32)	o	o	o	o	**XX**	**XX**
	Hasanah, 2007 (35)	o	o	o	o	~	**X**
	Prasetyo, 2006 (78)	o	o	**X**	**XX**	**X**	o
	Hernowo, 2002 (137)	o	o	**XX**	o	o	o
	Suprapto, 1997 (138)	o	o	^	**X**	^	o
OTHER COUNTRIES	Sulong et al., 2011 (127)	o	**XX**	**XX**	^	^	o
	Stern et al., 2010 (145) #	**XX**	o	o	^	o	o
	Sugunan et al., 2009 (22)	o	o	o	**X**	o	o
	Bhardwaj et al., 2008 (125)	o	o	o	**XX**[a)]	o	o
	Kawaguchi et al., 2008 (20)	o	o	o	o	o	o
	Thai et al., 2006 (143) *	o	o	o	o	o	o
	Vijayachari et al., 2004 (142) *	-	-	-	-	-	-
	Johnson et al., 2004 (103)	o	o	o	o	^	o
	Leal-Castellanos et al., 2003 (129)	o	o	o	**XX**[c)]	o	o
	Sehgal et al., 2003 (135)	o	o	o	o	o	o
	Sejvar et al., 2003 (146) #	**X**	o	o	^	o	o
	Phraisuwan et al., 2002 (154)	o	o	o	**XX**	o	o
	Morgan et al., 2002 (159) #	**XX**	o	o	^	o	o
	Tangkanakul et al., 2001 (139)	o	o	o	o	o	**X**
	Ashford et al., 2000 (9)	o	o	o	o	o	o
	Tangkanakul et al., 2000 (19)	o	o	o	**X**	o	o
	Campagnolo et al., 2000 (161)	o	o	**X**	^	o	^
	Murhekar et al., 1998 (117)	o	o	o	o	o	o
	Sasaki et al., 1993 (151)	o	^	o	**X**	o	o
	Childs et al., 1992 (152)	o	o	o	o	o	o
	Number of studies with significant association/number of studies examined the association	3/3	2/3	5/8	10/16	3/13	4/7

X = Significant (p<0.05) in bivariate analysis XX= Significant (p<0.05) in multivariate analysis
[a)] Contact of injured part with flood water [c)] Contact with animal excreta with no protection and with skin cut *= Study among children
#= Study among adventure race participants o = Factor was not examined ^ = Factor was examined, no significant association
~ = Factor was examined, no information regarding association test - = no information provided
(Adapted from Sakundarno,M, *Asia Pac J Public Health 1010539513498768.* 2013)

4.1.5 **Conclusions of sub-chapter 4.1**

Only a limited number of Indonesian studies have examined risk factors for leptospirosis infection in humans. Among the available studies, a number of those studies have not published their findings in national or international peer-reviewed journals; therefore these studies were included as grey literature. Most of the grey literature on leptospirosis risk factors is stored in libraries at local universities or local district health offices. Unfortunately, individuals not affiliated with these institutions are not readily able to access the grey literature held in the libraries due to the bureaucratic access procedures that are in place.

The percentage of examined studies that showed a significant association between a potential risk factor and human leptospirosis in Demak district, in other districts of Indonesia, and in other Asia-Pacific countries, was identified. These percentages are presented in Tables 4.10a, 4.10b, 4.10c, and 4.10d.

The results of a comparison of the percentages for Demak district and for other districts of Indonesia, for each potential risk factor, were divided into four groups. The first group consisted of potential risk factors where 50% or more of the selected studies showed a significant association with human leptospirosis in both Demak district and other districts of Indonesia. Potential risk factors included in this group were stagnant water in the surrounding areas around homes; poor home sanitation; the presence of rats, and human contact with stagnant water. The second group consisted of potential risk factors where 50% or more of the selected studies showed a significant association with human leptospirosis in Demak district, and less than 50% of the selected studies showed a significant association with human leptospirosis in other districts of Indonesia. Potential risk factors included in this group were bathing in rivers or ponds, washing clothes in rivers or ponds, and walking barefoot.

The third group consisted of potential risk factors where 50% or more of the selected studies showed a significant association with human leptospirosis in other districts of Indonesia, and less than 50% showed a significant association with human leptospirosis in Demak district. Potential risk factors included in this group were flooding within the last 14 days; poor sewerage; human contact with flood water; human contact with rats' bodies or tissues; activities in paddy fields; leisure activities; the presence of skin wounds; low education levels, and lack of knowledge of leptospirosis. The fourth group consisted of potential risk factors where less than 50% of the selected studies showed a significant association with human leptospirosis in both Demak district and other districts of Indonesia. Potential risk factors included in this group were the presence of domestic animals or livestock close to homes; human contact with domestic animals or live stock, or with their urine; using streams as a source of drinking water, and activities related to occupational risk factors (except for work involving contact with contaminated surface water, and activities in paddy fields).

The results of the comparison of the percentages between Indonesia and other Asia-Pacific countries, for each potential risk factor, were divided into four groups. The first group consisted of potential risk factors where 50% or more of the selected studies showed a significant association with human leptospirosis in both Indonesia and other Asia-Pacific countries. Potential risk factors included in this group were flooding within the last 14 days; stagnant water in the immediate surroundings around homes; poor home sanitation; human contact with stagnant water; human contact with flood water; bathing in rivers; washing clothes in rivers; work involving contact with contaminated surface water; activities in paddy fields; leisure activities; unhealthy personal hygiene; the presence of skin wounds, and lack of knowledge of leptospirosis.

The second group consisted of potential risk factors where 50% or more of the selected studies showed a significant association with human leptospirosis in Indonesia, and less than 50% of the selected studies showed a significant association with human leptospirosis in other Asia-Pacific countries. Potential risk factors included in this group were poor sewerage, and the presence of rats. The third group consisted of potential risk

factors where 50% or more of the selected studies showed a significant association with human leptospirosis in other Asia- Pacific countries, and less than 50% of the selected studies showed a significant association with human leptospirosis in Indonesia. Potential risk factors included in this group were not wearing personal protection; wearing shorts in an aquatic or wet environment; activities in agricultural fields other than paddy fields; activities in forests; cleaning up sewage, and swallowing river water. The fourth group consisted of potential risk factors where less than 50% of the selected studies showed a significant association with human leptospirosis in both Indonesia and other Asia-Pacific countries. Potential risk factors included in this group were the presence of domestic animals or livestock close to homes; swimming in streams or rivers; contact with rats' bodies or tissues; contact with domestic animals or livestock, or with their urine; using streams as a source of drinking water; fishing in rivers or ponds; clearing garbage, and low education levels.

The cut-off point of 50% is a mechanism that divides a group of reviewed studies into two parts with an equal number of studies in either part. This cut-off point was chosen because it was simple to apply in the field.

Tables 4.10 a,b,c, d present the numbers and percentages of the selected studies showing significant associations between leptospirosis in humans and animal, environmental, behavioural, occupational, recreational, personal hygiene, and socio-demographic factors. They are categorised according to study sites.

Table 4.10a Numbers and percentages of studies with a significant association between animal and environmental factors and leptospirosis infection in humans, by study site

STUDY SITES	Environmental and animal-related factors					
	Flooding within the last 14 days	Stagnant water in areas surrounding the house	Poor sewerage	Poor home sanitation	Presence of rats	Presence of domestic animals/ livestock
Demak district (n; %)	0; 0.0	2; 50.0	1; 33.3	3; 75.0	3; 60.0	0; 0.0
Other districts in Indonesia (n; %)	4; 100	4; 80.0	4; 66.7	5; 71.4	5; 62.5	0; 0.0
Indonesia (n; %)	4; 66.7	5; 62.5	5; 55.6	8; 72.7	8; 61.5	0; 0.0
Other Asia-Pacific countries (n; %)	2; 75.0	2; 50.0	0; 0.0	2; 50.0	3; 25.0	6; 42.9

Table 4.10b Numbers and percentages of studies with a significant association between behavioural factors and leptospirosis infection in humans, by study site

STUDY SITES	Behavioural factors										
	Contact with stagnant water	Contact with flood water/ rivers/ muddy areas	Swimming in streams/ rivers/ flood	Bathing in rivers/ ponds / flood water	Washing in or using rivers/ ponds/ flood water	Contact with rats ' bodies/ urine/ tissues	Contact with domestic animals' bodies, urine	Not wearing personal protection	Walking barefoot	Wearing shorts in wet places	Using streams as a source of drinking water
Demak district (n; %)	1; 50.0	0; 0.0	0; 0.0	2; 66.7	2; 66.7	0; 0.0	0; 0.0	0; 0.0	1; 100	0; 0.0	0; 0.0
Other districts in Indonesia (n; %)	2; 100	2; 100	0; 0.0	1; 33.3	1; 33.3	1; 50.0	0; 0.0	1; 33.3	0; 0.0	0; 0.0	0; 0.0
Indonesia (n; %)	3; 75.0	2; 50.0	0; 0.0	3; 50.0	3; 50.0	1; 25.0	0; 0.0	1; 25.0	1; 50.0	0; 0.0	0; 0.0
Other Asia-Pacific countries (n; %)	4; 80.0	3; 50.0	4; 40.0	6; 100	4; 80.0	1; 20.0	3; 37.5	3; 60.0	4; 57.1	1; 50.0	2; 25.0

Table 4.10c Numbers and percentages of studies with a significant association between occupational factors and leptospirosis infection in humans, by study site

STUDY SITES	Occupational related factors						
	Work involving contact with contaminated surface water or substance	Activities in paddy fields	Activities in agricultural fields other than paddy fields	Catching fish in rivers/ ponds/ irrigation waterways	Collecting wood/ work activity in forests	Cleaning up sewage	Clearing garbage
Demak district (n; %)	1; 33.3	0; 0.0	0; 0.0	0; 0.0	0; 0.0	0; 0.0	0; 0.0
Other districts in Indonesia (n; %)	4; 57.1	1; 100	0; 0.0	0; 0.0	0; 0.0	0; 0.0	0; 0.0
Indonesia (n; %)	5; 50.0	1; 50.0	0; 0.0	0; 0.0	0; 0.0	0; 0.0	0; 0.0
Other Asia-Pacific countries (n; %)	4; 66.7	3; 75.0	3; 60.0	1; 16.7	3; 100	1; 50.0	1; 33.3

Table 4.10d Numbers and percentages of studies with a significant association between recreational, personal hygiene, socio-demographic factors and leptospirosis infection, by study site

STUDY SITES	Recreational, personal hygiene, skin wounds and socio-demographic factors					
	Swallowing water (river)	Leisure/ hobby activities	Unhealthy personal hygiene	Presence of wounds on the limbs	Low education levels	Lack of knowledge or education on leptospirosis
Demak district (n; %)	0; 0.0	0; 0.0	0; 0.0	0; 0.0	0; 0.0	1; 33.3
Other districts in Indonesia (n; %)	0; 0.0	1; 100	3; 60.0	4; 100	3; 60.0	2; 100
Indonesia (n; %)	0; 0.0	1; 100	3; 50.0	4; 80.0	3; 30.0	3; 60.0
Other Asia-Pacific countries (n; %)	3; 100	1; 50.0	2; 100	6; 54.5	0; 0.0	1; 50.0

4.2 Socio-behavioural study related to leptospirosis risk factors and prevention

Specific objective 1b:
To obtain and synthesise information on the social and behavioural characteristics of communities as related to leptospirosis in leptospirosis-endemic areas

4.2.1 **Introduction**

This sub-chapter reports the results of interviews with key informants from Demak district. The purpose of this sub-chapter is to provide background information on behavioural factors related to leptospirosis that are common among people living in leptospirosis-endemic areas.

The lessons learned from the process of preparing and conducting interviews for this study are presented in this sub-chapter. These interviews were necessary in order to elicit relevant information from selected key informants in Demak district. The information obtained was important to the design and implementation of a leptospirosis intervention or control program.

4.2.2 **Characteristics of selected participants**

The 12 selected key informants were from Mranggen, Karangawen, Sayung, Demak, Bonang and Dempet sub-districts. Among the selected informants, six were from local primary health care centres and had health-related educational backgrounds; the other six informants were from sub-district administration offices, and had a non health-related educational background. The informants' average age was 39.9 years with a range of 35–55 years. These key informants' average length of experience of working with the local community was 16.25 years with a range of 5–30 years.

4.2.3 **Socio-behavioural characteristics related to leptospirosis in Demak district**

Three main topics were addressed in the interviews with selected informants. These were local practices involving contact with water and animals; community understanding regarding disease, treatment and prevention; and community understanding about leptospirosis.

4.2.3.1 Local activities involving contact with water and animals

The local activities involving contact with water and animals in Demak district included bathing and washing in rivers, working in paddy fields, fish harvesting, and cleaning open water drains. Bathing and washing in rivers are still customary among people in the sub-districts of Sayung, Demak, Bonang and Dempet. These are mostly people who reside along the river banks. People who do not use river water for bathing and washing use water from artesian wells. Water distributed by *perusahaan air minum* (drinking-water companies) and water from artesian wells are the usual sources of drinking water for most people in Demak district.

Working in paddy fields was found to be a regular activity for more than 50% of people in Demak district. Contact with paddy field water is therefore inevitable for them. The sources of paddy field water in Demak district are the rivers passing through Demak district area, such as Serang, Tuntang, Jajar, Wulan, and Jragung rivers; Kedungombo dam irrigation drainage; and rain water.

Fish harvesting in the ponds is usually manual; contact with pond water is inevitable for the fish harvesters. Fish ponds are found in several locations within Demak district. In Bonang sub-district, there is a catfish farming centre. The water for the centre's catfish ponds is sourced from the Jajar River. This catfish farming centre is the main source of the local community's income.

Open drains are cleared of accumulated waste or rubbish periodically, at 1–2 month intervals. Villagers do this work as *kerja bakti* (A group of 10 individuals or more voluntarily performing the same task together at the same time).

Keeping livestock close to residential premises is a common habit in Demak district. The livestock found in the district are goats, buffaloes, chickens, ducks and cows. In certain areas of Demak district, it is the usual practice to bathe buffaloes and goats using water from a stream or from open water drains.

...Kerbau dimandiin tiap sore, dulu pagi sore sekarang sore thok...banyak ni sepanjang saluran air ini...
(Buffaloes are bathed every evening, it used to be every morning and evening but now only every evening...there are many buffalo bathing activities along this open water drain...)
ID.611

It was reported that many people in the village hunted and killed rats in paddy fields without using protection such as rubber gloves or boots, and that they then threw dead rats onto the paddy fields or onto nearby roads.

...menangkap tikus...mayoritas orang-orang gak pake pengaman dalam arti gak pake masker atau sarung tangan...
(...catching rats... majority of people do not wear protection ...it means they do not wear masks or gloves...)
ID.511

... kalau sawahnya deket jalan raya ... ya dibuang ke jalan raya. Kalau di sawah ...ya digeletakkan di sawah saja…
(if the paddy field is close to a road ...dead rats are thrown to the road. If only in the paddy field…they just leave the dead rats in that paddy field...)
ID. 511

4.2.3.2 Community understanding regarding disease, treatment and prevention

A. Local community thinking about disease

People indicated that they would fear contracting a disease if they knew the danger of the disease. A disease was considered dangerous by local people when they had experienced family members or neighbours dying or being hospitalised because of that disease. If a disease was not life-threatening, they were not afraid.

...kalau dia tahu persis tentang akibat penyakit tertentu…dia akan takut…cuman kan mereka tidak mengetahui apa sih penyakit itu dan bagaimana risikonya…
(... if the people know exactly about the consequence of a certain disease...people will be afraid…but, unfortunately they do not know about the disease and its risks…)
ID.521

Key informants said similar things about supernatural causes of disease. They said that most local people knew that disease was not related to supernatural power, a curse or demons; only a few people in Demak district still believed that diseases were caused by a supernatural power or by a curse.

Communicable diseases such as acute respiratory infection, diarrhoea, dengue fever, and malaria, are the most prevalent diseases in Demak district. Dengue haemorrhagic fever is reported as the most life-threatening disease in the studied areas.

... yang paling banyak sekali ...dan paling dekat dengan kematian… kegawatannya tinggi itu ...ya… demam berdarah.
(the most prevalent disease ... and the closest to death... high fatality ... is... dengue haemorrhagic fever)
ID.111

When it came to factors related to a certain disease, most local people did not know about them and so tended to neglect them if the disease was not considered dangerous or life-threatening. For example, a number of people knew very little about local diseases that were predominant and life-threatening, such as dengue fever, in terms of their causation and risk factors. A small number of people knew that mosquitoes were an agent of disease transmission; they were aware that measures such as cleaning water containers, covering water containers and burying cans and bottles were things they should do to prevent disease transmission. However, most of them do not properly take the required precautions. Local people frequently ask to have their area sprayed with insecticide (fogging) to kill mosquitoes only when they know that one of their family

member or neighbours has contracted dengue haemorrhagic fever. For non-life threatening diseases, people tend to neglect the cause and risk factors.

B. What local people do when they get sick

Health service facilities available in Demak district include a district-level general hospital and several private hospitals, primary health care centres, and village health polyclinics. Physicians, nurses, private-practice midwives, and traditional healers are found in Demak district; supernatural healers (*orang pinter)* are found in each of the sub-districts.

Local people suffering from mild symptoms, such as a headache, fever or influenza, usually purchase medication from the closest street vendors to be found selling non-prescription drugs that can relieve their symptoms. If after 2–3 days the symptoms still persist, they will then go to a primary health care centre or village health polyclinic to seek treatment for their condition. People with sufficient money tend to visit a doctor at a private practice. Hospital is the preferred option for people suffering from a severe disease. Some people visit a witch-doctor for treatment at the first symptoms of disease; however, these people will usually go to a health service facility if their symptoms persist.

...mayoritas masyarakat di sini kalau penyakitnya sudah parah baru ke rumah sakit. Kalau ke puskesmas biasanya gak sampe parah ...ke warung dulu ...kalau gak mempan baru ke puskesmas...
(... the majority of people here will go to the hospital when they suffer from severe disease. They usually go to puskesmas *(primary health care centre) when their sickness is not severe... they go to street vendors to get non prescription medication... if the disease is not cured then they go to* puskesmas*...)*
ID.111

C. Health activities or interventions conducted in the community and their responses

Previous health programs or interventions implemented in Demak district have included free-of-charge mass treatment; free family planning services; nutritional enhancement

programs for children under five years old; blood donor services; health education, and water chlorination. In addition, key informants reported that the provincial government had donated towards a healthy public drinking water supply, the development of village health polyclinics, and to fund more mouse traps for the community.

Certain companies such as banks, industrial companies, educational institutions (Diponegoro University and Sultan Agung University medical schools), and groups such as high school alumni in collaboration with local medical doctor associations, have offered free-of-charge mass treatments for mild diseases. The nutritional enhancement program for children under five was sponsored by a traditional herbal company in collaboration with the local primary health care centre. University students who did field work in the district of Demak have also organised community blood donations in collaboration with the local Red Cross organisation and the local primary health care centre. The staffs of local primary health care centres disseminate health education to communities in villages where certain disease outbreaks may potentially occur. The Disease Vectors and Reservoir Research and Development Institute of the Indonesian Ministry of Health has carried out water chlorination exercises in the Bonang sub-district. The chlorination program took action on water containers in the homes of reported leptospirosis cases and also treated surrounding areas, including water in open drains and in ponds.

People living within the sub-district have responded enthusiastically and have attended the free-of-charge mass treatment services provided. Although there is a polyclinic in their village, they have been willing to pay the transport cost to the locality where the free-of-charge mass treatment is conducted.

...reaksi seperti pengobatan-pengobatan gratis...ya ...mereka sangat respon....apalagi kalau sudah ada embel-embelnya gratis...
(... response to the free-of-charge mass treatments ... yes... they are very responsive... especially where it is stated free of charge...)
ID.321

It was also reported that most people in the sub-district did not like attending activities that only involved health talks. One of the key informants suggested that health talks would get a better response if they were held just before the free-of-charge mass treatment or some other free treatment program. Another key informant also suggested that it was better not to use technical terms when giving health education talks because people could better understand the message when it was delivered using plain language.

...penyampaian informasi dengan bahasa yang aneh-aneh akan nggak masuk...pakai bahasanya yang cekak aos saja...
(...giving information using sophisticated or formal words will not be understood … use only simple everyday language...)
ID.611

4.2.3.3 Community understanding about leptospirosis

The local name for leptospirosis, *penyakit kencing tikus* (rat's urine disease), derives from the words usually used by health workers when delivering leptospirosis education to the community. They usually explain that this disease is transmitted through rat's urine.

A small number of locals had heard of leptospirosis. However, most of the people who had heard of leptospirosis were those who resided in the same village as, or close to the homes of known leptospirosis cases. Local primary health care centre staff, village midwives and district health office staff were the primary sources of information on leptospirosis for people living in the same villages as leptospirosis cases. A number of people living in areas with a low incidence of leptospirosis cases, or those not residing in the same village as leptospirosis cases, generally did not know about leptospirosis.

Key informants from endemic areas or sub-districts with many leptospirosis cases, such as Bonang and Demak sub-districts, reported that people in their sub-districts acknowledged that leptospirosis was dangerous.

...sangat berbahaya sekali dan mematikan ...dalam arti 4 hari tidak tertolong ...ya bisa mati...
(...very dangerous and deadly...it means that if in 4 days the victim cannot be saved ... could die...)
ID.511

On the contrary, key informants from sub-districts with few leptospirosis cases reported that most people in those sub-districts considered that leptospirosis was not a dangerous disease. The community paid little attention to the disease and did not make it a priority until a case occurred.

.. lepto belum jadi problem tersendiri… belum menganggap penyakit itu berbahaya …yang menakutkan… Belum...
(… lepto has not become a separate problem… has not considered that this disease is dangerous… frightening disease…not yet…)
ID.211

…karena disini kasusnya kan jarang terjadi... jadi kurang di perhatikanlah…tapi kalau pas ada orang yang sakit seperti itu…baru mereka perhatian…kalau sudah agak lama mereka tidak perhatian lagi…lupa…
(*... because cases here are rare…so it gets less attention…but when there is a person who contracted that disease…then they pay attention… if the time lapse between cases is quite far apart…the disease escapes their attention again…They forget…)*
ID.121

Many people did not know the symptoms associated with leptospirosis. They thought this disease had symptoms similar to those of typhoid fever.

… melihat penyakit leptospirosis ... itu kan masyarakat kebanyakan mereka tidak tahu …yang seperti apa penyakit leptospirosis itu. Soalnya sama seperti tipus...
(…to identify leptospirosis disease…most people do not know…what leptospirosis looks like. It is because of its similarity with typhus...)
ID.411

Key informants also described the kind of activities engaged in by leptospirosis cases prior to contracting the disease. These included walking through flood water; hunting and killing rats; working in the traditional market; cleaning sewers, and working in paddy fields. Additional information from key informants indicated that people did not wear gloves or other protective equipment when catching and killing rats.

Preventive action against leptospirosis undertaken in the district of Demak has included leptospirosis exhibitions in the villages where leptospirosis cases live, as well as epidemiological investigation by local primary health care staff and district health office staff for every case. Leptospirosis rapid test examinations have also been conducted among people who live close to reported leptospirosis cases. Posters and leaflets have been distributed to villagers where cases live and to people who visit local primary health care centres. Other preventive actions have included incidental mass culling of rats, chlorination of water containers in the homes of leptospirosis cases and also chlorination of nearby open water drains.

4.2.3.4 Other findings

Besides addressing the main topics, key informants also provided information regarding the community response to new programs or activities that had been introduced. In general, local people would enthusiastically participate in a new program or activity (including health-related programs) if they knew that they would receive gifts or rewards from organisers or institutions behind the program or activity. In contrast, they were reluctant to participate in activities or programs that required them to expend their own money. People expected to receive physical gifts, such as water pumps, mouse traps, fish nets, money, and free medical treatment. They were also more enthusiastic about undertaking activities or programs that were directed by individuals they already knew, and if a local key person was also involved in the activities.

The informants made suggestions for leptospirosis prevention programs that could be undertaken by local health institutions. The main thrust of these suggestions was that such programs should refresh the understanding of village cadres and use them to distribute information on leptospirosis to the community; give rewards to cadres; inform the community on how to conduct mass sewer cleaning and mass rat hunts, and also on how to hunt and kill rats, as well as how to bury or burn dead rats.

4.2.4 **Lessons learned**

The purpose of this part of sub-chapter 4.2 is to provide information on situations, especially unexpected or unplanned situations, which occurred during the data collection phase of this study. This information will benefit researchers who want to do similar studies in Indonesia or other developing countries.

In the preparation phase, it is important to establish a good relationship with local government and related institutions. Such a relationship can bring a number of benefits, such as cutting the waiting time for obtaining permission letters, obtaining more detailed information/data regarding the local leptospirosis situation, and making it easier to communicate with informants in the area of study and to schedule times for interviews. Obtaining phone numbers or other contacts for the informants is crucial; such information helps interviewers to contact informants and pass or receive important information related to the planned interviews.

In the implementation phase, it is necessary to factor in enough spare contingency time for unexpected or unplanned occurrences. Among other factors, investigators need to deal with informants who are civil servants in a developing country and who have a very busy work schedule. Contacting the informants at least a day before the agreed day for confirmation of a planned interview session is very important. A number of selected informants in this study postponed the previously agreed time for an interview due to orders from their superiors to conduct urgent activities, or else other unplanned urgent activities came up, or even natural disasters such as flooding. Leptospirosis-endemic areas are usually located in places that are prone to flood in the rainy season. Therefore, information on weather conditions around the date of the planned interview is also important. A new appointment should be scheduled when the previously agreed appointment has been postponed; this means there is a need to factor in additional time for implementing interviews.

Asking the informants to answer socio-behavioural questions related to leptospirosis a week before conducting the actual interview elicited a good response from the informants. They liked this approach because it made it less stressful for them to face the

interview session. Informants were now primed: they knew what they would be asked, and by the day of the interview they had already prepared or collected the information needed.

At least two voice recorders need to be provided for each interview, to avoid failed recordings due to unexpected device problems or human error, such as an error in setting the device. The interview recordings are important for generating interview transcripts.

4.2.5 **Conclusions of sub-chapter 4.2**

Selected informants provided information on the social and behavioural characteristics of the Demak district community. Local water-related activities undertaken by people in Demak district included bathing and washing clothes in rivers; working in paddy fields; fish harvesting; cleaning open water drains; keeping livestock close to residential premises; bathing buffaloes or goats, and hunting and killing rats.

People were afraid of diseases that resulted in the death of their neighbours or family members. Their knowledge regarding locally prevalent diseases, such as dengue fever, was limited, and only a few of them took action to reduce risk factors for locally prevalent diseases. They would go to the closest health care service if symptoms of a disease persisted beyond 3–5 days. Local primary health care centre and village polyclinics were the health service centres most frequently sought out by people in Demak district.

Demak people were enthusiastic about getting involved in activities that gave them physical rewards or gifts, or in free-of-charge mass treatment programs. However, they were reluctant to engage in activities that would oblige them to spend money.

A few people in Demak district knew about leptospirosis or *penyakit kencing tikus*; they were mostly people who resided in the same villages where leptospirosis cases had been reported. However, their knowledge regarding this disease and its risk factors was

insufficient. They knew about leptospirosis from local primary health care centre staff, local midwives, and district health office staff. Leptospirosis was considered dangerous by people who resided in the endemic areas with severe leptospirosis cases, or by people whose family members or neighbours had died of leptospirosis.

4.3 Field observation of leptospirosis risk factors

Specific objective 1c:
To obtain and evaluate more detailed information on environmental factors and community behaviour as related to leptospirosis risk factors in leptospirosis-endemic areas

4.3.1 Introduction

This sub-chapter reports the results of observations of the environment and of human behaviour related to human leptospirosis in Demak district. The purpose of this sub-chapter is to provide information on aquatic and wet locations, animals, and human activities related to leptospirosis infection in humans in Demak district.

Lessons learned from these observations in Demak district are presented here. This information will be beneficial for leptospirosis intervention planning in leptospirosis-endemic areas of Demak district, and in developing countries generally.

4.3.2 Observations of the environment related to leptospirosis risk factors

Three sub-districts were selected for environmental observation: Bonang, Demak, and Karangawen. The three sub-districts present relatively similar environments. Paddy fields, rivers, water drains, stagnant water, and fish ponds are the main environments related to leptospirosis transmission found in Demak district. Domestic animals or livestock usually found in close proximity to community premises and homes are chickens, ducks, goats, and buffaloes, and cows. A summary of environmental observations can be found in appendix G.

Paddy fields dominate the observed areas. Water for the paddy fields is sourced from rivers, irrigation drains, and rain water. Rats' burrows were seen in the paddy fields in all of the observed sub districts. A number of dead rats were seen on the road connecting the villages; local people intentionally throw dead rats onto roads after catching and killing them at home or in the paddy fields. It was also observed that cow stalls were located close to human houses, the sanitation of these stalls was poor, and excreta from the cows were discharged directly into open water drains or into local rivers.

Figure 4.1 Cow stall near open water drains

Rivers passing through the Demak district area include Tuntang, Jajar, Wulan, Jragung, and Serang. A section of Tuntang River borders on the local rubbish dump site, and many rats were found at this site. In the rainy season, these rivers overflow and flood into the surrounding areas beyond the river banks. It was observed that when flooding subsided, stagnant water and muddy areas were left in the areas immediately surrounding people's houses. The stagnant water would stand for about 1–4 weeks even without any further rainfall. The open water drainage system in the village and for homes did not function well, and this was one cause of stagnant water.

Figure 4.2 Poor home water drains

Fish ponds are to be seen in every observed sub-district. They are owned by individuals or by groups of people. Water for the individually-owned ponds is usually taken from a nearby river, or else rain water is used. Water for collectively owned ponds is taken from a nearby river in the rainy season and from the local water company in the dry season. Sheep were observed being shepherded around the fish ponds; these sheep are a potential source of leptospires spreading in leptospirosis-endemic areas. Ponds could be contaminated by leptospires carried in the sheep's urine.

Figure 4.3 Sheep shepherded around fish pond

Sanitation in a number of houses in the village is poor. Rats were seen in house yards. Chicken pens were seen at a number of houses, with wet or muddy soil in the surrounding area.

4.3.3 **Observation of behaviour related to leptospirosis risk factors**

Observations of human behaviour related to leptospirosis were conducted in the same sub-districts as for the environmental observations (a summary of behavioural observations can be found in appendix H). The majority of people in Demak district are paddy field farmers. Thus, work in paddy fields is the most frequent form of work activity for local people. Other activities related to human leptospirosis include catching fish; washing and bathing in rivers; cleaning up rivers; cleaning up ponds; hunting and killing rats; grooming and bathing water buffaloes or goats; hoeing corn fields; washing motorbikes, and sharpening sickles while using pond water to wash them.

Exactly what type of activity Indonesian farmers engage in while in paddy fields depends on the rice-farming cycle. The rice-farming cycle comprises sowing, sprouting, planting, growing, and harvesting phases. Before commencing the sowing phase, the paddy fields have to be prepared. Preparation of the fields includes setting up a watering system, ploughing, and fertilising the soil. Water is required in the preparation, sowing, sprouting, planting, and growing phases. However water has been drained from the paddy fields during the harvesting phase. Rice farmers have contact with water during the field preparation, sowing, sprouting, planting, and growing phases. In the field preparation and growing phases it is mostly the male farmers who do the work; in the sowing, sprouting, and planting phases, it is the female farmers who do most of the work.

Figure 4.4 Planting the paddy field

Observations of the paddy fields in Demak district were made during the sprouting, planting, and growing phases. People who work in the paddy fields during the sprouting and planting phases inevitably contact paddy field water or mud, specifically with their hands and feet, for more than an hour at a time. It was observed that they did not wear boots or gloves when they worked in the paddy fields. The majority of farmers worked in the paddy fields for six hours a day on average. After working in the paddy field they washed their hands and feet using water from the closest waterway or duct. In the growing phase the main activities were checking and cleaning weeds; chasing birds away; spreading fertilisers, and re-aligning the growth of paddy plants. The part of the farmers' bodies that most often made contact with water during work in the paddy fields was their feet. No waterproof equipment was used. Farmers worked about eight hours a day in the paddy fields during the growing phase. They washed their hands, feet, and face with paddy field water after working in the paddy field, without using soap. Washing without soap indicated a potential risk of exposure to leptospires.

Figure 4.5 Spreading fertilisers (left) and walking in a paddy field (right)

In Demak district, various methods are used to catch fish in the rivers, streams, or ponds, other than using fishing rods: nets, *apotas* (chemicals to intoxicate fish), and electric shock devices. Individuals using these methods need to enter the river, stream, or pond to catch the fish and thus have direct contact with stream, river, or pond water. Their

body from the waist down makes direct contact with the water, for about 1–2 hours. When they finish catching fish, they wash their hands and feet with stream or pond water, without using soap, and then go home.

Figure 4.6 Catching fish using an electric device (left) and using *apotas* (right)

It is still customary for people in certain areas of Demak district to wash clothes and bathe in rivers or streams. People who wash clothing dangle their legs and feet in the water, and use their hands to wash the clothes. This goes on for about an hour. They use soap or detergent for washing clothes. Similarly, people who bathe in rivers or streams immerse half of their bodies, chest-down, in river or stream water. Some of them use a plastic can to scoop up the river or stream water and pour it over the upper part of their bodies that is standing free, not immersed in the water. They use soap for these baths. Bathing in a river usually takes about 30 minutes on average.

Figure 4.7 Washing clothes and bathing in a river

Some people in Demak district periodically bathe water buffaloes and goats. Water buffaloes are usually bathed in streams or rivers in the afternoon. Buffaloes are led into a stream or river, and people follow them into the water. The buffaloes' carers brush the animals' skin and pour the stream water over the bodies of buffaloes that are not fully immersed in the stream water. After bathing the water buffaloes, people wash their own hands and feet using stream water. The process of bathing water buffaloes takes about 30–45 minutes.

Unlike bathing water buffaloes, to bathe goats people take their animals to the edge of water drains. Water for bathing the goats is taken from a stream, pond, or well. The goats' carers pour water over the animals, wash them with soap, and brush them. After bathing the goats, people washed their hands and feet with soap using well or stream water. The time taken for bathing goats was about 15–20 minutes on average for each goat. Bathing buffaloes and goats potentially puts their carers at risk of exposure to leptospires in leptospirosis-endemic areas.

Figure 4.8 Bathing buffaloes (left) and goats (right)

People in Demak district engage in hunting and killing rats in the paddy fields, particularly during the growing phase of the rice-farming cycle. Some people cull the rats by themselves, while others formed groups to do it together. After catching and killing the rats, they were seen to handle the dead rats without wearing gloves, disposing

of them on the surrounding land or on the street. Culling rats and handling dead rats without wearing gloves potentially risks exposure to leptospires.

Figure 4.9 Hunting and killing rats

4.3.4 **Lessons learned**

Field observation activities conducted before implementing an intervention provided researchers with a deeper understanding of the environment and people's activities in the intervention area. Interaction between researchers and local people during the environmental observation stage acted as a good preliminary introduction of researchers to the local community before conducting behavioural observations. Therefore, local people were familiar with the researchers and team by the time the behavioural observations began.

Involving local people, such as cadres, in the environmental observation process brought advantages for researchers and for cadres. Cadres were known to the local community, and they introduced the researchers and team to the local people. They guided the researchers to the best locations for observation, and they were also informal informants, supplying additional information regarding local people's behaviour. Researchers were also able to pass on to the cadres information regarding the environmental and behavioural risk factors for human leptospirosis while they were accompanying researchers for the environmental observation stage of the study.

4.3.5 **Conclusions of sub-chapter 4.3**

Physical environmental characteristics relating to leptospirosis transmission were found in the observed sub-districts. These environments included paddy fields with rats' burrows; rivers that frequently overflowed in the rainy season; poor housing conditions and village water drains; the presence of stagnant water in areas immediately surrounding houses, and fish ponds sourcing water from rivers. In addition, insanitary cow stalls were found in the observed area, and the cows' excreta were discharged directly into the village water drains. Rats were seen in house yards and inside villagers' homes.

Individual and group activities involving contact with water or animals were observed. These activities included the preparatory, sowing, sprouting, planting, and growing phases of paddy field rice-farming; catching fish; washing and bathing in rivers; cleaning up rivers; cleaning up ponds, hunting and killing rats; grooming and bathing water buffaloes or goats. After conducting these activities, a number of people washed their hands and feet using paddy field water, stream water, or pond water, without soap. People engaging in activities involving contact with water wore no boots or gloves. These observations indicated that some activities and behaviour practised by people in the investigated leptospirosis-endemic area brought with them potential risks for exposure to leptospires.

4.4 Summary of the findings of phase one: Identification of local leptospirosis risk factors

The first phase of this research is focused on the identification of local leptospirosis risk factors in a leptospirosis-endemic area with a paucity of information on local leptospirosis risk factors, using available sources of information. A summary of local leptospirosis risk factors identified in phase one, together with the linking of these phase-one findings with the findings in previous studies, and recommendations, are presented here.

4.4.1 Summary of local leptospirosis risk factors

A local potential risk factor for leptospirosis is considered a local risk factor for leptospirosis that can be included in the intervention planning process, if one of the following criteria is fulfilled:

First, 50% or more of the studies that have examined this local potential risk factor in the investigated/local district show that this local potential risk factor has a significant association with human leptospirosis infection. Local risk factors for human leptospirosis in Demak district that fulfilled this criterion were stagnant water in areas immediately surrounding homes; poor home sanitation; the presence of rats; contact with stagnant water; bathing in rivers or ponds; washing clothes in rivers or ponds, and walking barefoot. These local risk factors are also considered as specific leptospirosis risk factors for Demak district.

Second, less than 50% of the studies that have examined this local potential risk factor in the investigated/local district show that this local potential risk factor has a significant association with human leptospirosis infection, but 50% or more of the studies that have examined this potential risk factor in other districts show that this potential risk factor has a significant association with human leptospirosis infection.

Local risk factors in Demak district that fulfilled this criterion were flooding within the last 14 days; poor sewerage; human contact with flood water; human contact with rats' bodies or tissues; work involving contact with contaminated surface water; activities in

paddy fields; leisure activities; unhealthy personal hygiene; skin wounds; low education levels, and lack of knowledge of leptospirosis.

Third, less than 50% of studies that have examined this local potential risk factor in the investigated/local district show that this local potential risk factor has a significant association with human leptospirosis infection, and less than 50% of studies that have examined this potential risk factor in other districts show that this potential risk factor has a significant association with human leptospirosis infection, and this potential risk factor is shown to be prevalent or frequently seen (for environmental factors) or conducted (for behavioural factors) by people in the investigated/local district; or less than 50% of studies that have examined this local potential risk factor in the investigated/local district show that this local potential risk factor has a significant association with human leptospirosis infection, and less than 50% of studies that have examined this potential risk factor in other districts show that this potential risk factor has a significant association with human leptospirosis infection, and more than 50% of studies that have examined this potential risk factor in other nations show that this potential risk factor has a significant association with human leptospirosis infection. The local risk factor in Demak district that fulfilled this criterion was not wearing personal protection.

4.4.2 Linking of study findings and previous studies

Findings from the environmental and behavioural observations in Demak district confirmed the information given by key informants regarding local people's activities involving contact with water and animals. In addition, previous studies of risk factors for human leptospirosis in Demak district showed that most of the aquatic and wet environments and behaviour involving contact with water or animals were associated with human leptospirosis.

Conducting a socio-behavioural study as part of the process of identification of local human leptospirosis risk factors provides some advantages for preparation for an

intervention to prevent leptospirosis transmission. First, the study provides background on the characteristics of the local people and local community thinking about diseases, including leptospirosis. Second, the study provides information on local potential risk factors for leptospirosis, specifically on local people's activities involving contact with water and animals. Third, the study is a useful introductory step before conducting other studies, such as field observation, a KAP study, and intervention studies. Key informants selected in the socio-behavioural study were individuals that knew their communities and were known to their communities. Keeping a good relationship with the key informants helped smooth the next phase of study activity.

The main existing local environments observed in Demak district were paddy fields with rats' burrows in the surroundings; poor open sewers; ditches and drains with overflowing water; stagnant water; ponds with rats living in the surroundings, and poor home sanitation. These environmental conditions are potentially related to leptospirosis transmission in Demak district. Such local environments are commonly found in rural leptospirosis-endemic areas of Indonesia, and in other developing countries.(84)

4.4.3 Recommendations

A KAP survey of people's knowledge, attitude, and practice was recommended, to target people for an intervention. This KAP survey would focus on obtaining current information on human leptospirosis risk factors, verifying the results of the socio-behavioural study, and supporting the results of the field observation study. This KAP survey would also be used to provide base information for developing an intervention to prevent leptospirosis transmission.

4.5 Knowledge, attitude, and practice survey

Specific objective 2a:
To identify and evaluate the knowledge, attitudes, and practices of members of the community regarding leptospirosis risk factors and the prevention of leptospirosis in endemic areas.

4.5.1 Introduction

This sub-chapter reports the results of a first knowledge, attitude, and practice survey (KAP-1 survey) conducted in two selected villages in Demak district. The purpose of this sub-chapter is to provide early information on the knowledge, attitude and practice of local people regarding leptospirosis risk factors and prevention before the implementation of an intervention.

Characteristics of respondents, respondents' knowledge of leptospirosis, the attitude of respondents toward leptospirosis transmission prevention, and respondents' practices regarding leptospirosis prevention are presented. Results of the survey instrument pre-testing exercise are presented before presenting the results of the study itself.

4.5.2 Instrument pre-testing

To the best of the researchers' knowledge no standard questionnaire for collecting information on leptospirosis risk factors and on community knowledge, attitude, and practice regarding leptospirosis and actions to reduce exposure to leptospirosis risk factors has been established or published before. Questionnaire items on community knowledge, attitude and practice regarding leptospirosis and actions to reduce exposure to leptospirosis risk factors, were formulated based on leptospirosis theory, [1, 2] leptospirosis guidelines, [4, 203] the literature review of previous articles or studies on leptospirosis risk factor studies, [19, 21, 22, 83, 123, 124, 204-208] and the results of in-depth interviews and field observations from the first phase of this study. Health belief model

theory [209] and also KAP survey guidelines [210, 211] were adopted to guide the development of this leptospirosis KAP questionnaire.

The structure of the questionnaire comprised the characteristics of respondents, their knowledge of leptospirosis, their attitude towards activities to reduce exposure to leptospirosis risk factors, and their practices aimed at reducing exposure to leptospirosis risk factors. The questionnaire had been pre-tested (n= 40) with respondents residing in a village in Demak district other than the studied villages. Cronbach's coefficient alpha was calculated to assess the internal consistency of the leptospirosis KAP questionnaire items. The Cronbach coefficient alpha of the questionnaire items, after excluding items that affected the overall consistency, was 0.748.

4.5.3 **Respondents' characteristics**

The total number of respondents in this survey was 304; 150 people were from Kembangan village, Bonang sub-district, and 154 people from Bumirejo village, Karangawen sub-district.

The age average of all respondents was 40.1 ± 10.3 years; the age average of respondents in Kembangan village was 38.8 ± 11.1 years, and the age average of respondents in Bumirejo village was 41.3 ± 9.8 years. The proportion of females (168; 55.3%) was higher than that of males (136; 44.7%); the majority of respondents' level of education (221; 72.7%) was primary school, and almost all respondents' occupations involved contact with water or animals (294; 96.7%).
Table 4.11 shows the characteristics of respondents.

Table 4.11 Respondents' characteristics

Characteristics		Study location					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Gender	Male	63	42.0	73	47.4	136	44.7
	Female	87	58.0	81	52.6	168	55.3
Education level	Primary school	118	78.7	103	66.9	221	72.7
	High school	31	20.7	48	31.2	79	26.0
	Academy or higher	1	0.7	3	1.9	4	1.3
Occupation	Involves contact with water or animal	141	94.0	153	99.4	294	96.7
	Does not involve contact with water or animal	9	6.0	1	0.6%	10	3.3

4.5.4 **Knowledge, attitude, and practice regarding leptospirosis**

4.5.4.1 Knowledge about leptospirosis

Table 4.12 shows the respondents' knowledge about leptospirosis. More than half of the respondents (173; 56.9%) had not heard about leptospirosis before the survey. The majority of respondents did not know about the symptoms of leptospirosis (222; 73.0%); the danger of leptospirosis (247; 81.3%); the transmission of leptospirosis (219; 72.0%); risk factors for leptospirosis (220; 72.4%), or leptospirosis prevention (233; 72.6%). In general, the number of respondents in Kembangan village who did not know about the symptoms, danger, transmission, risk factors, and prevention of leptospirosis was higher than the number of respondents in Bumirejo village.

Respondents were considered to know about the symptoms of leptospirosis if they could mention at least three main symptoms. Respondents were considered knowledgeable about the transmission of leptospirosis if they could mention more than three modes of transmission. Respondents were considered to know about the risk factors for leptospirosis if they could mention more than three such factors.

Table 4.12 Knowledge of respondents about leptospirosis

Knowledge of leptospirosis		Study location					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Ever heard of leptospirosis disease before this survey	Yes	36	24.0	95	61.7	131	43.1
	No	114	76.0	59	38.3	173	56.9
	Total	150	100.0	154	100.0	304	100.0
Knowledge of leptospirosis symptoms or signs	Know	2	1.3	5	3.2	7	2.3
	Know a little	19	12.7	56	36.4	75	24.7
	Do not know	129	86.0	93	60.4	222	73.0
	Total	150	100.0	154	100.0	304	100.0
Knowledge of the danger of leptospirosis	Know	14	9.3	43	27.9	57	18.8
	Do not know	136	90.7	111	72.1	247	81.3
	Total	150	100.0	154	100.0	304	100.0
Knowledge of leptospirosis transmission	Know	0	0.0	4	2.6	4	1.3
	Know a little	18	12.0	63	40.9	81	26.6
	Do not know	132	88.0	87	56.5	219	72.0
	Total	150	100.0	154	100.0	304	100.0
Knowledge of leptospirosis risk factors	Know	0	0.0	0	0.0	0	0.0
	Know a little	19	12.7	65	42.2	84	27.6
	Do not know	131	87.3	89	57.8	220	72.4
	Total	150	100.0	154	100.0	304	100.0
Knowledge of leptospirosis prevention	Know	0	0.0	3	1.9	3	1.0
	Know a little	20	13.3	48	31.2	68	22.4
	Do not know	130	86.7	103	66.9	233	76.6
	Total	150	100.0	154	100.0	304	100.0

Table 4.13 shows the level of knowledge about leptospirosis among respondents who had heard of leptospirosis. A number of respondents who had heard about leptospirosis before the survey still did not know about its symptoms (50; 38.2%), danger (74; 56.5%), transmission (47; 35.9%), risk factors (47; 35.9%), or prevention (60; 45.8%). These results indicated that respondents needed to improve their knowledge.

Table 4.13 Knowledge about leptospirosis among respondents who had heard of leptospirosis

Knowledge of leptospirosis		Have you ever heard about leptospirosis?					
		Yes		No		Total	
		no	%	no	%	no	%
knowledge of symptoms of leptospirosis	Know	7	5.3	0	0.0	7	2.3
	Know less	74	56.5	0	0.0	74	24.3
	Do not know	50	38.2	173	100.0	223	73.4
knowledge of the danger of leptospirosis	Know	57	43.5	0	0.0	57	18.8
	Do not know	74	56.5	173	100.0	247	81.3
knowledge of leptospirosis transmission	Know	4	3.1	0	0.0	4	1.3
	Know less	80	61.1	0	0.0	80	26.3
	Do not know	47	35.9	173	100.0	220	72.4
knowledge of risk factors	Know	0	0.0	0	0.0	0	0.0
	Know less	84	64.1	0	0.0	84	27.6
	Do not know	47	35.9	173	100.0	220	72.4
knowledge of leptospirosis prevention	Know	3	2.3	0	0.0	3	1.0
	Know less	68	51.9	0	0.0	68	22.4
	Do not know	60	45.8	173	100.0	233	76.6

4.5.4.2 Attitude toward preventive actions to reduce exposure to leptospirosis risk factors

The respondents' attitude towards preventive actions to reduce exposure to leptospirosis risk factors is shown in Table 4.14 (a, b, c). A majority of the respondents, about 62.0%, were undecided whether they agreed, were neutral, or disagreed about stated actions related to the prevention of leptospirosis. About 25% of respondents agreed and strongly agreed on specific preventive actions against leptospirosis and about 4% disagreed or strongly disagreed.. The proportion of respondents who did not express their attitude toward actions for leptospirosis prevention was higher in Kembangan village (about 80%) than in Bumirejo village (about 44%). Among respondents who stated their attitude towards preventive actions, the percentage of respondents who agreed or strongly agreed with each action varied.

Table 4.14a Respondents' attitude towards preventive actions to reduce exposure to leptospirosis risk factors (a)

		Place of study					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Using soap when bathing goats or buffaloes prevents me from being infected by *penyakit kencing tikus*	Strongly disagree	0	0.0	1	0.6	1	0.3
	Disagree	3	2.0	19	12.3	22	7.2
	Neutral	5	3.3	8	5.2	13	4.3
	Agree	20	13.3	52	33.8	72	23.7
	Strongly agree	2	1.3	5	3.2	7	2.3
	Do not know	120	80.0	69	44.8	189	62.2
Wearing foot protection/ boots when cleaning the livestock stalls prevents me from being infected by *penyakit kencing tikus*	Strongly disagree	0	0.0	2	1.3	2	0.7
	Disagree	3	2.0	9	5.8	12	3.9
	Neutral	3	2.0	3	1.9	6	2.0
	Agree	22	14.7	61	39.6	83	27.3
	Strongly agree	2	1.3	12	7.8	14	4.6
	Do not know	120	80.0	67	43.5	187	61.5
Wearing boots while walking in muddy sites prevents me from being infected by *penyakit kencing tikus*	Strongly disagree	0	0.0	4	2.6	4	1.3
	Disagree	7	4.7	13	8.4	20	6.6
	Neutral	5	3.3	5	3.2	10	3.3
	Agree	17	11.3	54	35.1	71	23.4
	Strongly agree	1	0.7	10	6.5	11	3.6
	Do not know	120	80.0	68	44.2	188	61.8
Walking away from water puddles prevents me from being infected by *penyakit kencing tikus*	Strongly disagree	0	0.0	1	0.6	1	0.3
	Disagree	8	5.3	15	9.7	23	7.6
	Neutral	6	4.0	8	5.2	14	4.6
	Agree	15	10.0	60	39.0	75	24.7
	Strongly Agree	1	0.7	3	1.9	4	1.3
	Do not know	120	80.0	67	43.5	187	61.5
Walking away from flood water prevents me from being infected by *penyakit kencing tikus*	Strongly disagree	0	0.0	4	2.6	4	1.3
	Disagree	9	6.0	18	11.7	27	8.9
	Neutral	8	5.3	9	5.8	16	5.3
	Agree	10	6.7	51	33.1	61	20.1
	Strongly Agree	3	2.0	5	3.2	8	2.6
	Do not know	120	80.0	67	43.5	188	61.8

The number and percentage of respondents who agreed or strongly agreed with each action to prevent their infection by leptospirosis were as follows: using soap when bathing goats (79; 68.7%); wearing boots when working in a livestock stall (97; 82.9%); wearing boots when walking in muddy places (82; 70.7%); walking away from water puddles (79; 67.5%); walking away from flood water (69; 58.9%); avoiding baths in rivers (73; 63.5%); avoiding washing clothes in rivers (78; 67.2%); using soap when bathing in rivers (77; 66.9%); checking for the presence of skin wounds (72; 62.6%); treating skin wounds (83; 71.6%), and covering the wounds when working in aquatic or wet environments (84; 73.0%).

The majority of respondents in Kembangan village (95; 67.9%) and Bumirejo village (132; 88.6%) did not agree that washing clothes in a river was more enjoyable than washing at home. The majority of respondents who stated their attitude towards actions to prevent leptospirosis infection agreed or strongly agreed that performing these actions would finally add more money to their savings (99; 84.6%). A possible reason for this was that these respondents were living in close proximity to actual leptospirosis cases, and they knew how severe the disease could be and how expensive the cost of treatment.

Table 4.14b Respondents' attitude towards preventive actions to reduce exposure to leptospirosis risk factors (b)

		Place of study					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Avoiding bathing in rivers does not help me to prevent infection by *penyakit kencing tikus*	Strongly disagree	2	1.3	6	3.9	8	2.6
	Disagree	14	9.3	51	33.1	65	21.4
	Neutral	4	2.7	10	6.5	14	4.6
	Agree	9	6.0	17	11.0	26	8.6
	Strongly agree	1	0.7	1	0.6	2	0.7
	Do not know	120	80.0	69	44.8	189	62.2
Avoiding washing clothes in rivers does not help me to prevent infection by *penyakit kencing tikus*	Strongly disagree	0	0.0	5	3.2	5	1.6
	Disagree	17	11.3	56	36.4	73	24.0
	Neutral	3	2.0	5	3.2	8	2.6
	Agree	10	6.7	19	12.3	29	9.5
	Strongly agree	0	0.0	1	0.6	1	0.3
	Do not know	120	80.0	68	44.2	188	61.8
Using soap when bathing or when washing clothes in rivers does not help me to prevent infection by *penyakit kencing tikus*	Strongly disagree	2	1.3	11	7.1	13	4.3
	Disagree	13	8.7	51	33.1	64	21.1
	Neutral	6	4.0	7	4.5	13	4.3
	Agree	8	5.3	16	10.4	24	7.9
	Strongly agree	1	0.7	0	0.0	1	0.3
	Do not know	120	80.0	69	44.8	189	62.2
Checking for the presence of skin wounds on feet or hands does not prevent infection by *penyakit kencing tikus*	Strongly disagree	2	1.3	6	3.9	8	2.6
	Disagree	11	7.3	53	34.4	64	21.1
	Neutral	7	4.7	12	7.8	19	6.3
	Agree	10	6.7	13	8.4	23	7.6
	Strongly agree	0	0.0	1	0.6	1	0.3
	Do not know	120	80.0	69	44.8	189	62.2

Table 4.14c Respondents' attitude towards preventive actions to reduce exposure to leptospirosis risk factors (c)

		Place of study					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Treating wounds on feet or hands prevents infection by *penyakit kencing tikus*	Strongly disagree	0	0.0	2	1.3	2	0.7
	Disagree	7	4.7	17	11.0	24	7.9
	Neutral	5	3.3	2	1.3	7	2.3
	Agree	14	9.3	62	40.3	76	25.0
	Strongly agree	4	2.7	3	1.9	7	2.3
	Do not know	120	80.0	68	44.2	188	61.8
Covering skin wounds on feet or hands when working in wet places prevents infection by *penyakit kencing tikus*	Strongly disagree	1	0.7	1	0.6	2	0.7
	Disagree	3	2.0	11	7.1	14	4.6
	Neutral	8	5.3	7	4.5	15	4.9
	Agree	17	11.3	62	40.3	79	26.0
	Strongly agree	1	0.7	4	2.6	5	1.6
	Do not know	120	80.0	69	44.8	189	62.2
Doing activities to prevent the transmission of *penyakit kencing tikus* will finally add more money to my savings	Strongly disagree	1	0.7	0	0.0	1	0.3
	Disagree	3	2.0	5	3.2	8	2.6
	Neutral	3	2.0	6	3.9	9	3.0
	Agree	20	13.3	55	35.7	75	24.7
	Strongly agree	4	2.7	20	13.0	24	7.9
	Do not know	119	79.3	68	44.2	187	61.5
Washing in a river is more enjoyable than washing at home	Strongly disagree	2	1.3	15	9.7	17	5.6
	Disagree	93	62.0	117	76.0	210	69.1
	Neutral	12	8.0	6	3.9	18	5.9
	Agree	31	20.7	10	6.5	41	13.5
	Strongly agree	2	1.3	1	0.6	3	1.0
	Do not know	10	6.7	5	3.2	15	4.9

When respondents were asked how they felt about wearing boots when they worked, a number of them said that wearing boots when they were doing work involving contact with water was uncomfortable; it made it more difficult for them to walk and it interfered with their work. However, they said that they wore boots when they cleaned cow or buffalo stalls (results not presented in the table).

Respondents' opinions on potentially contracting leptospirosis and their feelings about being infected were elicited and are presented in Table 4.15. Only a few respondents (68; 22.4%) stated that they could be infected by leptospirosis. If they were to be infected or they knew their family or neighbours died or hospitalized because of leptospirosis, they said that they would be afraid and sad. In addition, they were worried that they did not have enough money to purchase medication or pay for treatment costs.

Table 4.15 Respondents' perceived susceptibility to leptospirosis, information assistance, cue to action, and self-confidence on taking action to prevent leptospirosis

		Place of study					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Do you think you can be infected by leptospirosis?	Yes	15	10.0	53	34.4	68	22.4
	No	32	21.3	37	24.0	69	22.7
	Do not know	103	68.7	64	41.6	167	54.9
In the last 3 months did you get information supporting you to do leptospirosis prevention?	Yes	4	2.7	16	10.4	20	6.6
	No	146	97.3	138	89.6	284	93.4
Taking action to prevent transmission of leptospirosis will finally add more money to my savings	Strongly disagree	1	0.7	0	0.0	1	0.3
	Disagree	3	2.0	5	3.2	8	2.6
	Neutral	3	2.0	6	3.9	9	3.0
	Agree	20	13.3	55	35.7	75	24.7
	Strongly agree	4	2.7	20	13.0	24	7.9
	Do not know	119	79.3	68	44.2	187	61.5
I am sure I can take action to prevent leptospirosis	Strongly disagree	1	0.7	1	0.6	2	0.7
	Disagree	1	0.7	2	1.3	3	1.0
	Neutral	5	3.3	4	2.6	9	3.0
	Agree	22	14.7	73	47.4	95	31.3
	Strongly agree	3	2.0	7	4.5	10	3.3
	Do not know	118	78.7	67	43.5	185	60.9

Ninety-nine respondents (32.6%) perceived that taking action to prevent transmission of leptospirosis would ultimately add more money to their savings. They mentioned that if they conducted leptospirosis-prevention activities they would not need to spend money to buy medication, the number of rats would reduce, their paddy plants could be saved from the rats' attack, and finally they could harvest the paddy. The majority of

respondents (284; 93.4%) stated that within the past three months before the interview they had not received any information to support them in conducting leptospirosis prevention activities. Twenty respondents (6.6%) who did receive information to support them in leptospirosis prevention reported that this information had come from local health workers (14; 70.0%). Regarding their confidence that they could undertake activities to reduce exposure to leptospirosis risk factor and prevent leptospirosis, the majority of respondents (185; 60.9%) were undecided whether they agreed or disagreed with the proposition that they could do so. (Table 4.15).

4.5.4.3 Practices reducing exposure to leptospirosis risk factors

Table 4.16 shows practices reported by respondents in relation to reducing leptospirosis risk factors. The majority, 217 respondents (71.4%), stated that they had worked or conducted activities in aquatic or wet places over the past 30 days before the interview. Such activities included working in paddy fields; rat hunting in paddy fields; cleaning livestock stalls; cleaning sewers; bathing buffaloes and goats; washing clothes in rivers, and bathing in rivers.

Among the respondents who conducted activities in aquatic or wet environments, 128 (59.0%) stated that they wore personal protection for their feet or hands. However, only 21 respondents (16.4%) wore rubber gloves, and only six respondents (4.7%) wore boots while working. Other forms of protection for the hands or feet that respondents used during their activities involving contact with water or animals were sandals, socks, and fabric gloves.

A large majority of respondents, 188 (86.6%) washed their hands and feet after working in wet environments or making contact with animals. A number of these respondents washed and used soap at home after working in wet environments; however, they did not use soap when washing their feet or hands at the work site, such as in the paddy fields.

The practice of checking for the presence of skin wounds on hands or feet before performing activities involving contact with water or animals was reported by 49

respondents (22.6%): of these, 23 (23.0%) respondents were from Kembangan village and 26 (22.2%) from Bumirejo village. About half (49.0%) of those who checked for the presence of skin wounds reported finding wounds on their hands or feet.

Table 4.16 Practices reducing exposure to leptospirosis risk factors

		Place of study					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Activities involving contact with water or animals in the last 30 days	Yes	100	66.7	117	76.0	217	71.4
	No	50	33.3	37	24.0	87	28.6
Wearing hand or feet protection during work in the last 30 days	Yes	52	52.0	76	65.0	128	59.0
	No	48	48.0	41	35.0	89	41.0
Wearing rubber gloves during work in the last 30 days	Yes	8	15.4	13	17.1	21	16.4
	No	44	84.6	63	82.9	107	83.6
Wearing boots during work in the last 30 days	Yes	1	1.9	5	6.6	6	4.7
	No	51	98.1	71	93.4	122	95.3
Washing hands and feet with soap after activities involving contact with water or animals in the last 30 days	Yes	83	83.0	105	89.7	188	86.6
	No	17	17.0	12	10.3	29	13.4
Checking for skin wounds before working in the last 30 days	Yes	23	23.0	26	22.2	49	22.6
	No	77	77.0	91	77.8	168	77.4
Finding skin wounds in the last 30 days	Yes	12	52.2	12	46.2	24	49.0
	No	11	47.8	14	53.8	25	51.0

4.5.5 **Conclusions of sub-chapter 4.5**

More than half of the respondents had not heard of leptospirosis before the survey. A number of respondents who had heard of leptospirosis before the survey still did not know about its symptoms, danger, transmission, risk factors, or prevention. The majority of respondents was undecided whether they agreed, were neutral, or disagreed with stated actions related to the prevention of leptospirosis. The percentage of respondents who agreed or strongly agreed with each action intended to protect them from

leptospirosis infection varied. Activities that these respondents had undertaken in aquatic or wet environments included working in paddy fields; rat hunting in paddy fields; cleaning livestock stalls; cleaning sewers; bathing buffaloes and goats; washing clothes in rivers, and bathing in rivers. A small number of respondents did practise checking for the presence of skin wounds before conducting activities related to contact with animals, and about half of them reported finding wounds on their hands or feet.

The results of this KAP study indicate that the risk factors for human leptospirosis in the studied leptospirosis-endemic area are specifically behavioural factors and also insufficient knowledge about leptospirosis. These results support the findings from a review of previous studies on leptospirosis risk factors, social behaviour studies, and field observation studies.

The results of the review of previous studies of leptospirosis risk factors, the social behaviour study, the field observation study, and the KAP survey provided important information that was recommended as input for the development of an intervention program to prevent leptospirosis transmission.

4.6 Intervention

Objective 2b:
To promote knowledge of leptospirosis risk factors, and to reduce risk exposure among people aged 18 years and older living or working in leptospirosis-endemic regions of Demak district in Central Java, Indonesia.

4.6.1 Introduction

This sub-chapter reports on an intervention to reduce exposure to leptospirosis risk factors in the district of Demak. The purpose of this sub-chapter is to provide facts about the development and implementation of an intervention program to reduce exposure to leptospirosis risk factors in a leptospirosis-endemic area with a paucity of available information on leptospirosis risk factors.

4.6.2 Prioritisation of local risk factors and activities for an intervention

Local risk factors were prioritised to determine the focus of an intervention to reduce exposure to leptospirosis risk factors. Information obtained from the first phase of this study and the results from the KAP-1 survey were used as sources of evidence-based data related to local leptospirosis risk factors. A local panel was formed to discuss and determine local risk factor(s) to be prioritised for an intervention. The members of the local panel were a local primary health care centre staffer in charge of a communicable disease control program; a village midwife; two local key-persons (the head of Kembangan village and a local staffer from the village government office who was responsible for community welfare); and an epidemiologist from the local university (Diponegoro University).

The process of prioritising local leptospirosis risk factors was adopted and modified from a problem prioritisation tool developed by the Family Health Outcome Project at the University of California, San Francisco.[212] The complete procedure of prioritisation is found in appendix D.

Table 4.17 Summary of scores and ranking for each leptospirosis risk factor

Leptospirosis risk factor	Participants					Total score	Rank
	1	2	3	4	5		
1. Stagnant water surrounding the house	12	13	13	13	12	63	9
2. Poor home sanitation	12	12	12	12	12	60	12
3. Presence of rats	11	12	13	13	12	61	11.5
4. Contact with stagnant water	14	16	18	18	18	84	6
5. Bathing in rivers	16	14	16	14	16	76	7
6. Washing clothes in rivers	18	18	18	18	18	90	4
7. Walking barefoot	20	20	21	20	21	102	3
8. Poor sewerage	10	14	14	14	10	62	10
9. Contact with flood water	13	13	13	13	13	65	8.5
10. Contact with bodies or tissues of rats	17	17	19	19	17	89	5
11. Activities in paddy fields	13	13	13	13	13	65	8.5
12. Presence of skin wounds	21	21	21	20	21	104	2
13. Low education levels	12	12	12	12	13	61	11.5
14. Lack of knowledge of leptospirosis	21	21	21	21	21	105	1

The choice of local leptospirosis risk factors to be included in the prioritisation process was based on the results of the first phase of this study. These local leptospirosis risk factors were the presence of stagnant water in areas immediately surrounding houses; poor home sanitation; the presence of rats; human contact with stagnant water; bathing in rivers, washing clothes in rivers; walking barefoot; poor sewerage; human contact with flood water; human contact with rats' bodies or tissues; activities in paddy fields; the presence of skin wounds; low education levels, and lack of knowledge of leptospirosis (Table 4.17).

The two local leptospirosis risk factors that scored the highest rankings were lack of knowledge of leptospirosis and the presence of skin wounds. Based on the results of the prioritisation process and discussion among panel members, the focus of the proposed intervention was therefore directed towards promoting the knowledge of leptospirosis risk factors and increasing the practice of checking for the presence of skin wounds before working in aquatic or wet environments. The practice of checking for the

presence of skin wounds was selected because it was related to skin wound prevention, and the results of KAP-1 survey had shown that only a small number of people (49; 22.6%) conducted such checks before engaging in activities involving contact with water or animals.

4.6.3 **Participants' characteristics**

Both the study sites and the participants selected for the intervention were similar to those selected for the KAP-1 survey. Unfortunately, 30 participants in the KAP-1 survey, in Kembangan village, the location for the intervention study, could not continue to participate in the study because they had moved elsewhere; the remaining 120 participants were willing to participate in the intervention study.

For the necessary control group, 120 participants were recruited from among the participants in the KAP-1 survey at Bumirejo village. Thus the total number of participants for the intervention study was 240; this number still fulfilled the minimum sample size requirement.

Table 4.18 shows the characteristics of the participants in the intervention study. The average age of all intervention study participants was 41.0 ± 9.98 years; the average age of participants from Kembangan village was younger (40.1 ± 10.1 years) than that of those from Bumirejo village (41.9 ± 9.8 years): thus there was no significant difference in participants' average ages between Kembangan and Bumirejo villages. In general, the proportion of females (125; 52.1%) was higher than that of males (115; 47.9%); however, the proportion of males from Bumirejo village (57.5%) was higher than the proportion of males from Kembangan village (38.3%). The level of education for the majority of the participants was primary school (203; 84.6%), and all participants' occupations involved contact with water or animals.

Table 4.18 Intervention study participants' characteristics

Characteristics		Study location					
		Kembangan village		Bumirejo village		Total	
		no	%	no	%	no	%
Gender	Male	46	38.3	69	57.5	115	47.9
	Female	74	61.7	51	42.5	125	52.1
Education level	Primary school	97	80.8	82	68.3	179	74.6
	High school	22	18.3	36	30.0	58	24.2
	Academy or higher	1	0.8	2	1.7	3	1.3
Occupation	Involving contact with water or animals	120	100.0	120	100.0	240	100.0
	Involving contact with water or animals	0	0	0	0	0	0

4.6.4 **Intervention activities**

Kembangan village was the chosen site for the intervention study; Bumirejo village was the control village, and no intervention program was implemented in Bumirejo village.

In Kembangan village, participants attended two main sessions, an introductory session and a group session. The objectives of the intervention were a) to increase the proportion of people in the target group that could identify leptospirosis risk factors (animal, environmental, and human-related) by at least 20% by the end of the program, b) to increase the proportion of people in the target group that could identify ways to prevent or reduce exposure to leptospirosis risk factors by at least 20% by the end of the program, c) to increase the proportion of people in the target group that could identify the benefits of preventing or reducing exposure to leptospirosis risk factors by at least 20% by the end of the program, and d) to reduce the proportion of people in the target group who do not take action to reduce exposure to a modifiable risk factor for leptospirosis by at least 20% by the end of program. Based on discussions among panel members, the selected action considered emblematic of reducing exposure to a

leptospirosis risk factor was checking for the presence of skin wounds before working in aquatic or wet environments.

4.6.4.1 Introductory session

Activities conducted in the introductory session included giving valuable information to participants, such as the goals of the intervention program and the reason participants should know about and take action to prevent the transmission of leptospirosis, and a short review of leptospirosis in general. The purpose of the short review of leptospirosis was to introduce the causes, signs and symptoms, risk factors, and consequences of leptospirosis; and to introduce the benefits of taking action to reduce exposure to leptospirosis risk factors.

Before and after commencing the short review of leptospirosis, participants were asked to fill in a questionnaire (this constituted a pre-test and post-test process).

The results of data analysis before and after the short review of leptospirosis showed that the majority of participants (about 70%) knew that rats are involved in leptospirosis transmission. The difference in the proportion of participants who knew that rats are a source of leptospirosis transmission before and after the short review was not statistically significant ($p= 0.875$) (Table 4.19). However, a few participants knew that cows (11; 9.2%) and goats (28; 23.3%) could be sources of leptospirosis transmission. After completing the short review of leptospirosis the proportion of participants who knew that cows (64; 53.3%) and goats (81; 67.5%) could be sources of leptospirosis transmission increased. The difference between the proportions of participants who knew that cows ($p: <0.001$) and goats ($p: < 0.001$) are sources of leptospirosis transmission before and after the short review was statistically significant (Tables 4.20 and 4.21).

Table 4.19 Participants' knowledge about rats as leptospirosis transmitters, before and after the short review

			Rat or mouse is a transmitter of leptospirosis (post test)		Total
			Yes	No	
Rat or mouse is a transmitter of leptospirosis (pre test)	Yes	n	68	21	89
		% within (pre test)	76.4%	23.6%	100.0%
		% within (post test)	78.2%	63.6%	74.2%
	No	n	19	12	31
		% (pre test)	61.3%	38.7%	100.0%
		% (post test)	21.8%	36.4%	25.8%
Total		N	87	33	120
		% (pre test)	72.5%	27.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.875

Table 4.20 Participants' knowledge about cows as leptospirosis transmitters, before and after the short review

			Cow is a transmitter of leptospirosis (post test)		Total
			Yes	No	
Cow is a transmitter of leptospirosis (pre test)	Yes	n	8	3	11
		% within (pre test)	72.7%	27.3%	100.0%
		% within (post test)	12.5%	5.4%	9.2%
	No	n	56	53	109
		% within (pre test)	51.4%	48.6%	100.0%
		% within (post test)	87.5%	94.6%	90.8%
Total		N	64	56	120
		% within (pre test)	53.3%	46.7%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p < 0.001

Table 4.21 Participants' knowledge about goats as leptospirosis transmitters, before and after the short review

			Goat is a transmitter of leptospirosis (post test)		Total
			Yes	No	
Goat is a transmitter of leptospirosis (pre test)	Yes	n	19	9	28
		% within (pre test)	67.9%	32.1%	100.0%
		% within (post test)	23.5.0%	23.1%	23.3%
	No	n	62	30	92
		% within (pre test)	67.4%	32.6%	100.0%
		% within (post test)	76.5%	76.9%	76.7%
Total		N	81	39	120
		% within (pre test)	67.5%	32.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p < 0.001$

More than half of the participants (70.0%) knew that leptospirosis transmission could occur in a paddy field before hearing the short review. No significant difference in the number of participants who knew this was found ($p = 0.302$) before and after completing the short review. (Table 4.22).

Table 4.22 Participants' knowledge about paddy fields as a place where transmission of leptospirosis to humans occurs, before and after the short review

			Paddy field is the place where transmission of leptospirosis to humans takes place (post test)		Total
			Yes	No	
Paddy field is the place where transmission of leptospirosis to humans takes place (pre test)	Yes	n	57	27	84
		% within (pre test)	67.9%	32.1%	100.0%
		% within (post test)	75.0%	61.4%	70.0%
	No	n	19	17	36
		% within (pre test)	52.8%	47.2%	100.0%
		% within (post test)	25.0%	38.6%	30.0%
Total		N	76	44	120
		% within (pre test)	63.3%	36.7%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p = 0.302$

Before hearing the short review, less than a third of participants (33; 27.5%) knew that rivers are places where leptospirosis transmission to humans occurs. Their knowledge

about this mode of transmission increased significantly (68; 56.7%), registering p < 0.001 after completing the short review (Table 4.23). Similarly, the proportion of participants who knew that livestock stalls are one of the places where leptospirosis transmission to humans occurs increased significantly (p< 0.001) from 40.0% before the short review, to 65.8% after completing the short review (Table 4.24)

Table 4.23 Participants' knowledge about rivers as places where transmission of leptospirosis to humans occurs, before and after the short review

			Rivers are places where transmission of leptospirosis to humans occurs (post test)		Total
			Yes	No	
Rivers are places where transmission of leptospirosis to humans occurs (pre test)	Yes	n	23	10	33
		% within (pre test)	69.7%	30.3%	100.0%
		% within (post test)	33.8%	19.2%	27.5%
	No	n	45	42	87
		% within (pre test)	51.7%	48.3%	100.0%
		% within (post test)	66.2%	80.8%	72.5%
Total		N	68	52	120
		% within (pre test)	56.7%	43.3%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p < 0.001

Table 4.24 Participants' knowledge about livestock stalls as places where transmission of leptospirosis to humans occurs, before and after the short review

			Livestock stalls are places where transmission of leptospirosis to humans occurs (post test)		Total
			Yes	No	
Livestock stalls are places where transmission of leptospirosis to humans occurs (pre test)	Yes	n	35	13	48
		% within (pre test)	72.9%	27.1%	100.0%
		% within (post test)	44.3%	31.7%	40.0%
	No	n	44	28	72
		% within (pre test)	61.1%	38.9%	100.0%
		% within (post test)	55.7%	68.3%	30.0%
Total		N	79	41	120
		% within (pre test)	65.8%	34.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p < 0.001

The number of participants who knew that fever is one of the symptoms of leptospirosis increased from 83 (69.2%) before hearing the review to 95 (79.2%) after completing the

review. Nonetheless, this increase was not statistically significant (p= 0.058). In contrast, participants' knowledge about muscle pain/ calf pain as a leptospirosis symptom increased significantly after hearing the short review (p< 0.001) (Tables 4.25 and 4.26).

Table 4.25 Participants' knowledge about fever as a symptom of leptospirosis, before and after the short review

			Fever is a symptom of leptospirosis (post test)		Total
			Yes	No	
Fever is a symptom of leptospirosis (pre test)	Yes	n	72	11	83
		% within (pre test)	86.7%	13.3%	100.0%
		% within (post test)	75.8%	44.0%	69.2%
	No	n	23	14	37
		% within (pre test)	62.2%	37.8%	100.0%
		% within (post test)	24.2%	56.0%	30.8%
Total		N	95	25	120
		% within (pre test)	79.2%	20.8%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.058

Table 4.26 Participants' knowledge about muscle pain/ calf pain as a symptom of leptospirosis, before and after the short review

			Muscle pain/ calf pain is a symptom of leptospirosis (post test)		Total
			Yes	No	
Muscle pain/ calf pain is a symptom of leptospirosis (pre test)	Yes	n	18	14	32
		% within (pre test)	56.3%	43.8%	100.0%
		% within (post test)	29.5%	23.7%	40.0%
	No	n	43	45	88
		% within (pre test)	48.9%	51.1%	100.0%
		% within (post test)	70.5%	76.3%	30.0%
Total		N	61	59	120
		% within (pre test)	50.8%	49.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p < 0.001

Before hearing the short review, less than half of the participants knew that leptospirosis could cause breathing difficulties (47; 39.2%) and death (39; 32.5%). After the short review, the number of participants who knew that leptospirosis could cause breathing

difficulties (76; 63.3%) and death (57; 47.5%) increased significantly (Tables 4.27 and 4.28).

Table 4.27 Participants' knowledge about breathing difficulties as one of the dangers of leptospirosis, before and after the short review

			Difficulty of breathing is one of the dangers of leptospirosis (post test)		Total
			Yes	No	
Difficulty of breathing is one of the dangers of leptospirosis (pre test)	Yes	n	33	14	47
		% within (pre test)	70.2%	29.8%	100.0%
		% within (post test)	43.4%	31.8%	40.0%
	No	n	43	30	73
		% within (pre test)	58.9%	41.1%	100.0%
		% within (post test)	70.5%	68.2%	60.8%
Total		N	76	44	120
		% within (pre test)	63.3%	36.7%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p < 0.001$

Table 4.28 Participants' knowledge about death as one of the dangers of leptospirosis, before and after the short review

			Death is one of the dangers of leptospirosis (post test)		Total
			Yes	No	
Death is one of the dangers of leptospirosis (pre test)	Yes	n	19	20	39
		% within (pre test)	48.7%	51.3%	100.0%
		% within (post test)	33.3%	31.7%	32.5%
	No	n	38	43	81
		% within (pre test)	46.9%	53.1%	100.0%
		% within (post test)	66.7%	68.3%	67.5%
Total		N	57	63	120
		% within (pre test)	47.5%	52.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p = 0.025$

Participants who knew before hearing the short review that 'staying healthy (no illness)' was a benefit of implementing preventive action against leptospirosis numbered 78 (65.0%). This number slightly increased (83; 69.2%) after completing the short review ($p= 0.51$) (Table 4.29).

Table 4.29 Participants' knowledge about 'staying healthy' as a benefit of implementing preventive action against leptospirosis, before and after the short review

			'Staying healthy' is a benefit of implementing leptospirosis preventive action (post test)		Total
			Yes	No	
'Staying healthy' is a benefit of implementing leptospirosis preventive action (pre test)	Yes	n	62	16	78
		% within (pre test)	79.5%	20.5%	100.0%
		% within (post test)	74.7%	43.2%	65.0%
	No	n	21	21	42
		% within (pre test)	50.0%	50.0%	100.0%
		% within (post test)	25.3%	56.8%	35.0%
Total		N	57	63	120
		% within (pre test)	69.2%	30.8%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p = 0.511

In contrast, after completing the short review, a significant increase (p= 0.001) in the number of participants who knew that 'no financial loss' was a benefit of implementing preventive action against leptospirosis was noticed. Similarly, a significant increase was also noticed after the short review in the number of participants (p< 0.001) who knew that 'still being alive (not dead)' was a benefit of implementing preventive action against leptospirosis (Tables 4.30 and 4.31).

Table 4.30 Participants' knowledge about 'no financial loss' as a benefit of implementing preventive action against leptospirosis, before and after the short review

			'No financial loss' is a benefit of implementing preventive action against leptospirosis (post test)		Total
			Yes	No	
'No financial loss' is a benefit of implementing preventive action against leptospirosis (pre test)	Yes	n	35	11	46
		% within (pre test)	76.1%	23.9%	100.0%
		% within (post test)	50.0%	22.0%	38.3%
	No	n	35	39	74
		% within (pre test)	47.3%	52.7%	100.0%
		% within (post test)	50.0%	78.0%	61.70%
Total		N	70	50	120
		% within (pre test)	58.3%	41.7%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p = 0.511

Table 4.31 Participants' knowledge about 'still being alive' as a benefit of implementing preventive action against leptospirosis, before and after the short review

			'Still being alive' is a benefit of implementing preventive action against leptospirosis (post test)		Total
			Yes	No	
'Still being alive' is a benefit of implementing preventive action against leptospirosis (pre test)	Yes	n	30	10	40
		% within (pre test)	75.0%	25.0%	100.0%
		% within (post test)	40.0%	22.2%	33.3%
	No	n	45	35	80
		% within (pre test)	56.3%	43.8%	100.0%
		% within (post test)	60.0%	77.8%	66.7%
Total		N	75	45	120
		% within (pre test)	62.5%	37.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p = 0.511

4.6.4.2 Group session

For the group session, participants were divided into groups of six participants each. The purpose of this session was to stimulate and provide more discussion about leptospirosis risk factors and actions to reduce exposure to leptospirosis risk factors. At the end of the session participants were expected to be able to identify three main factors related to leptospirosis, to identify local leptospirosis risk factors, to identify actions to reduce exposure to leptospirosis risk factors, and to demonstrate some action of interest. Checking for the presence of skin wounds before working in aquatic or wet environments was chosen as the main action of interest based on discussions among panel members. Pre-test and post-test checks were undertaken before and after implementation of the group session.

The number of participants who knew that animals are a main factor related to the transmission of leptospirosis slightly increased after activities in the group session ($p= 0.150$) (Table 4.32). However, the number of participants who knew that environmental ($p< 0.001$) and human factors ($p< 0.001$) were the main factors related to the transmission of leptospirosis increased significantly after education activities in the group session (Tables 4.33 and 4.34).

Table 4.32 Participants' knowledge about animals as one of the main factors related to leptospirosis transmission, before and after education activities

			Animals are related to the transmission of leptospirosis (post test)		Total
			Yes	No	
Animals are related to the transmission of leptospirosis (pre test)	Yes	n	72	11	83
		% within (pre test)	86.7%	13.3%	100.0%
		% within (post test)	78.3%	39.3%	69.2%
	No	n	20	17	37
		% within (pre test)	54.1%	45.9%	100.0%
		% within (post test)	21.7%	60.7%	30.8%
Total		N	92	28	120
		% within (pre test)	76.7%	23.3%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p = 0.150

Table 4.33 Participants' knowledge about environmental factors as one of the main factors related to leptospirosis transmission, before and after education activities

			Environmental factors are related to the transmission of leptospirosis (post test)		Total
			Yes	No	
Environmental factors are related to the transmission of leptospirosis (pre test)	Yes	n	39	4	43
		% within (pre test)	90.7%	9.3%	100.0%
		% within (post test)	48.8%	10.0%	35.8%
	No	n	41	36	77
		% within (pre test)	53.2%	46.8%	100.0%
		% within (post test)	51.3%	90.0%	64.2%
Total		N	80	40	120
		% within (pre test)	66.7%	33.3%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p< 0.001

The number of participants who could identify three main factors relating to leptospirosis transmission to humans before education activities in the group session was 10 (8.3%). This number increased significantly (40; 33.3%), registering p< 0.001 after education activities (Table 4.35).

Table 4.34 Participants' knowledge about human factors as one of the main factors related to leptospirosis, before and after education activities

			Humans are related to the transmission of leptospirosis (post test)		Total
			Yes	No	
Humans are related to the transmission of leptospirosis (pre test)	Yes	n	16	3	19
		% within (pre test)	84.2%	15.8%	100.0%
		% within (post test)	35.6%	4.0%	15.8%
	No	n	29	72	101
		% within (pre test)	28.7%	71.3%	100.0%
		% within (post test)	64.4%	96.0%	84.2%
Total		N	45	75	120
		% within (pre test)	37.5%	62.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p< 0.001

Table 4.35 Participants' knowledge of the main factors related to leptospirosis transmission to humans, before and after education activities

			Knowledge of the main factors related to leptospirosis transmission (post test)				
			do not know main factors	know 1 main factor	know 2 main factors	know 3 main factors	Total
Knowledge of the main factors related to leptospirosis transmission (pre test)	do not know main factors	n	5	5	2	3	15
		% within pretest	33.3%	33.3%	13.3%	20.0%	100.0%
		% within post test	62.5%	10.6%	8.0%	7.5%	12.5%
	know 1 main factor	n	3	42	15	15	75
		% within pretest	4.0%	56.0%	20.0%	20.0%	100.0%
		% within post test	37.5%	89.4%	60.0%	37.5%	62.5%
	know 2 main factors	n	0	0	7	13	20
		% within pretest	0.0%	0.0%	35.0%	65.0%	100.0%
		% within post test	0.0%	0.0%	28.0%	32.5%	16.7%
	know 3 main factors	n	0	0	1	9	10
		% within pretest	0.0%	0.0%	10.0%	90.0%	100.0%
		% within post test	0.0%	0.0%	4.0%	22.5%	8.3%
Total		N	8	47	25	40	120
		% within pretest	6.7%	39.2%	20.8%	33.3%	100.0%
		% within post test	100.0%	100.0%	100.0%	100.0%	100.0%

McNemar-Bowker test: < 0.001

Prior to education activities in the group session 89 (74.2%) participants knew that rats are a source of leptospirosis transmission to humans. This number increased non-significantly (97; 80.8%) after education (p= 0.185) (Table 4.36). In contrast, the number of participants who knew that cows (83; 69.2%) and goats (90; 75.0%) are

sources of leptospirosis transmission to humans increased significantly after education activities ($p < 0.001$) (Tables 4.37 and 4.38).

Table 4.36 Participants who knew that rats are a source of leptospirosis transmission to humans, before and after education activities

			Rats are a source of infection for leptospirosis transmission (post test)		Total
			Yes	No	
Rats are a source of infection for leptospirosis transmission (pre test)	Yes	n	79	10	89
		% within (pre test)	88.8%	11.2%	100.0%
		% within (post test)	81.4%	43.5%	74.2%
	No	n	18	13	31
		% within (pre test)	58.1%	41.9%	100.0%
		% within (post test)	18.6%	56.5%	25.8%
Total		N	97	23	120
		% within (pre test)	80.8%	19.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p = 0.185$

Table 4.37 Participants who knew that cows are a source of leptospirosis transmission to humans, before and after education activities

			Cows are a source of leptospirosis transmission (post test)		Total
			Yes	No	
Cows are a source of leptospirosis transmission (pre test)	Yes	n	51	4	55
		% within (pre test)	92.7%	7.3%	100.0%
		% within (post test)	61.4%	10.8%	45.8%
	No	n	32	33	65
		% within (pre test)	49.2%	50.8%	100.0%
		% within (post test)	38.6%	89.2%	54.2%
Total		N	83	37	120
		% within (pre test)	69.2%	30.8%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p < 0.001$

Table 4.38 Participants who knew that goats are a source of leptospirosis transmission to humans, before and after education activities

			Goats are a source of infection for leptospirosis transmission (post test)		Total
			Yes	No	
Goats are a source of infection for leptospirosis transmission (pre test)	Yes	n	54	8	62
		% within (pre test)	87.1%	12.9%	100.0%
		% within (post test)	60.0%	26.7%	51.7%
	No	n	36	22	58
		% within (pre test)	62.1%	37.9%	100.0%
		% within (post test)	40.0%	73.3%	48.3%
Total		N	90	30	120
		% within (pre test)	75.0%	25.0%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p < 0.001$

More than half of the participants (72; 60.0%) knew before the group session education activities that transmission of leptospirosis to humans could occur in paddy fields. After the education activity participants who were able to identify that transmission of leptospirosis to humans could occur in paddy fields numbered 84 (70.0%); however, this increase was not statistically significant ($p = 0.096$) (Table 4.39). In contrast, significant increases were seen in the number of participants who were able to identify that transmission of leptospirosis to humans could occur in rivers ($p = 0.001$), ponds ($p < 0.001$), and livestock stalls ($p = 0.001$) (Tables 4.40, 4.41, and 4.42).

Table 4.39 Participants who knew that paddy fields are places where the transmission of leptospirosis to humans can occur, before and after education activities

			Possible place for leptospirosis transmission: paddy field (post test)		Total
			Yes	No	
Possible place for leptospirosis transmission: paddy field (pre test)	Yes	N	56	16	72
		% within (pre test)	77.8%	22.2%	100.0%
		% within (post test)	66.7%	44.4%	60.0%
	No	N	28	20	48
		% within (pre test)	58.3%	41.7%	100.0%
		% within (post test)	33.3%	55.6%	40.0%
Total		N	84	36	120
		% within (pre test)	70.0%	30.0%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p = 0.096$

Table 4.40 Participants who knew that rivers are places where transmission of leptospirosis to humans can occur, before and after education activities

			Possible place for leptospirosis transmission: river (post test)		Total
			Yes	No	
Possible place for leptospirosis transmission: river (pre test)	Yes	N	43	10	53
		% within (pre test)	81.1%	18.9%	100.0%
		% within (post test)	57.3%	22.2%	44.2%
	No	N	32	35	67
		% within (pre test)	47.8%	52.2%	100.0%
		% within (post test)	42.7%	77.8%	55.8%
Total		N	75	45	120
		% within (pre test)	62.5%	37.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.001

Table 4.41 Participants who knew that ponds are places where transmission of leptospirosis to humans can occur, before and after education activities

			Possible place for leptospirosis transmission: pond (post test)		Total
			Yes	No	
Possible place for leptospirosis transmission: pond (pre test)	Yes	N	20	7	27
		% within (pre test)	74.1%	25.9%	100.0%
		% within (post test)	37.0%	10.6%	22.5%
	No	N	34	59	93
		% within (pre test)	36.6%	63.4%	100.0%
		% within (post test)	63.0%	89.4%	77.5%
Total		N	54	66	120
		% within (pre test)	45.0%	55.0%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p< 0.001

Before the education activities in the group session exposure to pond water was the least known possible source for the transmission of leptospirosis to humans among participants (27; 22.5%), whereas exposure to paddy field water was the most known possible source for transmission (72; 60.0%).

Table 4.42 Participants who knew that livestock stalls are places where transmission of leptospirosis to humans can occur, before and after education activities

			Possible place for leptospirosis transmission: livestock stall (post test)		Total
			Yes	No	
Possible place for leptospirosis transmission: livestock stall (pre test)	Yes	N	58	7	72
		% within (pre test)	89.2%	10.8%	100.0%
		% within (post test)	68.2%	20.0%	54.2%
	No	n	27	28	48
		% within (pre test)	49.1%	50.9%	100.0%
		% within (post test)	31.8%	80.0%	45.8%
Total		N	85	35	120
		% within (pre test)	70.8%	29.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.001

About 40% of participants in the group session already knew that washing clothes in rivers, planting in paddy fields, and cleaning sewers are activities that can enable leptospirosis transmission to humans, before education activities took place. In contrast, only 29 participants (24.2%) knew before the education activities that catching fish in rivers or ponds is a potential source for leptospirosis transmission to humans (Tables 4.43, 4.44, 4.45, and 4.46).

Table 4.43 Participants who knew that washing clothes in rivers enables transmission of leptospirosis to humans, before and after education activities

			Activity that enables leptospirosis transmission: washing clothes in rivers (post test)		Total
			Yes	No	
Activity that enables leptospirosis transmission: washing clothes in rivers (pre test)	Yes	n	40	13	53
		% within (pre test)	75.5%	24.5%	100.0%
		% within (post test)	58.8%	25.0%	44.2%
	No	n	28	39	67
		% within (pre test)	41.8%	58.2%	100.0%
		% within (post test)	41.2%	75.0%	55.8%
Total		N	68	52	120
		% within (pre test)	56.7%	43.3%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.028

After completing the education activities, the number of participants that reported knowing that washing clothes in rivers (p= 0.028), planting paddy fields (p= 0.001), and catching fish in rivers or ponds (p< 0.001) are potential modes of leptospirosis transmission increased significantly. However, the increase in the number of participants that reported cleaning sewers as a mode of leptospirosis transmission after the education activities was not statistically significant (p= 0.296).

Table 4.44 Participants who knew that planting in paddy fields enables transmission of leptospirosis to humans, before and after education activities

			Activity that enables leptospirosis transmission: planting paddy fields (post test)		Total
			Yes	No	
Activity that enables leptospirosis transmission: planting paddy fields (pre test)	Yes	n	55	9	64
		% within (pre test)	85.9%	14.1%	100.0%
		% within (post test)	64.7%	25.7%	53.3%
	No	n	30	26	56
		% within (pre test)	53.6%	46.4%	100.0%
		% within (post test)	35.3%	74.3%	46.7%
Total		N	85	35	120
		% within (pre test)	70.8%	29.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.001

Table 4.45 Participants who knew that cleaning sewers enables transmission of leptospirosis to humans, before and after education activities

			Activity that enables leptospirosis transmission: cleaning sewers (post test)		Total
			Yes	No	
Activity that enables leptospirosis transmission: cleaning sewers (pre test)	Yes	n	35	13	48
		% within (pre test)	72.9%	27.1%	100.0%
		% within (post test)	63.6%	20.0%	40.0%
	No	n	20	52	72
		% within (pre test)	27.8%	72.2%	100.0%
		% within (post test)	36.4%	80.0%	60.0%
Total		N	55	65	120
		% within (pre test)	45.8%	54.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.296

Table 4.46 Participants who knew that catching fish in rivers enables transmission of leptospirosis to humans, before and after education activities

			Activity that enables leptospirosis transmission: catching fish in rivers (post test)		Total
			Yes	No	
Activity that enables leptospirosis transmission: catching fish in rivers (pre test)	Yes	n	24	5	29
		% within (pre test)	82.8%	17.2%	100.0%
		% within (post test)	42.1%	7.9%	24.2%
	No	n	33	58	91
		% within (pre test)	36.3%	63.7%	100.0%
		% within (post test)	57.9%	92.1%	75.8%
Total		N	57	63	120
		% within (pre test)	47.5%	52.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p < 0.001$

Before the education activities, less than 50% of participants knew that flooding (37; 30.8%), paddy field water (56; 46.7%), and stagnant water (32; 26.7%) are environmental conditions that could enable leptospirosis transmission However, the proportion of participants who knew muddy soils to be a possible environmental condition for leptospirosis transmission was 65.8% (Tables 4.47, 4.48, 4.49, 4.50).

Table 4.47 Participants who knew flooding to be a possible environmental condition for transmission of leptospirosis to humans, before and after education activities

			Possible environmental condition for leptospirosis transmission: Flooding (post test)		Total
			Yes	No	
Possible environmental condition for leptospirosis transmission: Flooding (pre test)	Yes	n	31	6	37
		% within (pre test)	83.8%	16.2%	100.0%
		% within (post test)	50.0%	10.3%	30.8%
	No	n	31	52	83
		% within (pre test)	37.3%	62.7%	100.0%
		% within (post test)	50.0%	89.7%	69.2%
Total		N	62	58	120
		% within (pre test)	51.7%	48.3%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p < 0.001$

After education activities, the number of participants that knew flooding ($p<0.001$), paddy field water ($p= 0.006$), stagnant water ($p< 0.001$), and muddy soil ($p= 0.003$) are possible environmental conditions for leptospirosis transmission increased significantly.

Table 4.48 Participants who knew paddy field water to be a possible environmental condition for transmission of leptospirosis to humans, before and after education activities

			Possible environmental condition for leptospirosis transmission: paddy field water (post test)		Total
			Yes	No	
Possible environmental condition for leptospirosis transmission: paddy field water (pre test)	Yes	n	42	14	56
		% within (pre test)	75.0%	25.0%	100.0%
		% within (post test)	55.3%	31.8%	46.7%
	No	n	34	30	64
		% within (pre test)	53.1%	46.9%	100.0%
		% within (post test)	44.7%	68.2%	53.3%
Total		N	76	44	120
		% within (pre test)	63.3%	36.7%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p= 0.006$

Table 4.49 Participants who knew stagnant water to be a possible environmental condition for transmission of leptospirosis to humans, before and after education activities

			Possible environmental condition for leptospirosis transmission: Stagnant water (post test)		Total
			Yes	No	
Possible environmental condition for leptospirosis transmission: Stagnant water (pre test)	Yes	n	25	7	32
		% within (pre test)	78.1%	21.9%	100.0%
		% within (post test)	45.5%	10.8%	26.7%
	No	n	30	58	83
		% within (pre test)	34.1%	65.9%	100.0%
		% within (post test)	54.5%	89.2%	73.3%
Total		N	55	65	120
		% within (pre test)	45.8%	54.2%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: $p< 0.001$

Table 4.50 Participants who knew muddy soil to be a possible environmental condition for transmission of leptospirosis to humans, before and after education activities

			Possible environmental condition for leptospirosis transmission: Muddy soil (post test)		Total
			Yes	No	
Possible environmental condition for leptospirosis transmission: Muddy soil (pre test)	Yes	n	68	11	79
		% within (pre test)	86.1%	13.9%	100.0%
		% within (post test)	68.7%	52.4%	65.8%
	No	n	31	10	41
		% within (pre test)	75.6%	24.4%	100.0%
		% within (post test)	31.3%	47.6%	34.2%
Total		N	99	21	120
		% within (pre test)	82.5%	17.5%	100.0%
		% within (post test)	100.0%	100.0%	100.0%

McNemar test: p= 0.003

Table 4.51 Participants' knowledge of the main targets of leptospirosis transmission prevention, before and after education activities

			Knowledge of main targets of leptospirosis transmission prevention (post test)				
			do not know main targets	know 1 main target	know 2 main targets	know 3 main targets	Total
Knowledge of main targets of leptospirosis transmission prevention (pre test)	do not know main targets	n	1	8	2	1	12
		% within pretest	8.3%	66.7%	16.7%	8.3%	100.0%
		% within post test	33.3%	12.7%	7.1%	3.8%	10.0%
	know 1 main target	n	2	48	13	15	78
		% within pretest	2.6%	61.5%	16.7%	19.2%	100.0%
		% within post test	66.7%	76.2%	46.6%	57.7%	65.0%
	know 2 main targets	n	0	7	13	5	25
		% within pretest	0.0%	28.0%	52.0%	20.0%	100.0%
		% within post test	0.0%	11.1%	46.4%	19.2%	20.8%
	know 3 main targets	n	0	0	0	5	5
		% within pretest	0.0%	0.0%	0.0%	100.0%	100.0%
		% within post test	0.0%	0.0%	0.0%	19.2%	4.2%
Total		N	3	58	28	26	120
		% within pretest	2.5%	52.5%	23.3%	21.7%	100.0%
		% within post test	100.0%	100.0%	100.0%	100.0%	100.0%

McNemar-Bowker test: p< 0.001

Table 4.51 shows participants' knowledge of the main targets of leptospirosis transmission prevention, before and after education activities. The number of participants who reported knowing only one main target of leptospirosis transmission prevention decreased from 78 participants (65.0%) before the education activity to 58 participants (52.5%) after the education activity. In contrast, the number of participants who reported knowing two and three main targets of leptospirosis transmission prevention increased after the education activity ($p < 0.001$).

The majority of participants (87; 72.5%) identified that wearing boots when cleaning a stall is a measure to reduce exposure to leptospirosis risk factors before the education activities. In contrast, the fact that seeking information on leptospirosis risk factors is another measure to reduce exposure was identified by only a few participants (27; 22.5%). However, after education activities, seeking information on leptospirosis risk factors became the measure with the highest increase in the percentage of participants who identified it (Table 4.52).

Table 4.52 Activities to reduce exposure to leptospirosis risk factors identified by participants, before and after education activities

Activity to reduce exposure to leptospirosis risk factors	Number of participants who identified the activity and percentages (n; %)		p-value
	Before	After	
1. Mass hunting of rats	31; 25.8%	58; 48.3%	< 0.001
2. Cleaning up garbage or rubbish	64; 53.3%	74; 61.7%	0.154
3. Wearing boots when cleaning livestock stalls	87; 72.5%	100; 83.3%	0.015
4. Covering skin wounds before working in wet places	66; 55.0%	87; 72.5%	0.001
5. Avoiding walking in stagnant water	30; 25.0%	45; 37.5%	0.011
6. Seeking information on leptospirosis risk factors	27; 22.5%	52; 43.3%	< 0.001

After the group session, participants were given a sheet of paper containing statements about the procedure for checking for the presence of skin wounds. Education and demonstrations on how to check for the presence of skin wounds had already been provided during the education activities.

Participants were asked to arrange the statements on the paper as ordered steps for the procedure of checking for the presence of skin wounds before working in aquatic or wet environments. Participants who had finished arranging the statements were asked to demonstrate how to check for the presence of skin wounds. All participants had an opportunity to demonstrate the procedure.

A week after the intervention, 20 participants (16.7%) from the intervention group were selected randomly and visited. All of them had engaged in activities involving contact with water since participating in the intervention program, such as hunting rats (30.0%); bathing animals (10.0%); working in paddy fields (80.0%); washing clothes in rivers (40.0%), and walking in wet or muddy places (90.0%). All of them had checked for the presence of skin wounds, and they all correctly demonstrated the procedures for this. Half of the participants visited had skin wounds on their limbs. These skin wounds resulted from contact with sharp objects, such as sickles, snail shells, or paddy leaves. The majority of the participants (90.0%) had covered the skin wounds before working in wet environments.

4.6.5 Intervention evaluation

Another KAP survey (KAP-2) was undertaken after the intervention, with 240 participants, 120 from Kembangan village and another 120 from Bumirejo village. The results of KAP-2 were compared with the results of KAP-1 for each village. The proportions/percentages of participants who knew about leptospirosis and who practised checking for the presence of skin wounds before working in aquatic or wet environments were compared.

Finally, the amount of increase or decrease in the percentage of participants in the intervention group who knew about leptospirosis and who practised checking for the presence of skin wounds after the intervention was calculated; these final percentages took into account the increase or decrease in the percentage of participants who knew about leptospirosis and practised checking for skin wounds in the village with no intervention program (control village).

Table 4.53 shows that after the intervention, in general, the knowledge of leptospirosis among participants from Kembangan village had increased more than 20%. The topics that showed the four highest increases in the percentages of participants marking the 'Know' field were knowledge about the danger (85.0%), symptoms (75.0%), transmission (55.0%), and prevention of leptospirosis (55.0%).

Table 4.53 Percentages of participants who were knowledgeable about leptospirosis before and after the intervention period, Kembangan village (intervention group)

No	Knowledge		% before intervention (A)	% after intervention (B)	Difference of the percentages (B-A)*
1	Knowledge of symptoms of leptospirosis	Know	0.8	75.8	+ 75.0
		Know less	14.2	23.3	+ 9.1
		Do not know	85.0	0.8	- 84.2
2	Knowledge of the danger of leptospirosis	Know	10.0	95.0	+ 85.0
		Do not know	90.0	5.0	- 85.0
3	Knowledge of leptospirosis transmission	Know	0.0	55.8	+ 55.8
		Know less	11.7	42.5	+ 30.8
		Do not know	88.3	1.7	- 86.6
4	Knowledge of leptospirosis risk factors	Know	0.0	39.2	+ 39.2
		Know less	13.3	53.3	+ 40.0
		Do not know	86.7	7.5	- 79.2
5	Knowledge of leptospirosis prevention	Know	0.0	55.0	+ 55.0
		Know less	13.3	44.2	+ 30.9
		Do not know	86.7	0.8	- 85.9
6	Knowledge of the benefits of reducing exposure to leptospirosis risk factors	Know	0.0	9.8	+ 9.8
		Know less	11.8	87.3	+ 75.5
		Do not know	88.2	2.9	- 85.3

* + = increase - = decrease

Table 4.54 shows that the knowledge of leptospirosis among participants from Bumirejo village (the cotrol village) did not show a big increase during the study period. The three topics that showed the highest increases in the percentages of participants marking the 'Know' field were knowledge about symptoms (2.5%), risk factors (1.7%), and prevention of leptospirosis (1.7%). The two topics that showed the highest increases in the percentages of participants marking the 'Know less' field were prevention of

leptospirosis (14.2%) and the benefits of reducing exposure to leptospirosis risk factors (12.5%).

Table 4.54 Percentages of participants who were knowledgeable about leptospirosis before and after the intervention period, Bumirejo village (control group)

No	Knowledge		% before intervention (C)	% after intervention (D)	Difference of the percentages (D-C)*
1	Knowledge of symptoms of leptospirosis	Know	4.2	6.7	+ 2.5
		Know less	41.7	32.5	- 9.2
		Do not know	54.2	60.8	+ 6.6
2	Knowledge of the danger of leptospirosis	Know	30.0	28.3	- 1.7
		Do not know	70.0	71.7	+ 1.7
3	Knowledge of leptospirosis transmission	Know	2.5	3.3	+ 0.8
		Know less	43.3	45.0	+ 1.7
		Do not know	54.2	51.7	- 2.5
4	Knowledge of leptospirosis risk factors	Know	0.0	1.7	+ 1.7
		Know less	42.5	42.5	+ 0.0
		Do not know	57.5	55.8	- 1.7
5	Knowledge of leptospirosis prevention	Know	2.5	4.2	+ 1.7
		Know less	32.5	46.7	+ 14.2
		Do not know	65.0	49.2	- 15.8
6	Knowledge of the benefits of reducing exposure to leptospirosis risk factors	Know	0.0	0.0	0.0
		Know less	46.7	59.2	+ 12.5
		Do not know	53.3	40.8	- 12.5

* + = increase - = decrease

The difference in the percentages of participants demonstrating knowledge about leptospirosis pre- and post-intervention is shown in Table 4.55. The percentages of participants who were knowledgeable about leptospirosis after the intervention, after taking into account the change in participants' percentages in the control group, increased more than 20%, except for the percentage of participants who were knowledgeable about the benefits of reducing exposure to leptospirosis risk factors (9.8%).The highest observed increase was in the percentage of participants who were knowledgeable about the danger of contracting leptospirosis (86.7%).

Table 4.55 The difference in percentages of participants who were knowledgeable about leptospirosis before and after the intervention

No	Knowledge		difference of participants' percentages in the intervention village before and after the intervention (B-A)	difference of participants' percentages in the comparison village before and after the intervention (D-C)	total difference in the percentages before and after the intervention (B-A) – (D-C)*
1	Knowledge of symptoms of leptospirosis	Know	+ 75.0	+ 2.5	+ 72.5
		Know less	+ 9.1	- 9.2	+ 18.3
		Do not know	- 84.2	+ 6.6	- 77.6
2	Knowledge of the danger of leptospirosis	Know	+ 85.0	- 1.7	+ 86.7
		Do not know	- 85.0	+ 1.7	- 83.3
3	Knowledge of leptospirosis transmission	Know	+ 55.8	+ 0.8	+ 55.0
		Know less	+ 30.8	+ 1.7	+ 29.1
		Do not know	- 86.6	- 2.5	- 84.1
4	Knowledge of leptospirosis risk factors	Know	+ 39.2	+ 1.7	+ 37.5
		Know less	+ 40.0	0.0	+ 40.0
		Do not know	- 79.2	- 1.7	- 77.5
5	Knowledge of leptospirosis prevention	Know	+ 55.0	+ 1.7	+ 53.3
		Know less	+ 30.9	+ 14.2	+ 16.7
		Do not know	- 85.9	- 15.8	- 70.1
6	Knowledge of the benefits of reducing exposure to leptospirosis risk factors	Know	+ 9.8	0.0	+ 9.8
		Know less	+ 75.5	+ 12.5	+ 63.0
		Do not know	- 85.3	- 12.5	- 72.8

* + = increase - = decrease

Table 4.56 shows the percentage of participants who practised checking for skin wounds before commencing work in aquatic or wet environments pre- and post-intervention. The percentage of participants who practised checking for skin wounds in the intervention group increased by 68.9% after the intervention. Surprisingly, the percentage of participants in the control group who practised checking for skin wounds also increased by 34.7%; consequently, the total increase in the percentage of participants who practised checking for skin wounds in the intervention group was 68.9% – 34.7% = 34.2% (see Table 4.57).

Table 4.56 Percentage of participants who practised checking for skin wounds, Kembangan village (intervention) and Bumirejo village (control)

No	Practice		% before intervention (A)	% after intervention (B)	Difference of the percentages (B-A)*
1	Practise checking for skin wounds before working in wet environments (Kembangan village)	Yes	23.5	92.4	+ 68.9
		No	76.5	7.6	- 68.9
2	Practise checking for skin wounds before working in wet environments (Bumirejo village)	Yes	17.9	52.6	+ 34.7
		No	82.1	47.4	- 34.7

* + = increase - = decrease

Table 4.57 Total difference in percentages of participants who practised checking for skin wounds before and after the intervention

No	Practice		difference of participant percentages in the intervention village before and after the intervention (A)	difference of participant percentages in the comparison village before and after the intervention (B)	total difference of the percentages before and after the intervention (174)*
1	Practise checking for skin wounds before working in wet environments	Yes	+ 68.9	+ 34.7	+ 34.2
		No	- 68.9	- 34.7	- 34.2

4.7 Conclusions of sub-chapter 4.6

Based on the results of the prioritisation process and discussions among panel members, the intervention study focused on promoting knowledge of leptospirosis risk factors and increasing the practice of checking for the presence of skin wounds before working in aquatic or wet environments. Intervention activities were conducted in Kembangan village. Participants attended two main sessions, an introductory session and a group session.

After the intervention, the percentage of participants who were able to identify leptospirosis risk factors had increased by 37.3%; the percentage of participants who were able to identify ways of preventing or reducing exposure increased by 53.3%; the percentage of participants who were able to identify the benefits of preventing or reducing exposure to leptospirosis risk factors increased by 9.8%; and the percentage of participants who did not take action to prevent or reduce exposure to leptospirosis risk factors, such as checking for the presence of skin wounds, reduced by 34.2%. The objectives of the intervention activities were achieved, except in the case of the percentage of participants who were able to identify the benefits of preventing or reducing exposure to leptospirosis risk factors (less than 20% increase).

Information obtained from key informants, in the socio-behavioural study, confirmed that the intervention activities had gone smoothly. For example, the informants reported that people in Demak district enthusiastically participated in activities that were directed by individuals they already knew. Participants in the intervention undertook all the educational activities with enthusiasm because they had known the researcher and team before the intervention. The researcher and team had made prior contact with people in the study area when conducting the socio-behavioural study, the field observation study, and the KAP-1 survey. Participants complied with the instructions of local key persons; the selection of participants' homes for group activities and scheduling the times for activities were much easier when local key persons were also involved.

4.8 Summary of the findings

Obtaining information on local factors related to leptospirosis is vital to the process of developing an intervention to reduce exposure to leptospirosis risk factors, specifically in a leptospirosis-endemic area with a paucity of leptospirosis risk factor data. In Indonesia generally and in the district of Demak specifically, such information can be obtained by synthesising available data on local, national, or regional (the Asia-Pacific region) leptospirosis risk factors; and by obtaining information on the local environment, community characteristics and behaviour related to leptospirosis transmission in leptospirosis-endemic areas.

In leptospirosis-endemic areas of Indonesia where there is a paucity of published leptospirosis risk factor data to be found in national or international peer-reviewed journals, information related to leptospirosis at the local and national levels is obtained from grey literature. The results of synthesising this available information indicated that leptospirosis risk factors were localised to specific geographical areas: for example, bathing in rivers and washing clothes in rivers were activities shown by more than 50% of the selected studies to have significant associations with human leptospirosis infection in Demak district. In contrast, less than 50% of the selected studies in other districts of Indonesia showed significant associations between these risk factors and human leptospirosis. A few leptospirosis-related factors were shown by more than 50% of the selected studies to have significant association with human leptospirosis infection in both Demak district and other districts of Indonesia. These common factors were stagnant water in the areas immediately surrounding houses; poor home sanitation; the presence of rats, and human contact with stagnant water.

Other factors related to human leptospirosis infection were shown by more than 50% of the selected studies to have a significant association with human leptospirosis infection in other districts of Indonesia, but by less than 50% in Demak district. These factors were poor sewerage; human contact with flood water; activities in paddy fields; the

presence of skin wounds; leisure activities, contact with rats' bodies or tissues; low education levels, and lack of knowledge about leptospirosis.

Field observations showed that a number of physical environmental conditions related to leptospirosis transmission exist in Demak district. These conditions include rats' burrows in paddy fields; rivers that frequently overflow in the rainy season, inundating surrounding areas; the poor condition of house and village water drainage systems; the presence of stagnant water in areas immediately surrounding houses; fish ponds sourcing their water from rivers; poor sanitation of livestock stalls, and abundant rat populations, seen inside and outside houses. Local activities in Demak district involving contact with water and animals are bathing and washing clothes in rivers; working in paddy fields; fish harvesting; cleaning open water drains; bathing buffaloes or goats, and hunting or killing rats.

In-depth interviews with local informants showed that leptospirosis is considered a dangerous disease only by people who reside in the same village where leptospirosis cases have occurred, or by people who have experienced cases where leptospirosis caused either hospitalisation or death. Informants also reported that a number of people in Demak district still engaged in activities that put them at risk of contracting leptospirosis; less than 30% of people in Demak district knew of leptospirosis; and their knowledge about leptospirosis risk factors and prevention was insufficient.

Insufficient knowledge about factors related to leptospirosis infection and leptospirosis prevention among people in leptospirosis-endemic areas was confirmed by the results of the KAP-1 survey. The majority of respondents did not know about the symptoms, dangers, mode of transmission, risk factors, or prevention of leptospirosis. The majority of the KAP-1 survey respondents were also undecided whether they agreed, were neutral about, or disagreed with stated actions related to the prevention of leptospirosis. Among respondents engaged in activities in aquatic or wet environments only 16.4% wore rubber gloves and only 4.7% wore boots while working in such environments. Only 22.6% of respondents checked for the presence of skin wounds before working in

aquatic or wet environments, and about half of these reported that they had wounds on their hands or feet.

The information from the results of synthesising data on local and national leptospirosis risk factors, in-depth interviews with local key informants, field observations, and the KAP-1 survey provided the base information for developing an intervention to reduce exposure to leptospirosis risk factors in the endemic area, Demak district. Based on the results of discussion among panel members, an intervention program was developed that focused on promoting knowledge about leptospirosis risk factors and increasing the practice of checking for the presence of skin wounds. Two villages were selected for this intervention study: Kembangan village (the intervention village) and Bumirejo village (the comparison village). Participants selected for the intervention numbered 240, with 120 participants from Kembangan village and 120 from Bumirejo village.

Intervention activities consisted of two main sessions, an introductory session and a group session. Pre-tests and post-tests regarding leptospirosis were performed at each of the sessions. There was also an evaluation process after the intervention activity had been conducted.

Participants' knowledge about the symptoms, the danger, transmission, risk factors, and prevention of leptospirosis was found to have increased after the intervention. The increase in the percentage of participants who knew about the symptoms, the danger, mode of transmission, risk factors, and the prevention of leptospirosis was in the range of 9.8%–86.7% after the intervention. The increase in the percentage of participants who practised checking for skin wounds before working in aquatic or wet environments was 34.2% after the intervention.

CHAPTER 5
DISCUSSIONS AND LIMITATIONS

5.1 Introduction

Human leptospirosis exists in Indonesia, and the number of human leptospirosis cases is increasing.[28] Efforts to prevent or reduce the occurrence of human leptospirosis in Indonesia have been made. However, these activities have lacked coordination and integration, and have not been systematically planned or evaluated.[39]

Action to prevent or reduce the occurrence of human leptospirosis should be based on factual evidence.[26, 42] An important component of such evidence, required before any intervention can be made to prevent or reduce the occurrence of human leptospirosis, is evidence on specific local risk factors.[26, 215] However, in Indonesia, particularly in rural leptospirosis-endemic areas, information about local leptospirosis risk factors is either scarce or non-existent. On the other hand, there is public demand for local district health authorities and institutions to undertake action as soon as possible that will prevent or reduce the occurrence of human leptospirosis.

The time needed to provide standard evidence-based information to support the development of a leptospirosis intervention program is about six months to two years.[216] If nothing is done to control leptospirosis transmission in the leptospirosis-endemic areas during that interim period, outbreaks of leptospirosis are likely to occur.
On the other hand, action to control leptospirosis without the benefit of information on local risk factors for leptospirosis will be inadequate, and a waste of time and funds. Therefore, obtaining rapid information on local leptospirosis risk factors is a vital strategy to support any intervention program for leptospirosis control in endemic areas where there is a paucity of information about leptospirosis risk factors.

This chapter discusses identification of local leptospirosis risk factors in leptospirosis-endemic areas where there is a paucity of information on those risk factors, using

available sources of information. Next the chapter discusses the implications of using those sources of information for developing and implementing an intervention to reduce exposure to leptospirosis risk factors in endemic areas where there is a paucity of information on those risk factors. Finally, the chapter presents the limitations of the study in providing leptospirosis risk factor information to support the development of an intervention program to reduce exposure to leptospirosis risk factors.

5.2 Identification of local leptospirosis risk factors using available sources of information

The available sources of local leptospirosis risk factor information were sought in electronic databases, through internet searches or by visiting the local or national libraries. Available information about leptospirosis risk factors in Demak district was found in the local district health office library, local university libraries, and the national health research and development library. However, there were fewer studies of risk factors for leptospirosis in Demak district than studies related to other prevalent diseases, such as dengue haemorrhagic fever, tuberculosis, and acute respiratory diseases.

In addition, none of the results of studies on risk factors for human leptospirosis infection in Demak district had been published in international peer-reviewed journals. Therefore, the available previous leptospirosis risk factor studies of Demak district that were used for this research were mostly considered as grey literature. A similar lack of available leptospirosis risk factor studies was noted for other leptospirosis-endemic districts of Indonesia[39], and for endemic areas in other developing countries.[5, 10, 87]

The study undertook a review of previous leptospirosis risk factor studies of Demak district; this covered available grey literature including previous studies containing local leptospirosis risk factor information for Demak district or other endemic districts in Indonesia, and also articles about human leptospirosis risk factors that had been published in international peer-reviewed journals. A review of previous leptospirosis

risk factor studies is less expensive than conducting a new leptospirosis risk factor study. The most expensive part of conducting a new leptospirosis risk factor study, particularly in developing countries, would be the costs of laboratory tests such as MAT and PCR, needed to confirm case diagnosis; these tests are expensive because of their complexity, laborious procedures, and the fact that they require a well-equipped laboratory.[51, 89]

Relatively less time is required to accomplish a review of previous studies of risk factors for leptospirosis than would be needed for a new leptospirosis risk factor study. Most of the work in a review of previous studies consists of searching for information about leptospirosis risk factors in journal article databases via the internet, visiting local libraries, and also the synthesising of the selected journal articles. Facilities for database searches, and the skilled people needed to do the data synthesis, are vital to studies like this one. This implies a need for close collaboration between local health offices and local universities, because both data synthesis experts and access to previous leptospirosis risk factor studies published in peer-reviewed journals are more available at universities.

The review of previous studies allowed the inclusion of available leptospirosis risk factor studies from other endemic sites, information that benefited this study. First, the results of studies from other leptospirosis-endemic sites provided important additional information for the synthesis of leptospirosis risk factors in the studied area, Demak district. Second, the results of studies from other endemic sites were useful for the identification of similarities and differences in local leptospirosis risk factors reported from the studied district and from other endemic districts or other nations. This identification of similarities and differences in local leptospirosis risk factors helped researchers to determine specific local leptospirosis risk factors. In addition, the identification of similarities and differences in local leptospirosis risk factors afforded researchers some insight into certain leptospirosis risk factors usually found in endemic areas with environmental and behavioural characteristics that were relatively similar to characteristics of the studied area.

As an example of such new insight regarding local potential leptospirosis risk factors of interest, one previous study showed that the presence of skin wounds was not a local risk factor for leptospirosis infection in the district of Demak[83]; based on this study, skin wounds would not be considered a local risk factor to be included in the development of an intervention to reduce exposure to leptospirosis risk factors.

However, after reviewing and synthesising the results of other previous studies, the presence of skin wounds was considered to be a local risk factor that should be included in the development of an intervention. Indeed, the skin wounds risk factor was selected as one of main focuses of this study's intervention program (see sub-chapter 4.6).

Local risk factors for human leptospirosis that were identified in Demak district, a rural flood-prone area, are similar to those indicated by findings in leptospirosis risk factor studies conducted in rural flood-prone areas of Lao PDR[20], and in Chiapas, Mexico.[129] In Chiapas, the presence of skin wounds has been shown to be the main local risk factor for leptospirosis infection in humans. In contrast, skin wounds have not been considered a local risk factor in Demak district, based on the results of an examined previous study of Demak district;[83] however, the majority of the results from examined previous studies of other districts of Indonesia[21, 78, 124, 138] and of other Asia-Pacific countries,[19, 22, 125, 129, 151, 154] show a significant association between skin wounds and the occurrence of human leptospirosis infection. Therefore, this study considered skin wounds to be a local risk factor for leptospirosis in Demak district.

In-depth interviews with key informants indicated that people in the investigated leptospirosis-endemic area, Demak district, commonly engage in activities involving contact with water, such as bathing or washing in rivers, working in paddy fields, fish harvesting, and cleaning open water drains. They also engage with animals in activities such as bathing buffaloes or goats using water from streams or open water drains, and hunting and killing rats in paddy fields. These activities involving contact with water and animals in Demak district, a rural leptospirosis-endemic area, are consistent with epidemiological patterns of leptospirosis transmission to humans in rural areas.[2, 84]

Key informants reported that the majority of people in Demak district do not wear waterproof hand and feet protection when they engage in activities involving contact with water or animals. This information is consistent with the results of previous risk factor studies in Demak,[83] in other districts of Indonesia,[123, 124, 137] and in other Asia-Pacific countries.[19, 103, 127, 129] However, no significant association between not wearing personal protection and human leptospirosis infection was reported in the previous study on Demak district; only one of three studies that examined this association in other districts of Indonesia showed a significant association. In contrast, three out of four studies that examined this association in other Asia-Pacific countries showed a significant association. In addition, a study by Leal-Castellanos and team[129] in a rural leptospirosis-endemic area in Mexico pointed out the importance of wearing personal protection and of the presence of skin wounds when working in aquatic or wet environments, or with animals. Based on these findings, this study considered not wearing personal protection when working in aquatic or wet environments, or working with animals, to be a local leptospirosis risk factor in Demak district.

Key informants reported that the knowledge of people in Demak district about leptospirosis risk factors and prevention was insufficient. This information matches reports in previous leptospirosis risk factor studies of Demak district,[18, 82, 83] and of other districts of Indonesia.[32, 35]

In-depth interviews with key informants can be used as an introductory step before conducting other studies, such as field observations, knowledge, attitude and practice (KAP) studies, and intervention studies. The key informants in this study were selected individuals who knew their community and were known to their community. Maintaining a good relationship with key informants benefits later phases of the research.

The physical environmental characteristics relating to leptospirosis transmission that were observed in the district of Demak were paddy fields with rats' burrows; rivers that frequently overflowed in the rainy season; poor housing conditions; poor village water drains; poor sanitation at cow stalls; the presence of stagnant water in the areas immediately surrounding houses, and fish ponds sourcing water from nearby rivers. In addition, rats were seen in house yards and inside villagers' homes. These observations are consistent with the results of previous leptospirosis risk factor studies of Demak district.[18, 36, 82, 83, 136] However, these previous studies did not mention or describe the fact that rats' burrows are found in the paddy fields, or that cows' excreta are discharged directly into the village water drains.

The presence of numerous rats' burrows in paddy fields, and village drains contaminated by cows' urine in this leptospirosis-endemic area indicate that these paddy fields and village drains are potential sources for leptospirosis transmission. To support this indication, laboratory test results for leptospirosis in samples taken from rats in the paddy fields and from livestock (when available) are required.

Human activities involving contact with water and animals that were observed during the field observation study in Demak district were work in paddy fields; washing clothes in rivers; bathing in rivers; catching fish, and bathing water buffaloes and goats. These activities, except for bathing water buffaloes and goats, were reported in the previous leptospirosis risk factor studies of Demak.[18, 36, 83] However, bathing water buffaloes and goats were activities reported by key informants in the in-depth interviews (see sub section 4.2.3.1).

5.3 Implications of using existing leptospirosis-related risk factor data for developing public health interventions to reduce exposure to leptospirosis risk factors

Public health prevention programs mostly deal with the identification of sources of infection and disease transmission control.[26] Preventive or control programs for leptospirosis are focused on breaking the chain of leptospirosis infection, which is itself linked to leptospirosis risk factors. Therefore, information about local risk factors for leptospirosis is required to support the development and implementation of leptospirosis prevention and control programs, including any intervention to reduce exposure to leptospirosis risk factors in a leptospirosis-endemic area where there is a paucity of risk factor data.

In this study, a KAP survey was implemented before the development of an intervention. This survey found that more than half of the respondents who lived in the leptospirosis-endemic area (56.9%) had not heard about leptospirosis. Among those who heard about leptospirosis, the study identified a number of respondents who did not know about the symptoms (38.2%); the mode of transmission (35.9%); the risk factors (35.9%); the danger (56.5%), or the prevention (45.8%) of leptospirosis (Table 4.13). Compared to a KAP study in Trinidad,[217] a leptospirosis-endemic country, the proportion of respondents who had not heard about leptospirosis in Demak district was higher than that in Trinidad (47.6%); among respondents who had heard about leptospirosis, the percentage who did not know the signs or symptoms of leptospirosis was higher in Trinidad (47.0%) than that in Demak district. In contrast, the percentage of respondents in Trinidad who did not know the mode of transmission (21.5%) or the means of prevention (28.6%) was less than that in Demak district.

The results of this KAP survey in Demak district indicated that the distribution of information about leptospirosis to people in the endemic areas had not been properly implemented. This indication was supported by information coming from the study's key informants. According to these informants, the distribution of education materials

about leptospirosis by the staff of the local primary health care centre was usually confined to people living in the same location or the same village as existing or reported leptospirosis cases. The information was only given once, and there was no exercise to evaluate its impact. The proportion of respondents in the district with low levels of education (72.7%) may also account for the low level of understanding of the educational materials distributed to villagers.

The insufficient knowledge of leptospirosis found among people in Demak district echoes findings in other rural leptospirosis-endemic areas of Indonesia,[21, 32, 78] and in other developing countries.[139, 186, 217] Activities to improve people's knowledge are needed in such areas. Both the methods and the materials used in such educational activities should take into account the participants' level of education and occupational backgrounds. Therefore, collaboration between local health institutions and local universities is important to the planning and implementation of educational activities aimed at improving people's knowledge of leptospirosis in leptospirosis-endemic areas.

In this study's KAP survey (Tables 4.14a, b, and c), a large number of respondents said they were undecided on whether they agreed, were neutral about, or disagreed with stated actions related to leptospirosis prevention. Possible explanations for this situation were that respondents had not received information about leptospirosis (93.4%), or they had insufficient knowledge about leptospirosis.

Among the respondents who had engaged in activities in aquatic or wet environments within the past 30 days before the interview, 59.0% reported that they wore protection for their feet or hands. However, among those respondents who wore protection for their feet or hands, only 16.4% and 4.7% of them wore waterproof boots or rubber gloves respectively. This finding indicates that a number of respondents are willing to wear personal protection equipment, but they wore the wrong type of equipment. The possible explanations for this are that they do not know what the right type of personal protection equipment is, or they do not have enough money to buy the right equipment.

Checking for the presence of skin wounds before engaging in activities involving contact with water or animals was a practice found only among a few respondents (22.6%). Interestingly, about half of the percentage of respondents who did check their skin (49.0%) found skin wounds on their hands or feet. This finding indicates that checking for the presence of skin wounds before engaging in activities involving contact with water or animals is an important measure to prevent leptospirosis transmission via skin wounds. Checking for the presence of skin wounds is important because skin wounds are known as one of the risk factors for leptospirosis.[125, 129, 154]

The results of the KAP study in Demak district confirmed the presence of some local potential risk factors for human leptospirosis that had been reported in the review of previous studies and in the socio-behavioural study. These local potential risk factors for human leptospirosis include low levels of education, insufficient knowledge about leptospirosis, and practices related to human contact with water.

The intervention implemented in Demak district, the studied leptospirosis-endemic area where there is a paucity of information about local risk factors, was in the form of a preliminary intervention. This intervention was intended as an initial systematic activity to prevent or control leptospirosis transmission in the studied area.

This intervention was developed based on the available evidence about local risk factors for leptospirosis in Demak district as described in sub-chapter 5.2. In addition, the results of the prioritisation process showed that the lack of knowledge of leptospirosis and the presence of skin wounds were two local risk factors that should be selected as the focus for an intervention in Kembangan village, in Demak district. Hence, activities in the intervention were directed at reducing exposure by enhancing the knowledge of local people about leptospirosis risk factors and at increasing the practice of checking for the presence of skin wounds before working in aquatic or wet environments.

The issue of skin wounds, determined as one of the local risk factors in Demak district and selected as one of main focuses of the intervention, is an example of how important it was to conduct phase one of this research. The skin wounds issue would not have been picked out had this study based its determinations only on previous studies about leptospirosis risk factors in Demak district, since none of these had indicated that skin wounds were a local leptospirosis risk factor in the district. In contrast, a review of previous leptospirosis risk factor studies that included not only Demak district, but other districts of Indonesia, and other Asia-Pacific countries, combined with in-depth interviews with local key informants, field observations and the results of the KAP survey, led to this study's determination that the presence of skin wounds is a local risk factor for leptospirosis infection in Demak district.

An approach implemented in phase one of the research enabled the identification of 'hidden' local leptospirosis risk factors, such as the presence of skin wounds, which had not previously been recognised in the study area. This is an important finding of this research. This result will help in the design of future leptospirosis prevention programmes. Data from this study will contribute towards better understanding local leptospirosis risk factors and aid in developing intervention initiatives in endemic areas where there is a paucity of leptospirosis risk factor data. Leptospirosis endemic areas with limited risk factor data are still prevalent in Indonesia an in other developing countries.

5.4 Impact of an intervention to reduce exposure

The objectives of the intervention were to increase by at least 20% the proportion of people in the target group that knew about leptospirosis risk factors, the ways to prevent leptospirosis, and the benefits of preventing leptospirosis, by the end of the program. Furthermore, the intervention was targeted to reduce by at least 20% the proportion of people who did not take action to reduce their exposure to a risk factor for leptospirosis, by the end of program. Results of the intervention in Kembangan village, Demak

district, showed increases in the proportion of people in the target group who knew about leptospirosis risk factors, the ways to prevent leptospirosis, and the benefits of preventing leptospirosis, by 37.5%, 53.3%, and 9.8% respectively (Table 4.55); they also showed a decreased percentage of people who did not check for the presence of skin wounds before working in aquatic or wet environments, by 34.2% (Table 4.57).
These results indicated that the objectives of the intervention were attained, except for the proportion of people who knew about the benefits of preventing leptospirosis, which increased by only 9.8% (target was 20%).

The three main benefits of conducting leptospirosis prevention that were taught during the intervention activities were that people did not get the disease, people did not die, and they did not lose their money or savings. A person who knew the benefits of conducting leptospirosis prevention was defined as a person who was able to mention all three main benefits. Among those three main benefits, 'did not lose money' was the one mentioned least often by people in the target group, all living in a rural leptospirosis-endemic area. A possible reason for the low increase in the percentage of people in the target group who knew the benefits of conducting leptospirosis prevention is that respondents may have found it difficult to comprehend the relationship between 'did not lose money' and engaging in leptospirosis prevention activities.

An increase in the number of participants who were aware of leptospirosis symptoms, risk factors, and the ways to prevent leptospirosis was reported by Bipin and team from India.[188] Their educational intervention in the Navsari district of India used street plays and displayed posters to participants. However, unlike the intervention in Demak district, the intervention in Navsari district did not have a control group.

The assessment of the effects of an intervention program in this study was considered as an impact evaluation. The effect of this intervention program was considered to be the short-term effect of an intervention.[218]

To maintain the benefits of the intervention so it continues to be remembered and practised by people in the target group would require continual refreshment of intervention materials. Local key people and local health workers play a vital role in promoting community awareness of leptospirosis and providing peer support for sustaining healthy behaviours and shifting community norms to reduce exposure to local leptospirosis risk factors. Methods of refreshing the memories of people in the intervention target group have included displaying posters in public places, sticking stickers in easily seen places in the house, and providing work clothes bearing slogans referring to the benefits of conducting leptospirosis prevention activities. However, the effectiveness of these ways of keeping people aware of leptospirosis has not been evaluated. Therefore, new studies are needed to investigate the best ways of refreshing awareness among people in a target group after an intervention program aimed at leptospirosis prevention.

5.5 Limitations of the study

The limitations of this study are identified in this section. They include limitations related to literature search processes and to information given by informants in the in-depth interview, limitations associated with the KAP survey (generalisability), and limitations associated with the intervention evaluation.

Risk factor studies included in the review of available literature on previous studies were limited to studies with accessible full-text articles in Indonesian and English. Indonesian studies of leptospirosis risk factors that were included in the review were not selected from all leptospirosis-endemic districts in Indonesia because not every endemic district had been studied for leptospirosis risk factors, and not every leptospirosis risk factor study was accessible. Similarly, risk factor studies from countries with high leptospirosis endemicity that were not in English were excluded from the selection of international studies on leptospirosis risk factors for inclusion in the review. Thus, the findings of the review have limited generalisability.

The reporting quality of studies included in the review of previous studies was not strictly evaluated according to known guidelines for reporting observational studies, due to the limited number of previous studies on local leptospirosis risk factors that was available, and also because there was an urgent need to use information on local leptospirosis risk factors for an intervention to prevent leptospirosis immediately.

Informants in the in-depth interviews were expected to provide information on what local people knew, felt, or practised. However, there was a possibility that the informants might report their personal views. To minimise this possibility, two informants were selected for each sub-district, and their reports on the same questions were crosschecked.

Results derived from the cross-sectional design used for the KAP study are only relevant for the situation or condition prevailing at the time the study was conducted. Nevertheless, this study is valuable for identifying situations or conditions before the implementation of the intervention.

Participants for the intervention study were limited to paddy field farmers aged 18–60 years. Therefore, the results of this study cannot be generalised to all people in the leptospirosis-endemic area. However, this study is still important for health programmers in developing countries since most farmers in leptospirosis-endemic regions of developing countries are in the 18–60 age group.

Evaluation of the intervention activities was limited to impact evaluation or short-term effect evaluation. However, an evaluation several months later would be useful to evaluate people's retention of KAP elements; but this was not a part of this research.
As a consequence, the evaluation could only measure immediate changes in knowledge about leptospirosis, in attitudes towards preventive action against leptospirosis, and in practices such as actions to reduce exposure to leptospirosis risk factors. Additional time, funding, procedures, and activities are required to evaluate actual behavioural changes.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

The main objective of this research has been to investigate available leptospirosis risk factor data for the purpose of developing an intervention program in a leptospirosis-endemic area with a paucity of leptospirosis risk factor data. To achieve this objective, the study was designed in two phases, with each phase involving the investigation of a set of specific objectives.

This chapter presents the conclusions following discussions of the main findings arising from the investigation of each specific objective; recommendations, where applicable, are presented for the purpose of providing sufficient leptospirosis risk factor information for an intervention in endemic areas where there is a paucity of leptospirosis risk factor data.

6.1 Conclusions

The study findings reveal that there is a paucity of information about risk factors for leptospirosis in Demak district, a rural leptospirosis-endemic area of Indonesia. However, information on local risk factors is required for effective leptospirosis prevention and control. Problems arise when the need to take action to control or prevent the transmission of leptospirosis in an endemic area is urgent, yet the local risk factor data in rural or remote leptospirosis-endemic areas are insufficient or inadequate. Consequently, if efficient and effective intervention programs are required to be developed, it is essential that there is adequate provision of leptospirosis risk factors information in endemic areas with insufficient or inadequate leptospirosis risk factor data.

6.1.1 Phase one: identification of local leptospirosis risk factors

In the first phase of the study, the availability of local leptospirosis risk factor data was investigated; and local social, behavioural, and environmental characteristics that could be related to the occurrence of leptospirosis in humans were identified.

6.1.1.1

Specific objective 1a

To review and synthesise data associated with leptospirosis risk factors reported in grey literature and in international peer-reviewed sources, and to identify the distribution of similarities and differences in risk factors for leptospirosis in Indonesia and in the Asia-Pacific region.

In addressing specific objective 1a, the literature search strategy for collecting leptospirosis risk factor studies was described. (See section 3.2.1.) Most of the activity undertaken in the review of previous studies consisted of searching for information about leptospirosis risk factors in journal article databases via the internet, visiting local libraries, and synthesising the selected journal articles. The results of leptospirosis risk factor studies found in local grey literature and in peer-reviewed journals were used. Twenty international peer-reviewed articles and 14 studies on leptospirosis risk factors in Indonesia that fulfilled the inclusion criteria were included in the study. A number of the leptospirosis risk factor studies in Indonesia lacked diagnostic confirmation for cases cited, as they relied only on rapid test results and the clinical characteristics of respondents to support the diagnosis.

Results of the review and synthesis of data associated with leptospirosis risk factors reported in grey literature and in international peer-reviewed sources can be used to identify local risk factors. Local risk factors for human leptospirosis identified as specific leptospirosis risk factors for Demak district were stagnant water in the areas

immediately surrounding houses; poor home sanitation; the presence of rats; human contact with stagnant water; bathing in rivers or ponds, washing clothes in rivers or ponds, and walking barefoot.

Other identified local risk factors for human leptospirosis in Demak district were flooding within the last 14 days; poor sewerage; human contact with flood water; human contact with rats' bodies or tissues; work involving contact with contaminated surface water; activities in paddy fields; leisure activities; unhealthy personal hygiene; skin wounds; low education levels, and lack of knowledge of leptospirosis. Not wearing personal protection when working in aquatic or wet environments was added as a local risk factor for leptospirosis in Demak district because this factor fulfilled the required criteria. (See section 4.4.1.) The majority of people in Demak district did not wear waterproof protection for their hands (83.6%) and feet (95.3%) when they engaged in activities involving contact with water or animals; no significant association between not wearing personal protection and human leptospirosis infection was reported in the studies in Demak district; only one of three studies that examined this association in other districts of Indonesia (less than 50%) showed a significant association. In contrast, three out of four (more than 50%) reviewed studies that examined this association in other Asia-Pacific countries showed a significant association.

Relatively less time is required to accomplish a review of previous studies of risk factors for leptospirosis than would be needed for a new leptospirosis risk factor study. However, facilities for database searches, and the skilled people needed to do the data synthesis, are vital to studies like this one. This implies a need for close collaboration between local health offices and local universities

The review and synthesis of previous studies can give researchers new insight into local potential leptospirosis risk factors. For example, one previous study showed that the presence of skin wounds was not a local risk factor for leptospirosis infection in the district of Demak; based on this study, skin wounds would not be considered a local risk factor to be included in the development of an intervention to reduce exposure to leptospirosis risk factors. However, after reviewing and synthesising the results of other

previous studies, the presence of skin wounds was considered to be a local risk factor that should be included in the development of an intervention. Indeed, the skin wounds risk factor was selected as one of the main focuses of the study's intervention program in Demak district.

6.1.1.2

Specific objective 1b
To obtain and synthesise information on the social and behavioural characteristics of communities as related to leptospirosis in leptospirosis-endemic areas

In accordance with specific objective 1b, 12 local key informants were recruited from six selected sub-districts of Demak district. (See sub section 3.2.2.2). In-depth interviews were conducted with the key informants to obtain information about local practices involving human contact with water and animals, community beliefs regarding disease, how the community prevented the disease and sought treatment, and what the community knew about leptospirosis.

The in-depth interviews with local informants offer at least three benefits. First, they provide background on the characteristics of local people and local community thinking about diseases, including leptospirosis. Second, they provide information on local potential risk factors for leptospirosis, and specifically on local people's activities involving contact with water and animals. Third, the results of the interview can be used as basis for further studies, such as field observation studies on environmental and behavioural factors related to leptospirosis transmission, a knowledge, attitude and practice (KAP) study related to leptospirosis risk factors and prevention, and an intervention study to prevent leptospirosis transmission.

6.1.1.3

Specific objective 1c

To obtain and evaluate more detailed information on environmental factors and community behaviour as related to leptospirosis risk factors in leptospirosis-endemic areas

To address the requirements of this specific objective, the sub-districts of Bonang, Demak, and Karangawen were selected for study. (See sub-section 3.2.3.2.). Observation checklists and observation record forms were prepared. Environmental factors and human behaviour related to leptospirosis transmission were observed. (See subsections 3.2.3.3 and 3.2.3.4).

Field observation activities provided more detailed information on local potential environmental and behavioural risk factors. For example, previous studies did not mention or describe the fact that rats' burrows are found in the paddy fields, and that cows' excreta are discharged directly into the village water drains, as observed during this study. The presence of numerous rats' burrows in paddy fields, and village drains contaminated by cows' urine in this leptospirosis-endemic area indicate that these paddy fields and village drains are potential sources for leptospirosis transmission. To support this indication, routine laboratory examinations of local water and animals for the presence of leptospires should form part of a local system of surveillance that monitors leptospirosis risk factors in leptospirosis-endemic areas.

6.1.2 Phase two: an intervention to reduce exposure to leptospirosis risk factors

In the second phase of the study, the potential contribution of the available leptospirosis risk factor data to the development of an intervention program was investigated. Two main activities were conducted in this second phase, the KAP-1 survey and an actual intervention.

6.1.2.1

Specific objective 2a

To identify and evaluate the knowledge, attitudes, and practices of members of the community regarding leptospirosis risk factors and the prevention of leptospirosis in endemic areas.

In accordance with specific objective 2a, 304 respondents from Demak district were recruited, 150 respondents from Kembangan village and 154 respondents from Bumirejo village. (See sub-section 3.3.1.3). Selected respondents were visited and interviewed, with interviewers guided by a pre-tested questionnaire. (See sub-section 3.3.1.4).

The results of the KAP study confirmed the presence of some local potential risk factors for human leptospirosis reported in a review of previous studies and in the socio-behavioural study. These local potential risk factors for human leptospirosis include low levels of education, insufficient knowledge about leptospirosis, and practices involving contact with water.

The finding in Demak district that there is insufficient knowledge about leptospirosis has been replicated in other rural leptospirosis-endemic areas of Indonesia[21, 32, 78] and in other developing countries.[139, 186, 219] Activities to improve people's knowledge of the disease are needed in leptospirosis-endemic areas. Methods and materials used in these educational activities should take into account participants' level of education and occupational backgrounds. Therefore, collaboration between local health institutions and local universities is important to the planning and implementation of activities to promote people's knowledge of the disease in leptospirosis-endemic areas.

Checking for the presence of skin wounds before engaging in activities involving contact with water or animals was a practice adopted by only a few respondents (22.6%). Interestingly, about half of the percentage of respondents who did check their skin (49.0%) reported finding skin wounds on their hands or feet. This finding indicates

that checking for the presence of skin wounds before engaging in activities involving contact with water or animals is an important measure to prevent leptospirosis transmission via skin wounds.

6.1.2.2

Specific objective 2b
To promote knowledge of leptospirosis risk factors, and to reduce risk exposure among people aged 18 years and older living or working in leptospirosis-endemic regions of Demak district in Central Java, Indonesia.

In accordance with specific objective 2b, researchers undertook a prioritisation process to determine the focus of an intervention. The prioritisation of local leptospirosis risk factors was achieved using a process adopted and modified from a problem prioritisation tool developed by the Family Health Outcome Project at the University of California, San Francisco.[212]

The prioritisation process is an important step before conducting an intervention in leptospirosis-endemic areas. This process gives the researchers an opportunity to present their findings on the identification of local risk factors for human leptospirosis, and discuss them with local key people. Finally, local key people help prioritise local human leptospirosis risk factors for an intervention program facilitated by the researchers.

The results of the prioritisation process showed that lack of knowledge of leptospirosis and the presence of skin wounds were two key local risk factors. Hence these two factors were selected as the focus for an intervention in Kembangan village, Demak district.

Results of the intervention in Kembangan village, Demak district, showed increases in the proportion of people in the target group who knew about leptospirosis risk factors, the ways to prevent leptospirosis, and the benefits of preventing leptospirosis, by 37.5%,

53.3%, and 9.8% respectively; they also showed a decreased percentage of people who did not check for the presence of skin wounds before working in aquatic or wet environments, by 34.2%. These results indicated that the objectives of the intervention were attained.

Evaluation of the intervention activities was limited to impact evaluation or short-term effect evaluation. However, an evaluation several months later would be useful to evaluate people's retention of KAP elements; but this was not a part of this research.

6.2 Overall conclusions and recommendations

6.2.1 Overall conclusions

The overall conclusions of the research are:

1. An approach implemented in this research to the provision of leptospirosis risk factor information in endemic areas with insufficient or inadequate leptospirosis risk factor data can provide information about local risk factors for human leptospirosis. In addition, this approach is also able to identify 'hidden' local risk factors. Hidden in this case means that based only on results of previous local risk factor studies, a potential risk factor would not be considered a local risk factor to be included in the development of an intervention to reduce exposure to leptospirosis risk factors. However, after implementing the approach, this potential risk factor is considered to be a local risk factor that should be included in the development of an intervention.

   Example of the hidden local risk factor in this study is the presence of skin wounds issue, a factor that was determined as one of the local risk factors for Demak district and selected as one of main focuses for the intervention, exemplifies how important it was to conduct phase one of this research. Had the research been based only on previous studies about leptospirosis risk factors in Demak district, then none of these

previous studies would have indicated that skin wounds were a local leptospirosis risk factor in Demak district. In contrast, a review of previous leptospirosis risk factor studies that included not only Demak district, but other districts of Indonesia, and other Asia-Pacific countries, combined with in-depth interviews with local key informants, field observations and the results of the KAP survey, led to this study's determination that the presence of skin wounds is indeed a local risk factor for leptospirosis infection in Demak district. Another example of the hidden local risk factor in this research is not wearing personal protection when working in aquatic or wet environments.

2. The identified local risk factors for leptospirosis constitute important contributions to the development of an intervention to reduce leptospirosis transmission to humans. The intervention that were directed at reducing exposure by enhancing the knowledge of local people about leptospirosis risk factors and at increasing the practice of checking for the presence of skin wounds before working in aquatic or wet environments increased the proportion of people in the target group who knew about leptospirosis risk factors, the ways to prevent leptospirosis, and the benefits of preventing leptospirosis, by more than 20%. Moreover, result of the intervention also showed a decreased percentage of people who did not check for the presence of skin wounds before working in aquatic or wet environments.

6.2.2 Recommendations

The following key recommendations that have emerged from this study to mitigate the risk factors described above include the following:

1. Activities to improve people's knowledge of leptospirosis are needed in leptospirosis-endemic areas. Methods and materials used in these educational activities should take into account participants' level of education and occupational backgrounds.

2. There is a need for close collaboration between local health institutions and local universities that have data synthesis experts who can conduct reviews and synthesise information on diseases including leptospirosis. This collaboration will ensure that the process of reviewing and synthesising previously reported information in earlier studies goes smoothly; it will also assist with the implementation of socio-behavioural studies, field observation studies, KAP studies, and intervention studies.

3. To enable the effective investigation of cases for leptospirosis research purposes, the detection of common sources of outbreaks, and the implementation of appropriate control measures, it is important to provide local diagnostic testing laboratories that are accessible and affordable for local communities.

4. Routine laboratory examinations of local water and animals for the presence of leptospires are required as part of a local system of surveillance that can monitor leptospirosis risk factors in leptospirosis-endemic areas.

5. Checking for the presence of skin wounds before engaging in activities involving contact with water or animals is urgently needed to be informed to people in the leptospirosis-endemic areas.

6. Further research is needed to improve the criteria for the determination of the local leptospirosis risk factors that should be included in an intervention planning process in endemic areas where there is a paucity of information on leptospirosis risk factors.

7. The health authority of Demak district government and related local institutions need to be aware and take actions towards specific risk factors for Demak district

(stagnant water in the areas immediately surrounding houses; poor home sanitation; the presence of rats; human contact with stagnant water; bathing in rivers or ponds, washing clothes in rivers or ponds, and walking barefoot) and other identified local risk factors for human leptospirosis in Demak district (flooding within the last 14 days; poor sewerage; human contact with flood water; human contact with rats' bodies or tissues; work involving contact with contaminated surface water; activities in paddy fields; leisure activities; unhealthy personal hygiene; skin wounds; low education levels, and lack of knowledge of leptospirosis).

References:

1. Adler B, Peña-Moctezuma Adl. Leptospira and leptospirosis. Vet Microbiol. 2009;doi:10.1016/j.vetmic.2009.03.012.
2. Faine S, Adler B, Bolin C, Perolat P. Leptospira and Leptospirosis. 2 ed. Melbourne: MediSci; 2000.
3. Cerqueira GM, Picardeau M. A century of Leptospira strain typing. Infection, Genetics and Evolution. 2009;9:760-8.
4. WHO. Human Leptospirosis: Guidance for Diagnosis, Surveillance and Control: World Health Organization Press; 2003.
5. Vijayachari P, Sugunan AP, Shriram AN. Leptospirosis: an emerging global public health problem. J Biosci 2008;33(4):557-69.
6. Levett PN. Leptospirosis: A forgotten zoonosis? Clin Appl Immunol Rev. 2004;4:435-48.
7. Ahmed A, Anthony RM, Hartskeerl RA. A simple and rapid molecular method for Leptospira species identification. Infection, Genetics and Evolution. 2010;10:955-62.
8. Perez J, Goarant C. Rapid Leptospira identification by direct sequencing of the diagnostic PCR products in New Caledonia. BMC Microbiology. 2010;10:325.
9. Ashford DA, Kaiser RM, Spiegel RA, Perkins BA, Weyant RS, Bragg SL, et al. Asymptomatic infection and risk factors for leptospirosis in Nicaragua. Am J Trop Med Hyg. 2000;63(5,6):249-54.
10. Pappas G, Papadimitriou P, Siozopoulou V, Christou L, Akritidis N. The globalization of leptospirosis: worldwide incidence trends. Int J Infect Dis. 2008;12:351-7.
11. Victoriano AFB, Smythe LD, Gloriani-Barzaga N, Cavinta LL, Kasai T, Limpakarnjanarat K, et al. Leptospirosis in the Asia Pacific region. BMC Infectious Diseases 2009;9(147).
12. Plank R, Dean D. Overview of the epidemiology, microbiology,and pathogenesis of Leptospira spp. in humans. Microbes Infect. 2000;2:1265-76.
13. Bonita R, Beaglehole R, Kjellström T. Basic Epidemiology. Geneva: World Health Organization Press; 2006.
14. Rothman KJ, Greenland S, Lash TL. Modern Epidemiology. 3 ed: Lippincott Williams & Wilkins; 2008.
15. Porta M, Greenland S, Last JM, editors. A Dictionary of Epidemiology. Fifth ed. New York: Oxford University Press; 2008.
16. Sugunan AP. Epidemiology of leptospirosis. In: WHO, editor. Leptospirosis: Laboratory Manual. New Delhi: New Concept Information Systems Pvt. Ltd.; 2007. p. 13-21.
17. Loganathan N, Shivakumar S. Epidemiological Risk Factors of Urban Leptospirosis in North Chennai (Tamil Nadu) - A South India Study. 13th International Congress on Infectious Diseases; June 19-22; Kuala Lumpur Malaysia2008.
18. Priyanto A. Risk factors affecting the occurrence of leptospirosis: Study on cases in Demak district [Thesis]. Unpublished: Diponegoro University; 2008.
19. Tangkanakul W, Tharmaphornpil P, Plikaytis BD, Bragg S, Duangporn, Poonsuksombat, et al. Risk Factors Associated with Leptospirosis in Northeastern Thailand, 1998 Am J Trop Med Hyg. 2000;63(3,4):204-8.
20. Kawaguchi L, Sengkeopraseuth B, Tsuyuoka R, Koizumi N, Akashi H, Vongphrachan P, et al. Seroprevalence of Leptospirosis and Risk Factor Analysis in Flood-prone Rural Areas in Lao PDR. Am J Trop Med Hyg. 2008;78(6):957-61.
21. Wiharyadi D. Risk factors of leptospirosis in Semarang city, Indonesia [Thesis]. Unpublished: Diponegoro University Semarang; 2004.

22. Sugunan AP, Vijayachari P, Sharma S, Roy S, Manickam P, Natarajaseenivasan K, et al. Risk factors associated with leptospirosis during an outbreak in Middle Andaman, India. Indian J Med Res 2009;130:67-73.
23. Johnson ASM, Smith H, Joseph P, Gilman RH, Bautista CT, Campos KJ, et al. Environmental Exposure and Leptospirosis, Peru. Emerging Infec Dis 2004;10(6).
24. Douglin CP, Jordan C, Rock R, Hurley A, Levett PN. Risk Factors for Severe Leptospirosis in the Parish of St. Andrew, Barbados. Emerging Infectious Diseases. 1997;3(1).
25. Robertson H, Hanna J, Brookes D. Leptospirosis, annual report, 2002. Queensland Health, 2002.
26. John T. The Prevention and Control of human Leptospirosis. J Postgrad Med. 2005;51:205-9.
27. Indonesian Health Profiles 2010. Jakarta: Ministry of Health of the Indonesian Republic, 2011.
28. Indonesian Health Data Profiles 2011. Ministry of Health of the Indonesian Republic, 2012.
29. Wahjoedi I, Waluyo SJ, Murwani, Rahayu W. Surveilans faktor risiko lingkungan dan perilaku masyarakat pada kejadian leptospirosis di kecamatan Demak kabupaten Demak propinsi Jawa Tengah tahun 2009. 2009.
30. Hadisaputro S, editor. Faktor-faktor Risiko Leptospirosis. Simposium Leptospirosis; 2002; Semarang: Badan penerbit Universitas Diponegoro.
31. Murtiningsih B, Budiharta S, Supardi S. Risk factors of leptospirosis occurrence in Jogyakarta province and surroundings. Berita Kedokteran Masyarakat. 2005;21(1):17-24.
32. Okatini M, Purwana R, Djaja IM. Environmental factors and individual characteristics related to the occurrence of leptospirosis in Jakarta, 2003-2005. Makara Kesehatan. 2007;11(1):17-24.
33. Ristiyanto, Boewono DT, Sukamdani, Handayani FD, Mulyono A, Trapsilowati W, et al. Tindakan kedaruratan penanggulangan leptospirosis di kabupaten Demak, Jawa Tengah. 2008.
34. Wahjoedi I, Waluyo SJ, Murwani, Rahayu W. Surveilans faktor risiko lingkungan dan perilaku masyarakat pada kejadian leptospirosis di kecamatan Sayung kabupaten Demak propinsi Jawa Tengah tahun 2009. 2009.
35. Hasanah N. Factors related to the occurrence of leptospirosis in Bakung village of Klaten district, Central Java, 2007 [Final paper]. Unpublished: Diponegoro University Semarang; 2007.
36. Handayani FD, Ristiyanto. Distribution and environmental risk factors of leptospirosis transmission in Demak district, Central Java. Media Litbang Kesehatan. 2008;18(4):193-201.
37. Ristiyanto, Boewono DT, Handayani FD, Mulyono A, Suskamdani D, Trapsilowati W, et al. Tindakan Kedaruratan Penanggulangan Leptospirosis di Kabupaten Demak, Jawa Tengah. [Research Report] Salatiga: B2P2VRP-Balitbang Depkes RI; 2008.
38. Menanggulangi Masalah Kesehatan Akibat Banjir: Pengalaman Menghadapi Bencana banjir DKI Jakarta Awal Tahun 2002. Jakarta: Departemen Kesehatan Republik Indonesia, 2002.
39. Rencana Strategis Nasional Pengendalian Zoonosis Terpadu 2012-2017. Jakarta: Kementerian Negara Perencanaan Pembangunan Nasional / Kepala Badan Perencanaan Pembangunan Nasional 2012.

40. Widarso H, Gasem MH, Purba W, Suharto T, Ganefa S, editors. Pedoman diagnosa dan penatalaksanaan kasus penanggulangan leptospirosis di Indonesia. Jakarta: Departemen Kesehatan Republik Indonesia; 2008.
41. Kohatsu ND, Robinson JG, Torner JC. Evidence-based public health: an evolving concept. Am J Prev Med. 2004;27(5):417-21.
42. Brownson RC, Fielding JE, Maylahn CM. Evidence-based public health: A fundamental concept for public health practice. Annu Rev Public Health. 2009;30:175-201.
43. Jacobs JA, Jones E, Gabella BA, BonnieSpring, Brownson RC. Tools for implementing an evidence-based approach in public health practice. Preventing Chronic Disease. 2012;9:110324.
44. Green LW, Kreuter MW. Health Program Planning: An Educational and Ecological Approach. 4th ed. New York: McGraw-Hill; 2005.
45. Profil Kesehatan Indonesia 2009. Jakarta: Kementerian Kesehatan Republik Indonesia; 2010.
46. Buku Saku 2009: Visualisasi Data Kesehatan Provinsi Jawa Tengah. Semarang: Dinas Kesehatan Provinsi Jawa Tengah; 2010.
47. Gsell O. History of leptospirosis: 100 years. ZblBaktHygA. 1984;257:473-8.
48. Stimson AM. Note on an organism found in yellow-fever tissue. Public Health Reports. 1907;22(18):541.
49. Kobayashi Y. Discovery of the causative organism of Weil's disease: historical view. J Infect Chemother 2001;7:10-5.
50. Levett PN. Leptospirosis. Clin Microbiol Rev 2001;14(2):296-326.
51. Toyokawa T, Ohnishi M, Koizumi N. Diagnosis of acute leptospirosis. Expert Rev Anti Infect Ther 2011;9(1):111-21.
52. Ko AI, Goarant C, Picardeau M. Leptospira: the dawn of the molecular genetics era for an emerging zoonotic pathogen. Nat Rev Microbiol. 2009;7:736-47.
53. Bharti AR, Nally JE, Ricaldi JN, Matthias MA, Diaz MM, Michael A Lovett, et al. Leptospirosis: a zoonotic disease of global importance. Lancet Infect Dis 2003;3:757-71.
54. Xue F, Yan J, Picardeau M. Evolution and pathogenesis of Leptospira spp.: lesson learned from genomes. Microbes and Infection. 2009;11:328-33.
55. Ganoza CA, Matthias MA, Collins-Richards D, Brouwer KC, Cunningham CB, Segura ER, et al. Determining Risk for Severe Leptospirosis by Molecular Analysis of Environmental Surface Waters for Pathogenic Leptospira. PLoS Med. 2006;3(8):e308.
56. Levett PN. Usefulness of Serologic Analysis as a Predictor of the Infecting Serovar in Patients with Severe Leptospirosis. Clinical Infectious Diseases 2003;36(447-452).
57. Levett PN, Whittington CU. Evaluation of the Indirect Hemagglutination Assay for Diagnosis of Acute Leptospirosis. Journal of Clinical Microbiology. 1998;36(1):11-4.
58. Dezfully NK, Mehrabian S. Evaluation of Two Immunodiagnostic Assays (MAT and IFA) for Human Leptospirosis in Gilan Province - Iran. Jundishapur J Microbiol. 2012;5(4):582-4.
59. WHO. Report of the Second Meeting of the Leptospirosis Burden Epidemiology Reference Group. Geneva 2011.
60. Shekatkar SB, Harish BN, Menezes GA, Parija SC. Clinical and serological evaluation of leptospirosis in Puducherry, India. J Infect Dev Ctries. 2010;4(3):139-43.
61. Tanganuchitcharnchai A, Smythe L, Dohnt M, Hartskeerl R, Vongsouvath M, Davong V, et al. Evaluation of the Standard Diagnostics Leptospira IgM ELISA for diagnosis of acute leptospirosis in Lao PDR. Trans R Soc Trop Med Hyg 2012 September; 106(9-2): 563–566. 2012;106(9-2):563-6.

62. Gussenhoven GC, Hoorn MAWGVD, Goris MGA, Terpstra WJ, Hartskeerl RA, Mol BW, et al. LEPTO Dipstick, a Dipstick Assay for Detection of Leptospira-Specific Immunoglobulin M Antibodies in Human Sera. Journal of Clinical Microbiology. 1997;35(1):92-7.
63. Smits HL, Eapen K, Sugathan S, Kuriakose M, Gasem MH, Yersin C, et al. Lateral-Flow Assay for Rapid Serodiagnosis of Human Leptospirosis. Clin Diagn Lab Immunol. 2001;8(1):166-9.
64. Geertruida A, Posthuma-Trumpie, Korf J, Amerongen Av. Lateral flow (immuno)assay: its strengths, weaknesses, opportunities and threats. A literature survey. Anal Bioanal Chem. 2009;392:569-82.
65. Koury MC, Cisalpino EO, Angel HDA. The use of methanol extract of Leptospira interrogans in complement fixation tests for leptospirosis. Can J Microbiol. 1991;37:455-8.
66. Trueba GA, Bolin CA, Thoen CO. Evaluation of an enzyme immunoassay for diagnosis of bovine leptospirosis caused by Leptospira interrogans serovar hardjo type hardjo-bovis. J Vet Diagn Invest. 1990;2:323-9.
67. Flannery B, Costa D, Carvalho FP, Guerreiro H, Matsunaga J, Silva EDD, et al. Evaluation of Recombinant Leptospira Antigen-Based Enzyme-Linked Immunosorbent Assays for the Serodiagnosis of Leptospirosis. J Clin Microbiol. 2001;39(9):3303-10.
68. Myers DM. Serodiagnosis of Human Leptospirosis by Counterimmunoelectrophoresis. Journal of Clinical Microbiology. 1987;25(5):897-9.
69. Levett PN. Usefulness of Serologic Analysis as a Predictor of the Infecting Serovar in Patients with Severe Leptospirosis. Clinical Infectious Diseases. 2003;36:447-52.
70. Vijayachari P, Sugunan AP, Sehgal SC. Evaluation of Lepto Dri Dot as a rapid test for the diagnosis of leptospirosis. J Epidemiol Infect. 2002;129:617-21.
71. Levett PN, Haake DA. Leptospira Species (Leptospirosis). In: Mandell GL, Bennett JE, Dolin R, editors. Mandell, Douglass, and Bennett's Principles and Practice of Infectious Diseases. Seventh ed. Philadelphia: Elsevier; 2010.
72. WHO. WHO recommended surveillance standards. Geneva: World Health Organization, Department of Communicable Disease Surveillance and Response; 1999. 77 p.
73. Information for Clinical and Laboratory Support for Diagnosis, Management and Treatment of Leptospirosis in the Aftermath of a Disaster. Atlanta: Centers for Disease Control and Prevention, 2006.
74. Excerpt from “WHO recommended standards and strategies for surveillance, prevention and control of communicable diseases". Geneva: World Health Organization, 2009.
75. WHO. Leptospirosis: Laboratory Manual. New Delhi: New Concept Information Systems Pvt. Ltd; 2007.
76. PAHO. Leptospirosis. Epidemiological Bulletin. 2000;21(2):15-6.
77. Laras K, Van CB, Bounlu K, Tien NTK, Olson JG, Thongchanh S, et al. The Importance of Leptospirosis in Southeast Asia Am J Trop Med Hyg. 2002;67(3):278-86.
78. Prasetyo A. Risk factors of severe leptospirosis in Semarang city [Thesis]. Unpublished: Diponegoro University Semarang; 2006.
79. Gasem MH, Wagenaar JFP, Goris MGA, Adi MS, Isbandrio BB, Rudy A. Hartskeerl, et al. Murine Typhus and Leptospirosis as Causes of Acute Undifferentiated Fever, Indonesia. Emerging Infectious Diseases. 2009;15(6).
80. Smits HL, Chee HD, Eapen CK, Kuriakose M, Sugathan S, Gasem MH, et al. Latex based, rapid and easy assay for human leptospirosis in a single test format. Tropical Medicine and International Health. 2001; 6 (2):114-8.

81. Kusmiyati, Noor SM, Supar. Animal and human leptospirosis in Indonesia. Wartazoa. 2005;15(4):213-20.
82. Ikawati B, Nurjazuli N. Analysis on environmental characteristics related to the occurrence of leptospirosis in Demak district, Central Java,2009. Media Kesehat Masy Indones. 2010;9(1):33-40.
83. Anies, Hadisaputro S, Sakundarno M, Suhartono. Environmental and behavioral factors of leptospirosis occurrence. M Med Indones. 2009;43(6):306-11.
84. Lau CL, Smythe LD, Craig SB, Weinstein P. Climate change, flooding, urbanisation and leptospirosis: fuelling the fire? Trans R Soc Trop Med Hyg 2010;104:631-8.
85. Victoriano AFB, Smythe LD, Gloriani-Barzaga N, Cavinta LL, Kasai T, Limpakarnjanarat K, et al. Leptospirosis in the Asia Pacific region. BMC Infect Dis. 2009;9:147.
86. WHO. Report of the First Meeting of the Leptospirosis Burden Epidemiology Reference Group. Geneva 2010.
87. Informal Consultation on Global Burden of Leptospirosis: Methods of Assessment. Geneva: World Health Organization, 2006 25-27 October. Report No.
88. Abela-Ridder B, Sikkema R, Hartskeerl RA. Estimating the burden of human leptospirosis. International Journal of Antimicrobial Agents. 2010;36S:S5-S7.
89. Hartskeerl RA, Collares-Pereira M, Ellis WA. Emergence, control and re-emerging leptospirosis: dynamics of infection in the changing world. Clin Microbiol Infect. 2011;17:494-501.
90. Guerra M. Leptospirosis: Public Health Perspectives. International Workshop on Alternative Methods for Leptospira Vaccine Potency Testing: State of the Science and the Way Forward; Ames, Iowa2012.
91. Per Capita Personal Income by State [database on the Internet]. Bureau of Business and Economic Research, University of New Mexico,United States. 2011 [cited 2-3-2013]. Available from: bber@unm.edu.
92. Abella-Ridder B, Bertherat E, Durski K. Global burden of leptospirosis and cross-sectoral intervention for its prevention and control. Prince Mahidol Award Conference; Bangkok, Thailand2013.
93. Income Expenditure and Debt in 2011 [database on the Internet]. National Statistical Office, Ministry of Information and Communication Technology, Thailand. 2011 [cited 2-3-2013]. Available from: http://web.nso.go.th/index.htm.
94. Borja MP. Burden of Disease Study: Leptospirosis in an Urban Setting, Metro Manila 2012. Available from: http://cph.upm.edu.ph/Lepcon%20Web/GroupB.htm.
95. Schönberg A, Kämpe U, Rohloff. D. Methods for the detection of leptospires in sperm samples of boar. Berliner und Münchener tierärztliche Wochenschrift. 1980;93(9):166-71.
96. Bielanski AB, Surujballi O. Leptospira borgpetersenii Serovar hardjo Type hardjobovis in Bovine Embryos Fertilized in vitro. Can J Vet Res 1998;62:234-6.
97. Brotman DJ, Walker E, Lauer MS, O'Brien RG. In Search of Fewer Independent Risk Factors. Arch Intern Med 2005;165:138-45.
98. Encyclopedia of Biostatistics. Second ed: John Wiley and Sons, Inc. ; 2005. Risk Factor.
99. Beck JD. Risk revisited. Community Dent Oral Epidemiol. 1998;26:220-5.
100. Elder JK. The Influence of Environmental Factors on The Survival of Zoonotic Bacterial Pathogens with Special Reference to Leptospirae. Aust Microbiol. 1986;7:323-4.
101. Tobin ME, Fall MW. Pest Control: Rodents, in Agricultural Sciences. Encyclopedia of Life Support Systems (EOLSS): Developed under the Auspices of the UNESCO,Eolss Publishers,Oxford,UK; 2004.

102. Timm RM. Norway rats. In: Hygnstrom SE, Timm RM, Larson GE, editors. Prevention and Control of Wildlife Damage. United States of America: University of Nebraska-Lincoln; 1994.
103. Johnson MAS, Smith H, Joseph P, Gilman RH, Bautista CT, Campos KJ, et al. Environmental Exposure and Leptospirosis, Peru. Emerging Infec Dis. 2004;10(6):1016-22.
104. Barcellos C, Sabroza PC. The place behind the case: leptospirosis risks and associated environmental conditions in a flood-related outbreak in Rio de Janeiro. Cad Saúde Pública Rio de Janeiro. 2001;17 (supplement):59-67.
105. Reis RB, Ribeiro GS, Felzemburgh RDM, Santana FS, Mohr S, Melendez AXTO, et al. Impact of Environment and Social Gradient onLeptospira Infection in Urban Slums. PLoS Negl Trop Dis 2008;2(4):e228.
106. Ullmann LS, Langoni H. Interactions between environment, wild animals and human leptospirosis. The Journal of Venomous Animals and Toxins including Tropical Diseases. 2011;17(2):119-29.
107. Hartskeerl RA, Terpstra WJ. Leptospirosis in wild animals. Vet Q. 1996;18(Supplement 2):s149-s50.
108. Biscola NP, Fornazari F, Saad E, Richini-Pereira VB, Campagner MV, Langoni H, et al. Serological investigation and PCR in detection of pathogenic leptospires in snakes. Pesq Vet Bras 2011;31(9):806-11.
109. Gravekamp C, Korver H, Montgomery J, Everard CO, Carrington D, Ellis WA, et al. Leptospires isolated from toads and frogs on the Island of Barbados. Zentralblatt fur Bakteriologie : international journal of medical microbiology. 1991;275(3):403-11.
110. Damude DF, Jones CJ, Myers DM. A study of leptospirosis among animals in Barbados W.l. Trans R Soc Trop Med Hyg. 1979;73(2):161-8.
111. Gaumont R. Leptospirosis in European livestock. Rev SciTech Off Int Epiz. 1983;2(1):65-70.
112. Berlioz-Arthaud A, Kiedrzynski T, Singh N, Yvon J-Fo, Roualen G, Coudert C, et al. Multicentre survey of incidence and public health impact of leptospirosis in the Western Pacific. Trans R Soc Trop Med Hyg. 2007;101:714-21.
113. Perrocheau A, Perolat P. Epidemiology of leptospirosis in New Caledonia (South Pacific): A one-year survey. Eur J Epidemiol. 1997;13:161-7.
114. A Scientific Review of Leptospirosis and Implication for Quarantine Policy. Canberra: Animal Biosecurity-Biosecurity Australia, 2000.
115. Rim BM, Rim CW, Chang WH, Kakoma I. Leptospirosis Serology in Korean Wild Animals. J Wildl Dis. 1993;29(4):602-3.
116. Vijayachari P, Sugunan AP, Sharma S, Roy S, Natarajaseenivasan K, Sehgal SC. Leptospirosis in the Andaman Islands, India. Trans R Soc Trop Med Hyg. 2008;102:117-22.
117. Murhekar MV, Sugunan AP, Vijayachari P, Sharma S, Sehgal SC. Risk factors in the transmission of leptospiral infection. Indian J Med Res. 1998;107:218-23.
118. Natarajaseenivasan K, Boopalan M, Selvanayaki K, Suresh SR, Ratnam S. Leptospirosis among Rice Mill Workers of Salem, South India. Jpn J Infect Dis. 2002;55:170-3.
119. Tangkanakul W, Smits H, Jatanasen S, Ashford D. Leptospirosis: An Emerging Health Problem in Thailand. Southeast Asian J Trop Med Public Health. 2005;36 (2):1-7.
120. Bahaman AR, Ibrahim AL. A Review of leptospirosis in Malaysia. Vet Res Commun. 1988;12:179-89.

121. Spot Survey Leptospirosis di Jawa Tengah [Report]. Semarang: Dinas Kesehatan Provinsi Jawa Tengah; 2005.
122. Ristiyanto, Handayani FD, Gambiro, Wahyuni S. Spot Survey Reservoir Leptospirosis di Desa Bakung, Kecamatan Jogonalan, Kabupaten Klaten, Jawa Tengah. Bul Penel Kesehatan. 2006;34(3):105-10.
123. Sarwani D. Environmental risk factors related to the occurrence of severe leptospirosis [Thesis]. Unpublished: Diponegoro University Semarang; 2005.
124. Suratman. Analysis on environmental and behavioral risk factors affecting the occurrence of severe leptospirosis in Semarang city. Media Kesehat Masy Indones. 2008;7(2):54-9.
125. Bhardwaj P, Kosambiya JK, Desai VK. A case control study to explore the risk factors for acquisition of leptospirosis in Surat city, after flood. Indian J Med Sci. 2008;62(11):431-8.
126. Sarkar U, Nascimento SF, Barbosa R, Martins R, Nuevo H, Kalafanos I, et al. Population-based Case-control Investigation of Risk Factors for Leptospirosis during an Urban Epidemic. Am J Trop Med Hyg. 2002;66(5):605-10.
127. Sulong MR, Shafei MN, Yaacob NA, Hassan H, Daud A, Mohamad WMZW, et al. Risk Factors Associated with Leptospirosis among Town Service Workers. Int Med J. 2011;18(2):83-8.
128. Nardone A, Capek I, Baranton G, Campe`se C, Postic Dl, Vaillant Vr, et al. Risk Factors for Leptospirosis in Metropolitan France: Results of a National Case-Control Study,1999–2000. Clin Infect Dis. 2004;39:751-3.
129. Leal-Castellanos CB, Garcia-Suarez R, Gonzalez-Figueroa E, Fuentes-Allen JL, Escobedo-DeLaPen~A J. Risk factors and the prevalence of leptospirosis infection in a rural community of Chiapas, Mexico. Epidemiol Infect. 2003;131:1149-56.
130. Henry RA, Johnson RC. Distribution of the Genus Leptospira in Soil and Water. Applien and Environmental Microbiology. 1978;35(3):492-9.
131. Walker M. Method Development and Preliminary Applications for Leptospira Spirochetes in Water Samples. Reno: National Homeland Security Research Center U.S. Environmental Protection Agency, 2008.
132. Hawkins IR. Detecting *Leptospira* in Water: Evaluation of a Proposed Method [Thesis]: University of Hawaii; 2007.
133. Vital-Brazil JM, Balassiano IT, Oliveira FSd, Costa ADdS, Hillen L, Pereira MM. Multiplex PCR-based detection of leptospira in environmental water samples obtained from a slum settlement. Mem Inst Oswaldo Cruz. 2010;105(3):353-5.
134. Tansuphasiri U, Thipsuk C, Phulsuksombati D, Chanyasanha C. Duplex PCR-hybridization based detection of pathogenic leptospira in environmental water samples obtained from endemic areas in Northeast region of Thailand. Southeast Asian J Trop Med Public Health. 2006;37(4):729-41.
135. Sehgal S, Sugunan A, Vijayachari P. Leptospirosis Disease Burden Estimation and Surveillance Networking in India Southeast Asian J Trop Med Public Health. 2003;34(Suppl 2):170-7.
136. Putri MI. Environmental and behavioral factors related to leptospirosis occurrence in Demak district, 2009 [Final paper]. Unpublished: Diponegoro University; 2009.
137. Hernowo T. The relationship of personal hygiene and leptospirosis outbreaks in DKI Jakarta, 2002 [Thesis]. Unpublished: University of Indonesia; 2002.
138. Suprapto. Risk factors for leptospirosis disease in Semarang city [Thesis]. Unpublished: Diponegoro University Semarang; 1997.

139. Tangkanakul W, Pool T, Chunsuttiwat S, Siriarayaporn P, Ungchusak K. Environmental and Travel Factors Related to Leptospirosis in Thailand. J Med Assoc Thai 2001;84:1674-80.
140. Bruce MG, Sanders EJ, Leake JAD, Zaidel O, Bragg SL, Aye T, et al. Leptospirosis among patients presenting with dengue-like illness in Puerto Rico. Acta Trop. 2005;96:36-46.
141. Douglin CP, Jordan C, Rock R, Hurley A, Levett PN. Risk Factors for Severe Leptospirosis in the Parish of St. Andrew, Barbados. Emerging Infec Dis. 1997;3(1):78-80.
142. Vijayachari P, Sugunan AP, Murhekar MV, Sharma S, Sehgal SC. Leptospirosis among schoolchildren of the Andaman & Nicobar Islands, India: low levels of morbidity and mortality among pre-exposed children during an epidemic. Epidemiol Infect. 2004;132:1115-20.
143. Thai KTD, Binh TQ, Giao PT, Phuong HL, Hung LQ, Nam NV, et al. Seroepidemiology of leptospirosis in southern Vietnamese children. Trop Med Int Health. 2006;11(5):738-45.
144. Vanasco NB, Schmeling MF, Lottersberger J, Costa F, Ko AI, Tarabla HD. Clinical characteristics and risk factors of human leptospirosis in Argentina (1999–2005). Acta Trop. 2008;107:255-8.
145. Stern EJ, Galloway R, Shadomy SV, Wannemuehler K, Atrubin D, Blackmore C, et al. Outbreak of Leptospirosis among Adventure Race Participants in Florida, 2005. Clin Infect Dis. 2010;50:843-9.
146. Sejvar J, Bancroft E, Winthrop K, Bettinger J, Bajani M, Bragg S, et al. Leptospirosis in "Eco-Challenge" Athletes, Malaysian Borneo, 2000. Emerging Infec Dis. 2003;9(6):702-7.
147. Bovet P, Yersin C, Merien F, Davis CE, Perolat P. Factors associated with clinical leptospirosis: a population-based case-control study in the Seychelles (Indian Ocean). Int J Epidemiol. 1999;28:583-90.
148. Keenan J, Ervin G, Aung M, McGwin G, Jolly P. Risk Factors for Clinical Leptospirosis from Western Jamaica. Am J Trop Med Hyg. 2010;83(3):633-6.
149. Desai S, Treeck Uv, Lierz M, Espelage W, Zota L, Sarbu A, et al. Resurgence of Field Fever in a Temperate Country: An Epidemic of Leptospirosis among Seasonal Strawberry Harvesters in Germany in 2007. Clin Infect Dis. 2009;48:691-7.
150. Herrmann-Storck C, Brioudes A, Quirin R, Deloumeaux J, Lamaury I, Nicolas M, et al. Retrospective Review of Leptospirosis in Guadeloupe, French West Indies 1994–2001. West Indian Med J 2005;54(1):42-6.
151. Sasaki DM, Pang L, Minette HP, Wakida CK, Fujimoto WJ, Manea SJ, et al. Active Surveillance and Risk Factors for Leptospirosis in Hawaii. Am J Trop Med Hyg. 1993;48(1):35-43.
152. Childs JE, Schwartz BS, KsiazeK TG, Graham RR, LeDuc JW, Glass GE. Risk Factors Associated with Antibodies to Leptospires in Inner-city Residents of Baltimore: A Protective Role for Cats. Am J Public Health. 1992;82:597-9.
153. Everard COR, Bennett S, Edwards CN, Nicholson GD, Hassell TA, Carrington DG, et al. An investigation of some risk factors for severe leptospirosis on Barbados. J Trop Med Hyg. 1992;95:13-22.
154. Phraisuwan P, Whitney EAS, Tharmaphornpilas P, Guharat S, Thongkamsamut S, Aresagig S, et al. Leptospirosis: Skin Wounds and Control Strategies,Thailand, 1999. Emerging Infec Dis. 2002;18(12):1455-9.
155. Storck CH, Postic D, Lamaury I, Perez JM. Changes in epidemiology of leptospirosis in 2003–2004, a two El Nino Southern Oscillation period, Guadeloupe archipelago, French West Indies. Epidemiol Infect. 2008;136:1407-15.

156. Monahan AM, Miller IS, Nally JE. Leptospirosis: risks during recreational activities. J Appl Microbiol. 2009;107(3):707-16.
157. Narita M, Fujitani S, Haake DA, Paterson DL. Leptospirosis After Recreational Exposure to Water in Yaeyama Island, Japan Am J Trop Med Hyg. 2005;73(4):652-6.
158. Nakamura M, Taira K, Itokazu K, Kudaka J, Asato R, Kise To, et al. Sporadic Cases and an Outbreak of Leptospirosis Probably Associated with Recreational Activities in Rivers in the Northern Part of Okinawa Main Island. J Vet Med Sci. 2006;68(1):83-5.
159. Morgan J, Bornstein SL, Karpati AM, Bruce M, Bolin CA, Austin CC, et al. Outbreak of Leptospirosis among Triathlon Participants and Community Residents in Springfield, Illinois, 1998. Clin Infect Dis. 2002;34:1593-9.
160. Indonesia fokus 5 tujuan wisata prioritas di 2013. Press Release. Jakarta: Kementerian Pariwisata dan Ekonomi Kreatif Republik Indonesia, 2013 8 Januari Report No.
161. Campagnolo ER, Warwick MC, Marx HL, Cowart RP, Donnell HD, Bajani MD, et al. Analysis of the 1998 outbreak of leptospirosis in Missouri in humans exposed to infected swine. JAVMA. 2000;216(4):676-82.
162. Sakundarno M, Bertolatti D, Maycock B, Spickett J, Dhaliwal S. Review paper: Risk factors for leptospirosis infection in humans and implications for public health intervention in Indonesia and the Asia Pacific region. Asia Pacific Journal of Public Health. 2013;(In Press).
163. Hochedez P, Rosine J, Théodose R, Abel S, Bourhy P, Picardeau M, et al. Outbreak of Leptospirosis after a Race in the Tropical Forest of Martinique. Am J Trop Med Hyg. 2011;84(4):621-6.
164. Brockmann S, Piechotowski I, Bock-Hensley O, Winter C, Oehme R, Zimmermann S, et al. Outbreak of leptospirosis among triathlon participants in Germany, 2006. BMC Infect Dis. 2010;10:91.
165. Fraga TR, Barbosa AS, Isaac L. Leptospirosis: Aspects of Innate Immunity, Immunopathogenesis and Immune Evasion From the Complement System. Scand J Immunol. 2011;73:408-19.
166. Evangelista KV, Coburn J. Leptospira as an emerging pathogen: a review of its biology, pathogenesis and host immune responses. Future Microbiol 2010;5(9):1413-25.
167. Skufca J, Arima Y. Sex, gender and emerging infectious disease surveillance: a leptospirosis case study. WPSAR. 2012;3(3):doi: 10.5365/wpsar.2012.3.3.001.
168. Oliveira DSC, Guimaraes MJB, Portugal JL, Medeiros Z. The socio-demographic, environmental and reservoir factors associated with leptospirosis in an urban area of north-eastern Brazil. Ann Trop Med Parasitol. 2009;13(2):149-57.
169. Cachay ER, Vinetz JM. A Global Research Agenda for Leptospirosis. J Postgrad Med. 2005;51(3):174-8.
170. Lopes AA, Costa E, Costa YA, Sacramento E, OLliveira_junior ARRd, Lopes MB, et al. Comparative Study of The In-hospital Case-fatality Rate of Leptospirosis Between Pediatric and Adult Patients of Different Age Groups. Rev Inst Med Trop S Paulo. 2004;46(1):19-24.
171. Cetin BD, Harmankaya O, Hasman H, Gunduz A, Oktar M, Seber E. Acute Renal Failure: A Common Manifestation of Leptospirosis. Renal Failure. 2004;26(6):655-61.
172. Kobayashi Y. Human leptospirosis: Management and prognosis. J Postgrad Med. 2004;51(3):201-3.
173. Spichler AS, Vilaça PJ, Athanazio DA, Albuquerque JOM, Buzzar M, Castro B, et al. Predictors of Lethality in Severe Leptospirosis in Urban Brazil. Am J Trop Med Hyg. 2008;79(6):911-4.

174. Orpilla-Bautista ICL, Panaligan MM. Predictors of Mortality among Patients with Leptospirosis Admitted at the JRRMMC. The 8th Western Pacific Congress on Chemotherapy and Infectious Diseases; December 1-5; The Burswood International Resort Casino and Convention Centre, Perth, Australia2002.
175. Daher E, Zanetta DMT, Cavalcante MB, Abdulkader RCRM. Risk Factors for Death and Changing Patterns in Leptospirosis Acute Renal Failure. Am J Trop Med Hyg. 1999;61(4):630-4.
176. Dupont H, Dupont-Perdrizet Db, Perie JL, Zehner-Hansen S, Jarrige B, Daijardin JB. Leptospirosis: Prognostic Factors Associated with Mortality. Clin Infect Dis. 1997;25:720-4.
177. Panaphut T, Domrongkitchaiporn S, Thinkamrop B. Prognostic factors of death in leptospirosis: a prospective cohort study in Khon Kaen, Thailand. Int J Infect Dis. 2002;6(1):52-9.
178. Yersin C, Bovet P, Merien F, Clement J, Laille M, Ranst MV, et al. Pulmonary haemorrhage as a predominant cause of death in leptospirosis in Seychelles. Trans R Soc Trop Med Hyg. 2000;94:71-6.
179. Pappachan MJ, Mathew S, Aravindan KP, Khader A, Bharghavan PV, Kareem MMA, et al. Risk factors for mortality in patients with leptospirosis during an epidemic in northern Kerala. Natl Med J India 2004;17:240-3.
180. Unnikrishnan D, Pisharody R, Vijayalakshmy N. Prognostic Factors in Leptospirosis A Study From Kerala, India. Infectious Diseases in Clinical Practice. 2005;13(3):104-7.
181. Budiono E, Sumardi, Riyanto BS, Hisyam B, Hartopo AB. Pulmonary Involvement Predicts Mortality in Severe Leptospirosis Patients. Acta Med Indones-Indones J Intern Med. 2009;41(1):11-4.
182. Paganin F, Bourdin A, Dalban C, Courtin J-P, Poubeau P, Borgherini G, et al. Leptospirosis in Reunion Island (Indian Ocean): analysis of factors associated with severity in 147 confirmed cases. Intensive Care Med (2007) 33:1959–1966. 2007;33:1959-66.
183. Starfield B, Hyde J, Ge´rvas J, Heath I. The concept of prevention: a good idea gone astray? J Epidemiol Community Health. 2008;62:580-3.
184. Keller LO, Strohschein S, Lia-Hoagberg B, Schaffer MA. Population-Based Public Health Interventions: Practice-Based and Evidence-Supported. Part I. Public Health Nursing. 2004;21(5):452-68.
185. Agampodi SB, Agampodi TC, Thalagala E, Perera S, Chandraratne S, Fernando S. Do People Know Adequately about Leptospirosis? A Knowledge Assessment Survey in Post-outbreak Situation in Sri Lanka. Int J Prev Med 2010;1(3):158-63.
186. Wiwanitkit V. A Note from A Survey of Some Knowledge Aspects among A Sample of Rural Villagers in The Highly Endemic Area, Thailand. Rural Remote Health. 2006;6(526):1-6.
187. Hartskeerl RA, Collares-Pereira M, Ellis WA. Emergence, control and re-emerging leptospirosis: dynamic of infection in the changing world. Clin Microbiol Infect. 2011;17:494-501.
188. Bipin V, Abhay K, Patel P, Sushil P, Shaishav P. Educational Intervention to Increase Knowledge of Leptospirosis in Navsari District. National Journal of Community Medicine 2010;1(1):30-2.
189. Takafuji ET, Kirkpatrick JW, Miller RN, Karwacki JJ, Kelley PW, M. R. Gray K, et al. An Efficacy Trial of Doxycycline Chemoprophylaxis Againts Leptospirosis. N Engl J Med. 1984;310(8):497-500.

190. Sehgal SC, Sugunan AP, Murhekar MV, Sharma S, Vijayachari P. Randomized controlled trial of doxycycline prophylaxis against leptospirosis in an endemic area. Int J Antimicrob Agents. 2000;13:249-55.
191. Brett-Major DM, Lipnick RJ. Antibiotic prophylaxis for leptospirosis. Cochrane Database of Systematic Reviews. 2009;Issue 3:Art. No.: CD007342.
192. Bracho G, Varela E, Fernandez R, Ordaz B, Marzoa N, Menendez J, et al. Large-scale application of highly-diluted bacteria for Leptospirosis epidemic control. Homeopathy. 2010;99:156-66.
193. Peraturan Presiden Republik Indonesia Nomor 30 Tahun 2011 tentang Pengendalian Zoonosis, (2011).
194. Agustini M. Lingkungan Daerah Endemis Leptospirosis Desa Sumbersari. Kecamatan Moyudan, Kabupaten Sleman Propinsi Daerah Istimewa Yogyakarta [Thesis]: Gadjah Mada University; 2011.
195. Profil Kesehatan Kabupaten Demak Tahun 2011. Demak: Dinas Kesehatan Kabupaten Demak, 2012.
196. Demak Dalam Angka 2011. Demak: Badan Pusat Statistik Kabupaten Demak, 2011.
197. Ryan GW, Bernard HR. Data Management and Analysis Methods. In: Denzin NK, Lincoln YS, editors. Handbook of Qualitative Research. 2 ed. Thousand Oaks: Sage Publication, Inc; 2000. p. 769-801.
198. Taylor-Powel E, Renner M. Analysing Qualitative Data. Wisconsin: UW-Extension; 2003.
199. Graneheim UH, Lundman B. Qualitative content analysis in nursing research:concepts, procedures and measures to achieve trustworthiness. Nurse Education Today. 2004;24:105-12.
200. Lemeshow S, Hosmer DW, Klar J, Lwanga SK. Adequacy of Sample Size in Health Studies. Massachusetts: John Wiley and Sons; 1990.
201. Naing L, Winn T, Rusli BN. Practical Issues in Calculating the Sample Size for Prevalence Studies. Archives of Orofacial Sciences. 2006;1:9-14.
202. Lwanga SK, Lemeshow S. Sample Size determination in Health Study: A practical Manual. Geneva: World Health Organization; 1991.
203. Leptospirosis: Laboratory Manual. Port Blair: World Health Organization; 2007.
204. Phraisuwan P, Whitney EAS, Tharmaphornpilas P, Guharat S, Thongkamsamut S, Aresagig S, et al. Leptospirosis: Skin Wounds and Control Strategies,Thailand, 1999. Emerging Infectious Diseases. 2002;8(12):1455-9.
205. Kawaguchi L, Sengkeopraseuth B, Tsuyuoka R, Koizumi N, Akashi H, Vongphrachanh P, et al. Seroprevalence of Leptospirosis and Risk Factor Analysis in Flood-prone Rural Areas in Lao PDR. Am J Trop Med Hyg. 2008;78(6):957-61.
206. Bhardwaj P, Kosambiya J, Desai VK. A Case control study to explore the risk factors for acquisition of leptospirosis in Surat city, after flood. Indian Journal of Medical Sciences. 2008;62(11):431-8.
207. Agampodi SB, Agampodi TC, Thalagala E, Perera S, Chandraratne S, Fernando S. Do People Know Adequately about Leptospirosis? A Knowledge Assessment Survey in Post-outbreak Situation in Sri Lanka. International Journal of Preventive Medicine, Vol 1, No 3, Summer 2010. 2010;1(3):158-63.
208. Brown P, McKenzie M, Pinnock M, McGrowder. Environmental Risk Factors Associated with Leptospirosis among Butchers and Their Associates in Jamaica. wwwtheijoemcom 2011;2(1):47-57.

209. Champion VL, Skinner CS. The Health Belief Model. In: Glanz K, Rimer BK, Viswanath K, editors. Health Behavior and Health Education: Theory, Research and Practice. Fourth ed. San Francisco: John Wiley & Sons, Inc; 2008.
210. Goutille F, Crini V, Jullien P. Guideline for KAP Survey Managers. Handicap International; 2009.
211. WHO. Advocacy, communication and social mobilization for TB control: a guide to developing knowledge, attitude and practice surveys. Geneva: WHO Press; 2008. p. 50-8.
212. Developing an Effective MCH Planning Process: A Guide for Local MCH Programs. San Franscisco: Family Health Outcomes Project; 2003.
213. Sakundarno M, Bertolatti D, Maycock B, Spickett J, Dhaliwal S. Risk Factors for Leptospirosis Infection in Humans and Implications for Public Health Intervention in Indonesia and the Asia-Pacific Region. Asia Pac J Public Health 1010539513498768. 2013.
214. Sehgal SC, Vijayachari P, Sugunan AP, Umapathi T. Field application of Lepto lateral flow for rapid diagnosis of leptospirosis. Journal of Medical Microbiology 2003;52:897-901.
215. Nagy J, Fawcett SB. Chapter 19, Section 2: Understanding Risk and Protective factors: Their Use in Selecting Potential targets and Promising Strategies for Intervention. In: Schultz J, Axner M, editors. KU Work Group for Community Health and Development: The Community Tool Box: University of Kansas; 2013. p. 155.
216. Evidence-based methodologies for public health - How to assess the best available evidence when time is limited and there is lack of sound evidence. Stockholm: European Centre for Disease Prevention and Control (ECDC), 2011.
217. R.M.Mohan A, D.Chadee D. Knowledge, attitudes and practices of Trinidadian households regarding leptospirosis and related matters. Int Health. 2011;3(2):131-7.
218. Jirojwong S, Liamputtong P, editors. Population Health, Communities and Health Promotion. Melbourne: Oxford University Press; 2009.
219. R.M.Mohan A, D.Chadee D. Knowledge, attitudes and practices of Trinidadian households regarding leptospirosis and related matters. International Health.3(2):131-7.

APPENDICES

APPENDIX-A:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

FIELD OBSERVATION:
ENVIRONMENT CHECKLIST

Date of observation: ……../ ……. / …….. dd / mm / yyyy	Observer: 1. …….. 2. ……..
Name of village:	Name of Sub-district:
Time of observation: Start:	End:
1. Subjects observed: 1. Paddy field ☐ Go to 2.1. 2. Pond ☐ Go to 2.2. 3. River ☐ Go to 2.3. 4. Ditch ☐ Go to 2.4. 5. Other : _____ ☐ Go to 2.5.	
2. Characteristics: 2.1. Paddy field: a. Location (GPS): ……. b. Water source: …… c. Water stream direction: …… d. Rats signs surroundings: …….. e. Others: …… 2.2. Pond: a. Location (GPS): …… b. Water source: …… c. Water stream direction: …… d. Rats signs surroundings: …… e. Others: …… 2.3. River: a. Location (GPS): …….. b. Water source: …… c. Water overflow: …… d. Direction of water overflow: …… e. Observed floating dead rats: …….. f. Others: …….. 2.4. Ditch: a. Location (GPS): …… b. Water source: …… c. Water overflow: …….. d. Rat signs surroundings: …….. e. Observed floating dead rats: …… f. Others: ……..	

2.5. Other: …….
……
……

Picture taken: Y/N Video taken: Y/N

Raw map of subjects location:

APPENDIX-B:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

FIELD OBSERVATION:
OBSERVATION RECORD-FORM

Date of observation: ……../ …….. / …….. dd / mm / yyyy	Observer: 1. …….. 2. ……..
Name of village:	Name of Sub-district:
Time of observation: Start:	End:
Activities observed:	Observation no:
WHO (personal characteristics of people who are doing the risky activities such as age, gender, etc):	
WHAT (kinds of suspected infected materials such as river water, pond water, paddy field water/mud, body or tissues of infected animals, protection devices used):	
WHERE (place of doing the risky activities, location): Map location :	GPS measurement: Y/N

Picture taken: Y/N	Video taken: Y/N
HOW (the way, steps or sequence of activities they are doing):	
Notes:	

APPENDIX-C:

Study number: _____
Round: _____
Status: I / C

Risk factors for leptospirosis and the impact of an intervention to reduce exposures:

KNOWLEDGE, ATTITUDE AND PRACTICE SURVEY FOR LEPTOSPIROSIS RISK FACTORS AND PREVENTION

==========

INTRODUCTION:

Good ..... my name is ..... from Diponegoro University Semarang. We are currently conducting a survey on knowledge, attitude and practice regarding to leptospirosis risk factors and prevention of it. We would like to include you as a respondent. You may also ask me to clarify questions if you don't understand them and inform me if deciding to stop the interview at any time. Your responses will be kept strictly confidential. There will be no direct benefits for you being part of this study. However your responses will help to design appropriate actions to help community to recognize factors related to penyakit kencing tikus and its prevention. Thank you.

IDENTITY:

A1. Name : _____ A2. Gender: 1. Male 2. Female
A3. Age : _____ years
A4. Address :
_____

A5. Sub-district : _____ A6. District: _____

A7. Occupation :
_____
(in the last 30 day, list all that are available)

A7.1. Summary: Respondent's occupation:
1. Related to contact with water, animal or both
2. Not related to contact with water, animal or both

A8. Highest level of education attained:
1. Never attended in a formal school
2. Primary School (not completed)
3. Primary School (graduated)
4. Junior high school (not completed)
5. Junior high school (graduated)
6. High school (not completed)
7. High school (graduated)
8. Academy or higher

KNOWLEDGE ON LEPTOSPIROSIS RISK FACTORS AND PREVENTION

B1. Have you heard of 'penyakit kencing tikus' (rat urine disease)?

1. Yes → go to question B2
2. No → go to question B3

B2. How did you acquire information regarding penyakit kencing tikus for the <u>first time</u> from?

1. Family member: _____
2. Neighbor: _____
3. Health worker : _____
4. Media: _____
5. Other: _____

In your opinion:

B3. What are symptoms of penyakit kencing tikus? (Mention as many as possible)

_____

B3.1. Summary: respondent's knowledge regarding symptoms of leptospirosis

1. Know (at least 3 main symptoms of leptospirosis were mentioned)
2. Less know (1-2 main symptoms of leptospirosis were mentioned)
3. Do not know

(Main symptoms: High fever (> 38^{o}C), headache, calf pain, conjunctival suffusion/ red eyes)

B4. Is penyakit kencing tikus dangerous?

1. Yes → reason: _____
2. No → reason: _____
3. Do not know

B4.1. Summary: respondent's knowledge regarding the dangerous of leptospirosis

1. Know (life threatening)
2. Do not know (not life threatening or no answer)

B5. How is this disease transmitted to a person? (Mention as many as possible) _____

_____

_____

B5.1. Summary: respondent's knowledge on leptospirosis transmission:

1. Know (more than 3 ways of transmission were mentioned)
2. Less know (1-3 ways of transmission were mentioned)
3. Do not know

(Direct contact with rat's urine, direct contact with rat's tissues; direct contact with pet's urine (dog, cat) ; Direct contact with pet's tissues; Direct contact with farm animals' urine; Direct contact with farm animals' tissues; Contact with paddy field water; Contact with river water; Contact with sewer water; Contact with waterlogged; Contact with flood water; Through skin wounds; Others: _____)

B6. Mention anything that cause (related to) the occurrence of penyakit kencing tikus _____

_____

_____

B6.1. Summary: respondent's knowledge on factors related to the occurrence of leptospirosis

1. Know (more than 3 factors were mentioned)
2. Less know (1-3 factors were mentioned)
3. Do not know

(Risk factors: contaminated material/animal; human behaviors leading to contact with contaminated materials. Contributing factors: predisposing, enabling and reinforcing factors)

B7. How to prevent from being infected by penyakit kencing tikus? _____

_____

B7.1. Summary: respondent's knowledge on leptospirosis prevention

1. Know (3 or more ways were mentioned)
2. Less know (only 1-2 ways were mentioned)
3. Do not know

(Ways to prevent leptospirosis infection: Avoid direct contact with rats urine or tissues; avoid direct contact with pet's urine or tissues; avoid direct contact with farm animal's urine or tissues; avoid direct contact with paddy field water; avoid direct contact with river water; avoid direct contact with sewer water; avoid direct contact with stagnant water; avoid direct contact with flood water, cover skin wounds)

B8. Mention the benefits that you will obtain if you conduct activities to prevent from transmission of penyakit kencing tikus.

_____

_____

_____

ATTITUDES TOWARDS LEPTOSPIROSIS RISK FACTORS AND PREVENTION

Please CIRCLE the number that indicates your preference for each statement (only one number chosen for each statement)
1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

C1	I think penyakit kencing tikus may cause death	1------2------3------4------5
C2	Using soap when bathing goats or buffalos prevents me from being infected by penyakit kencing tikus	1------2------3------4------5
C3	Wearing foot protection/ boots when cleaning the cow, goat or buffalo stalls prevent me from being infected by penyakit kencing tikus	1------2------3------4------5
C4	Wearing boots while walking in the muddy sites prevent me from being infected by penyakit kencing tikus	1------2------3------4------5
C5	Walking away from water puddles prevents me from being infected by penyakit kencing tikus	1------2------3------4------5
C6	Walking away from flood water prevents me from contracting penyakit kencing tikus	1------2------3------4------5
C7	Avoid taking a bath in a river does not help me to prevents from being infected by penyakit kencing tikus	1------2------3------4------5
C8	Avoid washing clothes in a river does not help me to prevent from being infected by penyakit kencing tikus	1------2------3------4------5
C9	Using soap when taking a bath or when washing clothes in a river does not help me to prevent from being infected by penyakit kencing tikus	1------2------3------4------5
C10	Checking the presence of skin wounds on feet or hands does not prevent me from being infected by penyakit kencing tikus	1------2------3------4------5
C11	Giving treatment to the wounds on feet or hands prevents me from being infected by penyakit kencing tikus	1------2------3------4------5
C12	Covering the skin wounds on feet or hands when working in the watery places prevents me from being infected by penyakit kencing tikus	1------2------3------4------5
C13	Doing activities to prevent transmission of penyakit kencing tikus will finally add more money to my savings	1------2------3------4------5
C14	Washing in a river is more enjoyable than washing at home	1------2------3------4------5
C15	I am sure that I can do activities to prevent from penyakit kencing tikus	1------2------3------4------5

C16. What would be your feeling if you wear boots or gloves while doing works related to contact with water?

_____
_____
_____

C17. Do you think you can be infected by penyakit kencing tikus?

1. Yes, because

   _____
2. No, because

   _____
3. Do not know

C18. What would be your feeling if you were found out that you were infected by penyakit kencing tikus?

_____
_____

C19. In the last 3 months, did you receive any information that urges you to do activity to prevent penyakit kencing tikus?

1. Yes
2. No → go to D1

C20. Who gave the information in question C19? *(more than one answer is allowed)*

1. Family, mention _____
2. Neighbor, mention _____
3. Health worker, mention _____
4. Local formal leader, mention _____
5. Local informal leader, mention _____
6. Other, mention _____

PRACTICES RELATED TO EXPOSURE TO LEPTOSPIROSIS RISK FACTORS and PREVENTION
In the last 30 days:

D1. Did you do activities related to contact with water or animals?:

1. Yes
2. No → go to D11

D2. Kind of activities related to contact with water or animals: *(more than one answer is allowed)*

1. Rat hunting in the paddy field
2. Bathing farm animal (goats, buffalo, etc)
3. Cleaning farm animal barn
4. Cleaning sewer
5. Working in the paddy field
6. Taking a bath in the river
7. Washing in the river
8. Walking in the watery or muddy place
9. Other: _____

D3. Duration of contact with water or animal for each activity: _____ minutes (on average)

D4. Did you wear hand and/or foot protectors when doing activity related to contact with water or animal tissues?
1. Yes
2. No → go to D7

D5. Kind of hand and/or foot protectors used: (more than one answer is allowed)
1. Gloves (plastic or rubber made)
2. Boots
3. Shoes other than boots
4. Sandals
5. Other, _____

D6. How often did you use hand and/or foot protectors while in contact with water or animals?
1. Always
2. Occasionally (50% or more of the total number of activities performed)
3. Rare (less than 50% of the total number of activities performed)

D7. Did you use soap when doing activity related to water or animals?
1. Yes, explain (type of soap, when it was used, etc)
   _____
2. No

D8. Did you check the presence of wound on hands or feet before performing activity related to contact with water or animal?
1. Yes, explain
   _____
2. No, reason _____ Go to D11

D9. Did you find wounds on your hands or feet?
1. Yes, location: _____ wound description (scratch, cut, puncture, etc):
   _____
2. No → Go to D11

D10. What did you do with your wound(s)? *(more than one answer is allowed)*
1. Nothing
2. Cover the wound: _____
3. Gave treatment: _____
4. Other: _____

What will you do?
(asked to respondent who did and who did not do any work related to contact with water or animal in the last 30 days)

D11. Imagine that you are a farmer who is going to paddy field in the morning to plant the young paddy (for woman) or to re arrange the paddy plants rows (for man). In relation to the prevention of penyakit kencing tikus, tell me what should be paid attention and done?

_____

1. Check the presence of scratched wound on the limbs 1. Yes 2. No
   If yes, what will you do to the wound?
   1.1. Nothing, reason _____
   1.2. Take care of it, explain _____
   1.3. Other, _____
   If no, reason _____
2. Wearing hand protector 1. Yes 2. No
   2.1. If yes, explain _____
   2.2. If no, reason _____
3. Wearing foot protector 1. Yes 2. No
   3.1. If yes, explain _____
   3.2. If no, reason _____
4. Washing hands and feet 1. Yes 2. No
   4.1. If yes, explain (when,water source, soap) _____
   4.2. If no, reason _____

D12. Imagine you are going to the place with watery and muddy soil. In relation to prevention of penyakit kencing tikus, tell me what should be paid attention and done?

_____

1. Check the presence of scratch wound on your limbs 1. Yes 2. No
   If yes, what will you do to the wound?
   1.1. Nothing, reason _____
   1.2. Take care of it, explain _____
   1.3. Other, _____
   If no, reason _____
2. Wearing feet protector 1. Yes 2. No
   2.1. If yes, explain _____
   2.2. If no, reason _____
3. Washing feet 1. Yes 2. No
   3.1. If yes, explain (when, water source, soap) _____
   3.2. If no, reason _____

======= End of question ======

FOR INTERVIEWER ONLY:
Date of interview : _____ Signature : _____ Code of interviewer : _____
Notes (including impressions found during interview):
_____
_____

APPENDIX-D:

Risk factors for leptospirosis and impact of an intervention to reduce exposures:

PRIORITIZING LOCAL LEPTOSPIROSIS RISK FACTORS FOR AN INTERVENTION

---

1. Objective and process of prioritization

The objective of a prioritization activity is to determine which local leptospirosis risk factors are prioritized for an intervention.

Process of prioritizing the local leptospirosis risk factors was adapted and modified from a problem prioritization tool by the Family Health Outcome Project at the University of California, San Francisco.[1] The process included forming a local panel; selection of prioritization criteria for the ranking of leptospirosis risk factors; developing criteria rating scales; weight the prioritization criteria; review, discuss and agree on the local leptospirosis risk factors list; use weighted criteria to score local leptospirosis risk factors; sum participants' scores/ rank leptospirosis risk factors, discuss and confirm results.

2. Local panel

Local panel consisted of:

- Local primary health care center staff who is in charge for communicable disease control program (1 person),
- Local village midwives (1 person),
- Local key person (2 persons),
- Epidemiologist from a local university (1 person).

3. Selection of prioritization criteria for the ranking of leptospirosis risk factors

Criteria are standards used to judge, decide about or deal with something.[1, 2] It will assist in setting priorities among leptospirosis risk factors identified in the district of Demak. Criteria used in the prioritization process are prevalence of leptospirosis risk factor, contact possibility, and changeability.

4. **Developing criteria rating scales**

Each criterion is assigned a scale of scoring definitions. The scales of scoring definitions for each criterion are as follows:

- Prevalence of leptospirosis risk factor: the number of existing risk factor of interest or the number of people with a risk factor of interest in the local area of study. Scores:

1 = No risk factor of interest found in the studied area based on observation results or study reports.

2 = The risk factor is only localized in less than 5% of the community houses in a village, OR the risk factor is possessed by less than 10% person(s) living in the village (skin wound, bites, etc).

3 = The risk factor is localized in 5%- 25% of the community houses in a village, OR the risk factor is possessed by 10%-25% of people living in a village.

4 = The risk factor is localized in more than 25% of the community houses in a village, OR the risk factor is possessed by more than 25% of persons living in a village.

- Contact possibility: possibility of people with the risk factor (i.e. skin wounds) to contact with water or animal, or possibility of the risk factor (i.e. stagnant water) to contact with people. Scores:

1 = No possibility
2 = Low possibility (less than 25% of people with the risk factor to contact with water or animal, or the risk factor to contact with less than 25% of village people).
3 = Medium possibility (25%-50% of people with the risk factor to contact with water or animal, or the risk factor to contact with 25% - 50% of village people)
4 = High possibility (more than 50% of people with the risk factor to contact with water or animal, or the risk factor to contact with more than 50% of village people)

- Changeability: possibility to change the risk factor or to reduce exposure to the risk factors according to time, funding allocation, community willingness, and existing supporting facilities for activity to reduce exposure to the risk factor. Scores:

1 = Low (unlikely possible)
2 = Medium (possible)
3 = High (highly possible)

5. Weighting the prioritization criteria

A weighting was used to adjust for the fact some of the criteria were more important than others. The panel decided that criterion contact possibility was weighted 1, prevalence of leptospirosis risk factor was weighted 2, and changeability was weighted 3.

6. Reviewing, discussing, and listing the local risk factors of leptospirosis in humans

Based on information obtained from literature review, in-depth interview with local key informants, field observation, and KAP-1 survey in Demak district, local leptospirosis risk factors were identified. The list of local leptospirosis risk factor was as follows:

a. Stagnant water surrounding the house
b. Poor house sanitation
c. Existence of rats
d. Contact with stagnant water
e. Taking a bath in a river
f. Washing clothes in a river
g. Walking barefoot
h. Poor sewer condition,
i. Contact with flood water
j. Contact with bodies or tissues of rats
k. Activities in paddy fields
l. Existence of skin wounds
m. Low education
n. Lack of knowledge on leptospirosis

7. Using weighted criteria to score the local risk factor for leptospirosis in humans

Each panel member rated the selected risk factors for leptospirosis in humans using the criterion scale and the assigned weighting for each criterion.

8. Summing participants' scores and ranking leptospirosis risk factors

Each member of the panel gave total score for each leptospirosis risk factor, and total score for each leptospirosis risk factor was calculated and recorded in the summary ranking table. Finally, the total score of each leptospirosis risk factor was ranked.

LEPTOSPIROSIS RISK FACTOR PRIORITIZATION TOOL

Participant code: _____

Criterion 1:	Prevalence of leptospirosis risk factor (1,2,3,4)			
Criterion 2:	Contact possibility (1,2,3,4)			
Criterion 3:	Changeability (1,2,3)			
Leptospirosis risk factor	In the line below each criterion number (e.g. C1), record assigned weight as decided by the group. Then, for each leptospirosis risk factor, score each criterion and multiply the score by the assigned weight. Add weighted criterion scores to obtain total score for each selected leptospirosis risk factor			Total score for leptospirosis risk factor
	C1	C2	C3	
	X 2	X 1	X 3	
1. Stagnant water surrounding the house				
2. Poor house sanitation				
3. Existence of rats				
4. Contact with stagnant water				
5. Taking a bath in a river				
6. Washing clothes in a river				
7. Walking barefoot				
8. Poor sewer condition				
9. Contact with flood water				
10. Contact with bodies or tissues of rats				
11. Activities in paddy fields				
12. Existence of skin wounds				
13. Low education level				
14. Lack of knowledge on leptospirosis				

SUMMARY RANKING TABLE

Leptospirosis risk factor	Participants					Total	Rank
	1	2	3	4	5		
1. Stagnant water surrounding the house							
2. Poor house sanitation							
3. Existence of rats							
4. Contact with stagnant water							
5. Taking a bath in a river							
6. Washing clothes in a river							
7. Walking barefoot							
8. Poor sewer condition							
9. Contact with flood water							
10. Contact with bodies or tissues of rats							
11. Activities in paddy fields							
12. Existence of skin wounds							
13. Low education level							
14. Lack of knowledge on leptospirosis							

LEPTOSPIROSIS RISK FACTOR PRIORITIZATION TOOL

Participant code:_1_

Criterion 1:	Prevalence of leptospirosis risk factor (1,2,3,4)			
Criterion 2:	Contact possibility (1,2,3,4)			
Criterion 3:	Changeability (1,2,3)			
Leptospirosis risk factor	In the line below each criterion number (e.g. C1), record assigned weight as decided by the group. Then, for each leptospirosis risk factor, score each criterion and multiply the score by the assigned weight. Add weighted criterion scores to obtain total score for each selected leptospirosis risk factor			Total score for leptospirosis risk factor
	C1	C2	C3	
	X 2	X 1	X 3	
1. Stagnant water surrounding the house	8	3	1	12
2. Poor house sanitation	8	3	1	12
3. Existence of rats	8	2	1	11
4. Contact with stagnant water	6	2	6	14
5. Taking a bath in a river	6	4	6	16
6. Washing clothes in a river	8	4	6	18
7. Walking barefoot	8	3	9	20
8. Poor sewer condition	4	2	4	10
9. Contact with flood water	8	4	1	13
10. Contact with bodies or tissues of rats	4	4	9	17
11. Activities in paddy fields	8	4	1	13
12. Existence of skin wounds	8	4	9	21
13. Low education level	8	3	1	12
14. Lack of knowledge on leptospirosis	8	4	9	21

LEPTOSPIROSIS RISK FACTOR PRIORITIZATION TOOL

Participant code: __2__

Criterion 1:	Prevalence of leptospirosis risk factor (1,2,3,4)			
Criterion 2:	Contact possibility (1,2,3,4)			
Criterion 3:	Changeability (1,2,3)			
Leptospirosis risk factor	In the line below each criterion number (e.g. C1), record assigned weight as decided by the group. Then, for each leptospirosis risk factor, score each criterion and multiply the score by the assigned weight. Add weighted criterion scores to obtain total score for each selected leptospirosis risk factor			Total score for leptospirosis risk factor
	C1	C2	C3	
	X 2	X 1	X 3	
1. Stagnant water surrounding the house	8	4	1	13
2. Poor house sanitation	8	3	1	12
3. Existence of rats	8	3	1	12
4. Contact with stagnant water	6	4	6	16
5. Taking a bath in a river	4	4	6	14
6. Washing clothes in a river	8	4	6	18
7. Walking barefoot	8	3	9	20
8. Poor sewer condition	8	2	4	14
9. Contact with flood water	8	4	1	13
10. Contact with bodies or tissues of rats	4	4	9	17
11. Activities in paddy fields	8	4	1	13
12. Existence of skin wounds	8	4	9	21
13. Low education level	8	3	1	12
14. Lack of knowledge on leptospirosis	8	4	9	21

LEPTOSPIROSIS RISK FACTOR PRIORITIZATION TOOL

Participant code: __3__

Criterion 1:	Prevalence of leptospirosis risk factor (1,2,3,4)			
Criterion 2:	Contact possibility (1,2,3,4)			
Criterion 3:	Changeability (1,2,3)			
Leptospirosis risk factor	In the line below each criterion number (e.g. C1), record assigned weight as decided by the group. Then, for each leptospirosis risk factor, score each criterion and multiply the score by the assigned weight. Add weighted criterion scores to obtain total score for each selected leptospirosis risk factor			Total score for leptospirosis risk factor
	C1	C2	C3	
	X 2	X 1	X 3	
1. Stagnant water surrounding the house	8	4	1	13
2. Poor house sanitation	8	3	1	12
3. Existence of rats	8	4	1	13
4. Contact with stagnant water	8	4	6	18
5. Taking a bath in a river	6	4	6	16
6. Washing clothes in a river	8	4	6	18
7. Walking barefoot	8	4	9	21
8. Poor sewer condition	8	2	4	14
9. Contact with flood water	8	4	1	13
10. Contact with bodies or tissues of rats	6	4	9	19
11. Activities in paddy fields	8	4	1	13
12. Existence of skin wounds	8	4	9	21
13. Low education	8	3	1	12
14. Lack of knowledge on leptospirosis	8	4	9	21

LEPTOSPIROSIS RISK FACTOR PRIORITIZATION TOOL

Participant code: __4__

Criterion 1:	Prevalence of leptospirosis risk factor (1,2,3,4)			
Criterion 2:	Contact possibility (1,2,3,4)			
Criterion 3:	Changeability (1,2,3)			
Leptospirosis risk factor	In the line below each criterion number (e.g. C1), record assigned weight as decided by the group. Then, for each leptospirosis risk factor, score each criterion and multiply the score by the assigned weight. Add weighted criterion scores to obtain total score for each selected leptospirosis risk factor			Total score for leptospirosis risk factor
	C1	C2	C3	
	X 2	X 1	X 3	
1. Stagnant water surrounding the house	8	4	1	13
2. Poor house sanitation	8	3	1	12
3. Existence of rats	8	4	1	13
4. Contact with stagnant water	8	4	6	18
5. Taking a bath in a river	4	4	6	14
6. Washing clothes in a river	8	4	6	18
7. Walking barefoot	8	3	9	20
8. Poor sewer condition	8	2	4	14
9. Contact with flood water	8	4	1	13
10. Contact with bodies or tissues of rats	6	4	9	19
11. Activities in paddy fields	8	4	1	13
12. Existence of skin wounds	8	3	9	20
13. Low education	8	3	1	12
14. Lack of knowledge on leptospirosis	8	4	9	21

LEPTOSPIROSIS RISK FACTOR PRIORITIZATION TOOL

Participant code: __5__

Criterion 1:	Prevalence of leptospirosis risk factor (1,2,3,4)			
Criterion 2:	Contact possibility (1,2,3,4)			
Criterion 3:	Changeability (1,2,3)			
Leptospirosis risk factor	In the line below each criterion number (e.g. C1), record assigned weight as decided by the group. Then, for each leptospirosis risk factor, score each criterion and multiply the score by the assigned weight. Add weighted criterion scores to obtain total score for each selected leptospirosis risk factor			Total score for leptospirosis risk factor
	C1	C2	C3	
	X 2	X 1	X 3	
1. Stagnant water surrounding the house	8	3	1	12
2. Poor house sanitation	8	3	1	12
3. Existence of rats	8	2	2	12
4. Contact with stagnant water	8	4	6	18
5. Taking a bath in a river	6	4	6	16
6. Washing clothes in a river	8	4	6	18
7. Walking barefoot	8	4	9	21
8. Poor sewer condition	4	2	4	10
9. Contact with flood water	8	4	1	13
10. Contact with bodies or tissues of rats	4	4	9	17
11. Activities in paddy fields	8	4	1	13
12. Existence of skin wounds	8	4	9	21
13. Low education	8	4	1	13
14. Lack of knowledge on leptospirosis	8	4	9	21

SUMMARY RANKING TABLE

Leptospirosis risk factor	Participants					Total	Rank
	1	2	3	4	5		
1. Stagnant water surrounding the house	12	13	13	13	12	63	9
2. Poor house sanitation	12	12	12	12	12	60	12
3. Existence of rats	11	12	13	13	12	61	11.5
4. Contact with stagnant water	14	16	18	18	18	84	6
5. Taking a bath in a river	16	14	16	14	16	76	7
6. Washing clothes in a river	18	18	18	18	18	90	4
7. Walking barefoot	20	20	21	20	21	102	3
8. Poor sewer condition	10	14	14	14	10	62	10
9. Contact with flood water	13	13	13	13	13	65	8.5
10. Contact with bodies or tissues of rats	17	17	19	19	17	89	5
11. Activities in paddy fields	13	13	13	13	13	65	8.5
12. Existence of skin wounds	21	21	21	20	21	104	2
13. Low education level	12	12	12	12	13	61	11.5
14. Lack of knowledge on leptospirosis	21	21	21	21	21	105	1

References:

1. Developing an Effective MCH Planning Process: A Guide for Local MCH Programs. San Franscisco: Family Health Outcomes Project; 2003.
2. Cambridge Advanced Learner's Dictionary. Cambridge University Press; 2008.

APPENDIX-E:

Risk factors for leptospirosis and impact of an intervention to reduce exposures:
Intervention:

TEACHING PLAN

Session 1 Introductory Meeting

Session 2 Group Interactive Lecturing Session

Session 3 Demonstration and Simulation Session

Field Observation

Pre & Post-test

Session 1 Introductory meeting

Objective:
At the end of the session the participants should be able to:

- Know the program objectives
- Identify the cause of leptospirosis
- Identify the signs and symptoms of leptospirosis
- Identify the consequence of an untreated leptospirosis case
- Be more aware of the benefits of preventing or reducing exposure to leptospirosis risk factors

Activity	Learning Contents	Methods and Teaching Aids	Principles of Learning	Duration
Pre-meeting activities	Registration			
1. Welcome & Introduction to Program	1.1. Introduction of the facilitators 1.2. Introduction of participants	1.1. Facilitator introduce the team member 1.2. Facilitator asks participants to introduce themselves 1.3. Facilitator explain the reasons for conducting the program	- Motivation	30 minutes
2. Introduction to the program and sessions	2.1. Objective of the program and the sessions 2.2. Schedule and materials of each session 2.3. Participants expectation 2.4. Ground rules of the sessions	2.1. Explain the program goal and objectives of each session (1,2,3) 2.2. Exposition of program schedules and materials used 2.3. Collect and write participants expectations on flip charts 2.4. Introduce and establish rules to assure the fluency of the session's activities e.g. notify in advance unable to attend in the session,	- Motivation - Primacy	45 minutes

Activity	Learning Contents	Methods and Teaching Aids	Principles of Learning	Duration
		respect other's opinion, etc.		
3. Lecturing session	3.1. Short leptospirosis overview on: The cause of leptospirosis, the incubation period, the signs and symptoms, the consequences of an untreated case 3.2. The burden of leptospirosis, specifically in Demak district.	3.1. Pre-test 3.2. Facilitator presents lecture materials supported by relevant teaching media 3.3. Discussion 3.4. Facilitator asks participants to restate the lecture points 3.5. Post-test	- Reception/ transmission	45 minutes

Resources and Requirements:

1. Registration book
2. Flip Charts
3. Flip Chart stand
4. Permanent markers
5. Laptop computer
6. LCD projector
7. LCD Screen
8. Video recorder
9. Pre-test and Post test forms
10. Meeting room for 60 people
11. Facilitators

Session 2 Group session: Interactive Lecturing Session

Objective:
At the end of the session the participants should be able to:

- Identify three main factors related to leptospirosis transmission
- Identify local risk factor for leptospirosis
- Identify ways to prevent or reduce the exposure to leptospirosis risk factors

Activity	Learning Contents	Methods and Teaching Aids	Principles of Learning	Duration
Pre-test				15 minutes
1. Identification of three main factors related to leptospirosis transmission	1.1. Animal factor 1.2. Environmental factor 1.3. Human factor	1.1. Brainstorming of factor related to leptospirosis according to participant's view 1.2. Participants will be shown pictures or video where the cases reside or work, then facilitator asks them to identify factors related to leptospirosis 1.3. Discuss together factors identified by participants and group it into 3 main factors: animal, environmental, and human factors	- Reception/ transmission	30 minutes
2. Identification of local risk factor related to leptospirosis transmission	2.1. Local animal related to leptospirosis 2.2. Local environmental related to leptospirosis 2.3. Local human	2.1. Participants will be shown pictures or video showing animal, environment, and human behavior that	- Exploration/ documenting	30 minutes

Activity	Learning Contents	Methods and Teaching Aids	Principles of Learning	Duration
	factors related to leptospirosis	exist in their surroundings. 2.2. Facilitator asks participants to identify or tell which local animals, environment and human factors that are related to leptospirosis 2.3. Discuss together local factors identified by participants		
3. Introduction to principles of leptospirosis transmission prevention	3.1. Transmission cycle 3.2. Principles to prevent and reduce exposure to leptospirosis risk factors	3.1. Showing pictures an explain the transmission cycle of leptospirosis 3.2. Discuss how to prevent or reduce exposure to leptospirosis risk factors (focused on the local risk factors).	- Reception/ transmissio n	30 minutes
Post-test				15 minutes

Resources and Requirements:

1. Flip Charts
2. Flip Chart stand
3. Permanent markers
4. Laptop computer
5. LCD projector
6. LCD Screen
7. Video recorder
8. Pre-test and Posttest forms
9. Meeting room for maximum 10 people
10. Related pictures and video/film
11. Facilitators

Session 3 Group session: Demonstration and Simulation

Objective:

After participating in the demonstration and simulation session, participants are able to perform actions to prevent or reduce exposure to local leptospirosis risk factors of interest in the proper way.

Activity	Learning Contents	Methods and Teaching Aids	Principles of Learning	Duration
1. Demonstration on the measures to prevent or reduce exposure to leptospirosis risk factors	Demonstration on: 1.1. How to check skin wounds on the body 1.2. How to take care of skin wounds	1.1. Show the video, picture, demonstration that show on how to check the presence of skin wound 1.2. Discuss the content of video, picture, or demonstration	- Modeling/ Imitation	30 minutes
2. Simulation to perform measures to prevent or reduce exposure to leptospirosis risk factors	2.1. Simulation on how to check skin wound on the body 2.2. Simulation on how to take care of skin wounds	2.1. Each participant is asked to show in front of the group member how to check the skin wounds on the body. 2.2. Other participants are asked to watch their colleague who are doing simulation 2.3. Discuss the results of simulation activity	- Modeling/ Imitation - Intensity	45 minutes
3. Review of		3.1. Facilitator	- Intensity	30 minutes

Activity	Learning Contents	Methods and Teaching Aids	Principles of Learning	Duration
activities in session 1,2,3	3.1. Materials for session 1,2,3	summarizes the materials for session 1,2,3 and presented to the target group 3.2. Facilitator asks participants randomly to restate the lesson learned for the activities in session 1,2,3.		
Announcement	observation procedure	Facilitator explain the procedure of field observation to participants		15 minutes

Resources and Requirements:

12. Flip Charts
13. Flip Chart stand
14. Permanent markers
15. Laptop computer
16. LCD projector
17. LCD Screen
18. Video recorder
19. Meeting room for maximum 10 people
20. Related pictures and video/film
21. Facilitators

APPENDIX-F:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures:

CHECKING THE EXISTENCE OF SKIN WOUNDS
BEFORE WORKING IN THE WATERY PLACE

==========

HANDS:

Key words for a sequence: *lift- observe-turn-observe-wipe-feel-turn-wipe-feel-mixed*

1. LIFT your hands to the front of you with palm of the hand facing down,
2. OBSERVE the hand (for existence of lumps or scratches) starting from the upper arm to the finger tip of the hand,
3. TURN your hand to make your hand palm facing up,
4. OBSERVE the hand (for existence of lumps or scratches) starting from the fingertip to the upper arm,
5. WIPE the examined hand with your right hand (for wiping the left hand) or with your left hand (for wiping the right hand) starting from your upper arm to the tip of your hand finger,
6. FEEL whether any part of skin surface of your hands is different with the surrounding (scratches, lump, warm, pain),
7. TURN your hand to make your hand palm facing down,
8. WIPE the examined hand with your other hand from the finger tip to the upper arm,
9. FEEL whether any part of skin surface of your hands is different with the surrounding (scratches, lumps, warm, pain),
10. OBSERVE, WIPE, FEEL the inter finger areas of hands.

LEGS:

Key words for a sequence: *determine-observe-wipe-feel-mixed*

1. DETERMINE how deep your legs will be exposed by water (up to knee or to hips),
2. OBSERVE (existence of lumps or scratches) starting from hip or knee to finger tips of the foot (front and back of the leg, including foot sole),
3. WIPE the leg from hip or knee to finger tip of the foot (front and back of the leg, including foot sole),
4. FEEL whether any part of skin surface of your legs is different with the surrounding (scratches, lumps, warm, pain),
5. OBSERVE, WIPE, FEEL the inter finger areas of foot.

*****

APPENDIX-G:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures:
FINDINGS OF FIELD OBSERVATION (ENVIRONMENT)

Objective: To observe places or animals in the village or surroundings related to leptospirosis occurrence

LOCATION	OBSERVED OBJECTS RELATED TO LEPTOSPIROSIS	OBSERVATION RESULTS
BONANG, DEMAK, and KARANGAWEN SUB DISTRICTS	Paddy fields	- Water sources for paddy fields in Demak district are from closest river, irrigation dam, and rain water. - Rat's holes were found along the border of almost all paddy fields - Goats were found roaming in the surrounding of paddy field. - Water snails were found in the paddy fields; broken shells of these snails were sharp and could cause skin wounds.
	Fish pond (catfish)	- Sources of water for fish ponds were from the closest river (in the rainy season) and from the local District Drinking Water Company in the dry season. - No rat holes or burrows were found in surrounding the pond. - In some of the ponds, goats were seen roaming in the surrounding.
	Rivers	- Several small rivers are passing the observed area in Demak district - In sub district of Demak, a section of a river was bordering on the local waste dump site, and many rats were found in this local waste dump site. - In the rainy season, water from these rivers overflowed and caused flooding to the areas surrounding the rivers
	Open water drains	- Mostly located in front of the house. - Water in the drains usually overflowed and created puddles or stagnant water in the area surrounding the drains. - Many chickens were in the area surrounding the drains. - Some rat's holes were found in the drainage borders.
	Cow stall	- Some of the stall were located on the side of people house / attached to the house wall. - Sanitation of the stalls was poor, and excretion of

LOCATION	OBSERVED OBJECTS RELATED TO LEPTOSPIROSIS	OBSERVATION RESULTS
		the cows was discharged directly to the open water drains or to a local river.
	Duck pens	- Many duck pens were found in the house yard. - Many water puddles found in the yard and in area surrounding the duck pens. -
	Stagnant water	- A number of stagnant water were seen on the house yards, pathways, public field - Waters sources of the stagnant water were from overflowed rivers, drains, and rain.
	Poor sanitation of the house	- A number of local houses sanitation were poor, house yard with muddy soils and stagnant water area, clogged sewer, scattered rubbish on the house yard - Rats scurried around the house
	Dead rats on the street	- A number of dead rats were seen on the street especially in the rice harvesting season. People hunted and killed rats in the paddy fields, and they threw them on the street or land surrounding the paddy fields.

Summary:

Three selected sub districts for environmental observation were Bonang, Demak, and Karangawen. Similarity in environmental situation related to leptospirosis was seen among observed areas. Paddy fields, rivers, water drains, fish ponds, stagnant water, and poor house sanitation were main findings of the environmental observation.
Paddy fields dominated most of observed areas. Rats' burrows were seen in all observed paddy fields. A number of rats were scurrying around the local houses and around the local dump site.

APPENDIX-H:

Risk factors for leptospirosis and the impact of an intervention to reduce exposure

FINDINGS OF FIELD OBSERVATION (BEHAVIOUR)

Objective: To observe people's activities related to leptospirosis occurrence in the district of Demak

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
Working in the paddy field There are several phases in managing paddy field: 1) Preparing soils in order to be ready for planting paddy. Soil has to be ploughed using tractors or traditionally using plough instrument pulled by buffalos, 2) Planting the young paddy in the paddy field, 3) Giving fertilizer and cleaning the field from wild plants, 4) Maintaining the plants by preventing them from rats, birds and insects attack, 5) Harvesting the ripen paddies.	BONANG sub-district	- Paddy field water and many rats were found in areas surrounding the paddy field.	16.00-18.30 everyday The activity was in the fourth phase in managing paddy field.	A man who works as administrative staff of village office and he was also a paddy field farmer	- After working at the village office, he went to paddy field to chase the birth away from his paddy field. - After chasing the birds away, he went to the nearest river to wash his face, hands and feet. He also used river water for gargling. - During working at the paddy he did not wear sandals or boots. - No effort to check whether there were skin wounds in the body limbs before working in the paddy field. -
		- Paddy field water and many rats were found in areas surrounding the paddy field. -	7-12 am and 2-5 pm everyday The activity was in the fourth phase in managing paddy field.	A man who was working a paddy field	- He went to his paddy field to chase birds away and to set up generator to produce electricity current to kill or to chase rats away from his paddy field. - He also walked through his paddy field to check and clean the existence of wild-grown plants or of spoiled paddy plant caused by rats attack. He did not use boots or gloves while working in the paddy field. - No effort to check whether there were wounds in the body limbs before working in the paddy field. -
		- Paddy field water	7-10 am The activity was in the fourth phase in managing paddy field	A men who was working in a paddy field	- He walked through his paddy field to clean up snails from the paddy plants. - He did not use boots or gloves; he had direct contact with paddy field water. - After working in the paddy field, he washed his hands and feet using water from the nearest water drain. -
	DEMAK subdistrict,	- Paddy field water	7-10 am and 3-5 pm The activity was in the third phase in	A man who was working as a farmer and a cemetery keeper.	- Before going to the paddy field, he went to cemetery at 6 pm to check and clean up the cemetery. Starting about 7 am he worked in paddy field. Activities conducted in

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
			managing paddy field.		the paddy field included: checking and cleaning up the spoiled paddy plants and wild-grown plants, and giving fertilizers. His hands and feet were exposed directly to paddy field water; he did not wear feet and hands specific protectors to avoid direct contact with paddy field water. - At about 10 am he finished working and he washed his hands and feet using paddy field water. He came back to paddy field again at about 3 pm to do the same work as he did in the morning. - He was an ex leptospirosis patient. He told that before he got sick, he had wound in his feet and he did not take care of it. He did not cover that wound while he worked in the paddy field. - Although he had experience of suffering from leptospirosis, he did not check for the existence of skin wounds in his limbs before working in the paddy field.
		- Paddy field water	6-12 am and 2-5 pm The activity was conducted in the third phase in managing paddy field	A man who was working in the paddy field	- He started working in the paddy field at about 6 am in the morning and at about 2 pm in the afternoon. His activities in the paddy field included: checking and cleaning up the spoiled paddy plant and wild-grown plants, re-arranging the rows of paddy plants to make enough distance between rows. He also had a small field of land in the middle of his paddy field. This field was used to grow vegetables. Besides working in the paddy field, he also worked in this vegetables field. He gave water to this field by splashing paddy field water using his hands. He did not wear any specific hands and feet protection while working in the watery places. - No effort to check whether there were skin wounds in the body limbs before working in the paddy field. -
		- Paddy field water	9.50 am This activity	Two men were pulling big plastic bag full	- Young paddy plants from the place where paddy seedling were planted (in the middle of

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
			(moving the young paddy plants) was done in the second phase in managing paddy field	of bunch of young paddy *	paddy field) had to be moved and planted in the entire paddy field. - Young paddy plants were tied into many bunches and those bunches were put in to the wide fabric sacks. - Two men pulled the sacks to move it to the side of paddy field. The feet of those men were directly in contact with paddy field water for about 10 minutes for moving each big sack full of young paddy plant bunches. They repeated this activity for about 10 times before they took a rest. - No boots and gloves were worn to avoid direct contact with paddy field water. -
	KARANGAWEN subdistrict,	- Paddy field water	9.45 am This activity (planting the young paddy) was conducted in the second phase in managing paddy field	Eight women about 40-55 years old wearing 'caping' (head cover made of woven bamboo) were working in the paddy field	- Women with several bunch of young paddy plants were working in the paddy field. They planted the young paddy one by one in a row (backward moving). - They conducted this activity about 6 hours a day and it was separated into two sessions: 7.30 – 10.30 am and 2 – 5 pm. - They did not wear waterproof device for their feet and hands to avoid direct contact with paddy field water. - No efforts to check for the existence of skin wounds on the limbs before working in the paddy field. -
		- Paddy field water	8.45 am This activity (giving fertilizers) was conducted in the third phase in managing paddy field	A man, about 40 years old carrying container filled with fertilizers , was working in the paddy field*	- Spreading fertilizers on the paddy field was implemented manually. The left hand of this man was holding a container full of fertilizers, and his right hand took and dispersed fertilizers out on the paddy field repetitively. - He did this activity for about 3 hours without wearing feet and hands protectors to avoid direct contact with paddy field water.
Catching fish	KARANGAWEN subdistrict,	- River water	Saturday and Sunday morning	A man who was catching fish by applying 'apotas' chemical	- Catching fish in this village is usually considered as an income supplement. - He used 'apotas' (chemical to intoxicate fish) and a wide fish net . Wide net was fixed in the lower part of the river; apotas was diluted and put in the river water at the higher section of the river.

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
					He walked in the river water from the higher section of the river to the lower section of the river with fish net on his hand to catch intoxicated fish. - No protection was worn to avoid direct contact with river water. - No efforts to check whether there were skin wounds on their limbs before entering the river.
		- River water	8.50 am	A man, carrying a motorcycle battery on his back and holding 2 sticks, was walking in the river to catch fish *	- He used an electric shock tool to make fish loss of consciousness. The electricity generator used was a 12 volt motorcycle battery; and it was carried on his back. The tool consisted of 2 sticks that were connected to the battery. - He walked through the river water, and each of his hands held the stick. When he saw a fish, he put the sticks in between the fish to create an electrical shock to the fish. The shocked fish was lost their consciousness and floated on the water. Therefore, the man took easily the floating fish. - No protection was used to avoid directly contact with river water. - This activity was done for about 2 hours. -
Washing motorbike	BONANG subdistrict,	- Water of the unutilized pond	9.30 am (Incidentally)	A man who was washing his motorbike *	- This activity was conducted at the unutilized small pond on the side of Bonang Street. This pond was originally used as an irrigation pool control for watering paddy field. Some village people used the water from this pond to wash their motorbikes. - He took the water from the pool using a small container and then poured the water on his motorbike. He repeated this action four times and brushed the surface of his motorbike using a cloth. - He did not wear boots or gloves when he conducted this activity. - This activity was conducted for about 30 minutes.

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
Washing clothes and bathing in the river	BONANG sub district	- Tuntang river water	Morning at 10.30	A man was bathing and a woman was washing clothes*	- The woman feet were submerged in the river water during washing clothes for about 1 hour. Her hands were repeatedly in contact with water on and off. Soap or detergent was used for washing clothes. - The man's chest down was submerged in the river water. He rinsed his body repeatedly using his hands. He bathed for about 30 minutes.
Cleaning up a river	DEMAK sub district	- River water of dusun Prigi (Prigi hamlet)	2.30 pm	Two men were cleaning up the a river *	- Cleaning up a river was a local government program and it was implemented periodically. - Two men were in charge to clean up the river. They submerged their bodies up to their chests. Each of them held a garden fork to grab and pull the rubbish to the side of the river. - No waterproof clothing was worn to avoid direct contact with river water. - They were working in the river for about 1-1.5 hours. -
Hunting and catching rats	KARANGAWEN sub district	- Paddy field water - Rat's tissues or excretion	8.40 am This activity was conducted in the third phase of maintaining paddy field	A men was working in the paddy field *	- He was cleaning up the wild grown plants in the paddy field. - While he was doing the activity, he saw rats in his paddy field, and then he hunted and killed the rats (three rats). He held the dead rats with his hand without wearing gloves, and then he threw the dead rats to the side of the paddy field. No effort to bury the dead rats.
Hoeing the corn field	KARANGAWEN sub district	- Muddy soils - Irrigation drain water	9.30 am	A man, about 50 years old, was working in the corn field*	- The corn field was close to the paddy field and both fields using the same source of water from irrigation drain. - He was hoeing the corn field soil. The soil was muddy and his feet were submerged in the muddy soil about 10-20 cm deep. He did not wear boots. This activity was done for about 2 hours. -

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
Caring and bathing buffalos	KARANGAWEN sub district	- Ditch water - Buffalo stall that is in one house with people.	2 pm – 5 pm	A woman who was taking care of her buffalos	- Buffalo was living under one roof with the owner. - Sanitation of the stall was poor. - About 3 pm she took out her buffalos from the stall, and they were driven to the ditch at the border of the village. Buffalos submerged their bodies for about an hour. After about an hour, she bathed them by brushing their skin using a bunch of grass and ditch water. After bathing the buffalos, she let the buffalos grazed in the field. While buffalos were eating grasses, she went home to clean buffalo's stall. Buffalos' stools and urine were thrown at the back of her house. She did not wear hands and feet protectors to avoid direct contact with water and animal excretion. After cleaning the stall she went back to the field to drive the buffalos back home. - No effort to check whether there were skin wounds in the limbs before bathing buffalos or cleaning buffalo's stall. - She did not know about leptospirosis.
Bathing goats	BONANG sub district	- River water - Goats excretion	8-9.30 am	A man who was bathing goats*	- Firstly, he washed the goat skin with bathing soap and water in a container. The water was taken from a nearest river. - Secondly, he and his goats went and entered the river to wash off the soap on the goat's skin. His knees down were submerged in the river water. His hands were directly contacted with the river water. - He did not use gloves or body protector to avoid direct contact with river water or goat's excretion. - This work took about an hour to bathe 3 goats.
Cleaning up a pond	BONANG Sub district	- Pond water and river water	10.30 am (this activity was conducted once a month)	A man, as a farmer and fish breeder, was cleaning up a pond*	- He entered into the water, and his chest down was submerged in the water. - He walked through the water to collect green algae, and then he threw the algae to the outside of the pond. - He worked for about 2 hours in the pond. - No efforts to check whether there were skin wounds on his body before entering the water.

ACTIVITIES	WHERE	WHAT	WHEN	WHO	HOW
Sharpening a sickle	DEMAK Sub district	- Pond water	2.30 pm	A man, about 40 years old, was sharpening a sickle *	- A man was sharpening his sickle at the side of a pond. His knees down were submerged in the pond water. His hands held a sickle and rubbed the sickle on a whetstone. After rubbing the sickle on the whetstone several times, he washed and submerged the sickle with his hands in the pond water. This sequence of activity was repeated several times for about 20 minutes. - He did not wear boots or glove when conducting this activity.

SUMMARY: The majority of people in Demak district were paddy field farmers. Thus, activity in a paddy field was the most frequent activity done by local people. Other activities related to human leptospirosis carried out by people in the study area included catching fish, washing and bathing in a river, cleaning up a river, cleaning up ponds, hunting and killing rats, taking care and bathing water buffalos or goats, hoeing a corn fields, washing motor bikes, and sharpening sickles using pond water to wash the sharpened sickles.

APPENDIX-I-1:

In-depth Interview respondent no: _____

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

PERSONAL CONSENT FORM

I, _____, have read information sheet and understand that this study has been designed to find local factors related to leptospirosis and to promote better health for the community.

I understand that as part of this study the interviewer will be asking me questions and it will be recorded.

I know that I do not have to answer these questions and I may stop at any point.

I have had a chance to ask the interviewer any questions I had.

I agree to participate in this study.

Signed _____

Witness _____

Date _____

APPENDIX-I-2:

Observation-respondent no: _____

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

PERSONAL CONSENT FORM

I, _____, have read the information sheet and understand that this study has been designed to find local modifiable factors of leptospirosis and to promote better health for the community.

I understand that as part of this study the observer will be observing and videotaping me while I am doing my daily activities.

I know that I do not have to agree to be observed and I may stop at any point.

I have had a chance to ask the observer any questions I had.

I agree to participate in this study.

Signed _____

Witness _____

Date _____

APPENDIX-I-3:

KAP Survey-respondent no: _____

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

PERSONAL CONSENT FORM

I, _____ , have read the information sheet and understand that this study has been designed to find local modifiable factors of leptospirosis and to promote better health for the community.

I understand that as part of this study the interviewer will be asking me questions.

I know that I do not have to answer these questions and I may stop at any point.

I have had a chance to ask the interviewer any questions I had.

I agree to participate in this study.

Signed _____

Witness _____

Date _____

APPENDIX-I-4:

Intervention-respondent no: _____

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

PERSONAL CONSENT FORM

I, _____, have read the information sheet and understand that this study has been designed to find local modifiable factors of leptospirosis and to promote better health for the community.

I understand that as part of this study the researcher will give health education to me on leptospirosis risk factors and prevention.

I know that I do not have to agree to be given health education and I may stop at any point.

I have had a chance to ask the researcher any questions I had.

I agree to participate in this study.

Signed _____

Witness _____

Date _____

APPENDIX-I-5:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

IN-DEPTH INTERVIEW PARTICIPANTS INFORMATION SHEET

Background of research

Leptospirosis is common in Indonesia especially in the flood prone area. Number of leptospirosis cases is increasing annually. Demak district is one of the predominant areas contributing to leptospirosis cases in Central Java province. Previous studies indicate that activities in wet places or occupational contact with water, the existence of skin wounds and the existence of rats in the house are factors related to leptospirosis found in developing countries. To prevent the occurrence of leptospirosis, identification of local factors related to leptospirosis and an intervention to reduce exposures are needed.

Purpose of research

I am interested to identify local risk factors of leptospirosis, and then to design, implement, and evaluate an intervention that will reduce exposure to risk factors of leptospirosis. Activities will be performed to fulfill the objective of this study. One of those activities is an in-depth interview to obtain information on social and behavioural characteristics of Demak district community.

What the research will do

I will distribute a preliminary questionnaire and I would like you to complete it in 3 days. I will interview you at least a week after the collection of preliminary questionnaire. The interview process will take approximately 1 hour and it will seek information on social behavioural background of Demak community, health related background of the community and leptospirosis related knowledge, attitude and background. We will set a mutually agreed time and location for in-depth interview. The interview will be recorded to help with transcription.

Your role in this research

You are asked to read and sign the consent form. You have an opportunity to ask questions regarding the study and have the right to reject to participate in this study at any time.

You are asked to complete the preliminary questionnaire in 3 days and provide the time about 1 for in-depth interview. You will receive a gift for participating in this study with IDR 50.000 in value. The gift will be given after the in-depth interview.

Confidentiality

The information you provide will be kept separate from your personal details. Access to your identity will be restricted to only the project team (interviewer/researcher and supervisors). Additionally, it will not be identified in any way in the write up of information. The information will be kept secure and private by the principal investigator.

Further information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 97/2010). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect

participants. If needed, verification of approval can be obtained either by writing to the Curtin University
Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or emailing hrec@curtin.edu.au.

Contact person

M. Sakundarno Adi, MD, Msc.
Project Coordinator – Risk factors for leptospirosis and an intervention to reduce exposures
Ph. (+62) 081390902627
Facsimile: 62-24-7460044
Email: adisakundarno@yahoo.com

Thank you very much for your involvement in this study, your participation is greatly appreciated. Please keep this letter for your information

APPENDIX-I-6:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

OBSERVATION PARTICIPANTS INFORMATION SHEET

Background of research

Leptospirosis is common in Indonesia especially in the flood prone area. Number of leptospirosis cases is increasing annually. Demak district is one of the predominant areas contributing to leptospirosis cases in Central Java province. Previous studies indicate that activities in wet places or occupational contact with water, the existence of skin wounds and the existence of rats in the house are factors related to leptospirosis found in developing countries. To prevent the occurrence of leptospirosis, identification of local factors related to leptospirosis and an intervention to reduce exposures are needed.

Purpose of research

I am interested to identify local factors related to leptospirosis, and then to design, implement, and evaluate an intervention that will reduce exposure to factors related to leptospirosis. Several activities will be performed to fulfill the purpose of this study. One of those activities is an observation on behaviour related to leptospirosis in the district of Demak.

What the research will do

I would like to interview you to obtain information regarding your daily activity related to leptospirosis such as activities related to contact with water and/or animal in your house or surroundings. I will conduct observation on your activities related to leptospirosis. After completing the observation I will discuss with you when additional information regarding the activity you have done are required.

Your role in this research

You are asked to read and sign the consent form. You have an opportunity to ask questions regarding the study and have the right to reject to participate in this study at any time. You are asked to allocate time approximately 30 minutes to provide information regarding your activities related to contact with water and animals. You are asked to allow observers to observe your activities in your house or surroundings (approximately an hour). You will receive a gift for participating in this study with IDR 50.000 in value. The gift will be given after all observations are completed.

Confidentiality

The observation results will be kept separate from your personal details. Access to your identity will be restricted to only the project team (interviewer/researcher and supervisors). Additionally, it will not be identified in any way in the write up of information. The information will be kept secure and private by the principal investigator.

Further information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 97/2010). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect

participants. If needed, verification of approval can be obtained either by writing to the Curtin University
Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or emailing hrec@curtin.edu.au.

Contact person

M. Sakundarno Adi, MD, Msc.
Project Coordinator – Risk factors for leptospirosis and an intervention to reduce exposures
Ph. (+62) 081390902627
Facsimile: 62-24-7460044
Email: adisakundarno@yahoo.com

Thank you very much for your involvement in this study, your participation is greatly appreciated. Please keep this letter for your information

APPENDIX-I-7:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

KAP SURVEY PARTICIPANTS INFORMATION SHEET

Background of research

Leptospirosis is common in Indonesia especially in the flood prone area. Number of leptospirosis cases is increasing annually. Demak district is one of the predominant areas contributing to leptospirosis cases in Central Java province. Previous studies indicate that activities in wet places or occupational contact with water, the existence of skin wounds and the existence of rats in the house are factors related to leptospirosis found in developing countries. To prevent the occurrence of leptospirosis, identification of local factors related to leptospirosis and an intervention to reduce exposures are needed.

Purpose of research

I am interested to identify local factors related to leptospirosis, and then to design, implement and evaluate an intervention that will reduce exposure to factors related to leptospirosis. Several activities will be performed to fulfill the purpose of this study. One of those activities is a survey on knowledge, attitude and practice (KAP) related to leptospirosis prevention.

What the research will do

I will conduct 2 serial interviews. A first interview will be implemented before implementation of an intervention and a second interview will be conducted after implementation of the intervention. The survey will search for your basic knowledge on factors related to leptospirosis and prevention, attitudes towards leptospirosis prevention and practice with regard to reducing exposure to leptospirosis. The interview process will take approximately 30 minutes.

Your role in this research

You are asked to read and sign the consent form. You have an opportunity to ask questions regarding the study and have the right to reject to participate in this study at any time.
You are asked to provide time of approximately 30 minutes for an interview.
You will receive a gift for participating in this study with IDR 50.000 in value. The gift will be given after the interview is accomplished.

Confidentiality

The information will be kept separate from your personal details. Access to your identity will be restricted to only the project team (interviewer/researcher and supervisors). Additionally, it will not be identified in any way in the write up of information. The information will be kept secure and private by the principal investigator.

Further information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 97/2010). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect

participants. If needed, verification of approval can be obtained either by writing to the Curtin University
Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or emailing hrec@curtin.edu.au.

Contact person

M. Sakundarno Adi, MD, Msc.
Project Coordinator – Risk factors for leptospirosis and an intervention to reduce exposures
Ph. (+62) 081390902627
Facsimile: 62-24-7460044
Email: adisakundarno@yahoo.com

Thank you very much for your involvement in this study, your participation is greatly appreciated. Please keep this letter for your information

APPENDIX-I-8:

Risk factors for leptospirosis and the impact of an intervention to reduce exposures

INTERVENTION PARTICIPANTS INFORMATION SHEET

Background of research

Leptospirosis is common in Indonesia especially in the flood prone area. Number of leptospirosis cases is increasing annually. Demak district is one of the predominant areas contributing to leptospirosis cases in Central Java province. Previous studies indicate that activities in wet places or occupational contact with water, the existence of skin wounds and the existence of rats in the house are factors related to leptospirosis found in developing countries. To prevent the occurrence of leptospirosis, identification of local factors related to leptospirosis and an intervention to reduce exposures are needed.

Purpose of research

I am interested to identify local factors related to leptospirosis, and then to design, implement and evaluate an intervention that will reduce exposure to factors related to leptospirosis. Intervention will be in the form of activities to make you aware and take actions to avoid or minimize the exposure to the local factors related to leptospirosis.

What the research will do

Serial of health education activities will be implemented. The education includes theory and practice that are designed to increase your awareness and ability to avoid or minimize the exposure to the local factors related to leptospirosis.

Your role in this research

You are asked to read and sign the consent form. You have an opportunity to ask questions regarding the study and have the right to reject to participate in this study at any time.

You are asked to provide time of approximately 2 hours a week for doing health educational process.

You will receive a transportation cost reimbursement with IDR 10.000 for each 2-hours meeting. The reimbursement will be given after the each meeting.

Confidentiality

The information will be kept separate from your personal details. Access to your identity will be restricted to only the project team (interviewer/researcher and supervisors). Additionally, it will not be identified in any way in the write up of information. The information will be kept secure and private by the principal investigator.

Further information

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 97/2010). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University

Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or emailing hrec@curtin.edu.au.

Contact person

M. Sakundarno Adi, MD, Msc.
Project Coordinator – Risk factors for leptospirosis and an intervention to reduce exposures
Ph. (+62) 081390902627
Facsimile: 62-24-7460044
Email: adisakundarno@yahoo.com

Thank you very much for your involvement in this study, your participation is greatly appreciated. Please keep this letter for your information