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Knowledge, Attitude and Practices towards Leptospirosis among Lakeshore Communities of Calamba and Los Baños, Laguna, Philippines

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Abstract: Leptospirosis is a serious and potentially fatal zoonotic disease, but often neglected owing to lack of awareness. This study examined the knowledge, attitudes, and practices concerning leptospirosis among agricultural (n = 152) and non-agricultural (n = 115) workers in the lakeshore communities of Calamba and Los Baños, Laguna, Philippines. The findings showed no significant differences for the knowledge and attitude scores between agricultural and non-agricultural workers. However, agricultural workers had significantly lower prevention practice scores than non-agricultural workers. The ordinary least squares regression model identified gender, use of broadcast media as a source of health information, and knowledge and attitudes about leptospirosis as significant predictors of prevention practices common to both workers. Higher educational attainment was significantly associated with prevention practices among agricultural workers, while higher age and income level were significantly associated with prevention practices among non-agricultural workers. Public health interventions to improve leptospirosis knowledge and prevention practices should include health education and promotion programs, along with the strengthening of occupational health and safety programs in the agricultural sector.

Keywords: leptospirosis; KAP; zoonotic disease; occupational health and safety; agriculture

1. Introduction

Leptospirosis is a zoonotic disease caused by pathogenic *Leptospira* bacteria that are excreted in the urine of infected animals, such as rodents, livestock, and domestic pets [1,2]. It can be acquired by direct contact with an infected animal or by indirect contact with an environment contaminated with the urine of infected animals [3]. The infection can manifest a wide range of symptoms, from a mild flu-like illness to more severe complications such as jaundice, meningitis, hemorrhage, and renal dysfunction [1]. Leptospirosis is highly endemic in the Philippines, and has been reported in a variety of environmental settings and risk exposures. Urban leptospirosis outbreaks have been associated with the expansion of slum communities, poor sanitation and waste disposal, and occurrences of

excessive rainfall and floods that create ecological conditions for rat-borne disease transmission [4,5]. In rural areas, leptospirosis is reported as an occupational disease among agricultural and animal workers [6–8]. It is also recognized among the health constraints of workers engaged in integrated animal-fish farming systems [9]. One epidemiological report estimated that an average of 680 cases and 40 leptospirosis-related deaths occurred every year in the Philippines, with a prevalence rate of 10 per 100,000 person-years [10]. Another seroprevalence survey, however, derived an annual incidence rate of 10,655 per 100,000 population, indicating that leptospirosis may be grossly under-reported in the country [11].

Despite the increasing incidence, leptospirosis remains a neglected disease that suffers from lack of awareness especially among high risk groups [11,12]. Agricultural workers engaged in crop farming, fish culture, and livestock raising and slaughtering are among the groups at high risk of acquiring leptospirosis because their work entails close contact with infected animals or urine-contaminated water and soil [13–18]. Moreover, agricultural workers typically lack awareness and basic knowledge of leptospirosis, hence making them more vulnerable to infection [19].

The understanding of individual knowledge of the disease and health behavior plays an important role in disease prevention, and in improving occupational health and safety. The Knowledge, Attitude and Practice (KAP) survey model offers a conceptual framework for analyzing human behavior and its effects on choices or interventions by characterizing knowledge, feelings, and actions [20]. The model considers the importance of an individual's knowledge and attitude in influencing behavior change [21,22]. It also recognizes the impact of external factors, such as socioeconomic and environmental influences, on individual behavior [23–25]. There are few KAP studies on leptospirosis among agricultural workers. Previous studies have focused mainly on describing the knowledge and awareness of leptospirosis among farmers in Sri Lanka and Thailand [19,26]. A recent study in the Philippines described leptospirosis-related knowledge, attitude, and practices among residents, health workers, and officials [27]. In all these studies, the causal relationship between knowledge or attitudes and leptospirosis prevention were excluded from the analyses. Moreover, the influence of socio-demographic characteristics on leptospirosis prevention practice was also not considered. Socio-demographic characteristics have been recognized as independent factors for leptospirosis transmission and therefore can affect individual preventive health behavior [28]. Identifying and understanding the influence of socio-demographic characteristics, knowledge and attitudes about leptospirosis on prevention practice could facilitate the management of specific targeted factors in the overall leptospirosis prevention strategy.

This study was undertaken to examine the knowledge, attitudes and practices towards leptospirosis among the lakeshore communities of Calamba and Los Baños, Laguna, Philippines. Recognizing the occupational nature of leptospirosis, the KAP responses were further differentiated according to occupation, *i.e.*, agricultural and non-agricultural workers. Aside from knowledge, attitude and practices, the study examined pertinent factors that influenced leptospirosis prevention practice. This information is important for tailoring public health strategies, and for establishing baseline levels for future evaluation of the progress of health interventions. It is hypothesized that leptospirosis prevention practice would be significantly associated with socio-demographic characteristics, knowledge, and attitude.

2. Methods

2.1. KAP Questionnaire and Measures

A questionnaire was developed based on previous KAP studies on leptospirosis [27,29,30]. The list of KAP questions is given in Appendix 1. The first part of the questionnaire focused on the socio-demographic characteristics of the respondents. The second part measured the respondents' prevailing knowledge of the causative organism and transmission, signs and symptoms, and prevention. It consisted of 10 questions designed to solicit True/False/Unknown responses. A score of

1 was given for each correct answer, while incorrect answers and "I don't know" responses were scored 0. The total knowledge score for each respondent was a sum ranging from 0 to 10. The third part of the questionnaire evaluated respondents' attitudes towards leptospirosis. It consisted of a five-level Likert scale question format (1 = *strongly disagree*, 2 = *disagree*, 3 = *not sure*, 4 = *agree*, 5 = *strongly disagree*), with an acceptable level of reliability (Cronbach's alpha set at 0.815). The total attitude score for each respondent could range from 1 to 25, with higher scores indicating a more positive attitude towards leptospirosis, *i.e.*, having a more optimistic disposition or beliefs about leptospirosis prevention.

The final part of the questionnaire assessed respondents' leptospirosis prevention practices. It consisted of a five-level Likert scale question format (1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*, 5 = *always*), with an acceptable level of reliability (Cronbach's alpha set at 0.764). The total practice score for each respondent could range from 1 to 35, with higher scores indicating higher adherence to prevention practices. The raw scores for knowledge, attitude, and practice were calculated into percentage scores by dividing the scores obtained by the respondents with the possible maximum score and multiplying by 100.

2.2. Data Analyses

The data were coded and analyzed using STATA software version 13 [31]. The differences in the mean KAP scores between agricultural and non-agricultural workers were compared using a *t*-test. The ordinary least squares (OLS) regression method was used to evaluate the influence of socio-demographic characteristics, knowledge, and attitudes about leptospirosis on prevention practice. The OLS model is empirically specified by:

$$PRACTICE_i = \beta_0 + \beta_1 AGE + \beta_2 GENDER + \beta_3 HIGHSCHOOL + \beta_4 COLLEGE + \beta_5 INCOME + \beta_6 BROADCASTMEDIA + \lambda_1 KNOWLEDGE + \lambda_2 ATTITUDE + \varepsilon_i \quad (1)$$

where $PRACTICE$ is the dependent variable that denotes the leptospirosis practice score of respondent i; β_0 represents the constant term; AGE is a continuous variable representing the age of the respondent in years; $GENDER$ is a dummy variable representing 1 for a male respondent and 0 for a female respondent; $HIGHSCHOOL$ is a dummy variable representing 1 if the respondent attained high school education and 0 if not; $COLLEGE$ *i*s a dummy variable representing 1 if a respondent attained college education and 0 if not; $INCOME$ is a continuous variable that denotes the household income of the respondent in pesos per month; $BROADCASTMEDIA$ is a dummy variable representing 1 if a respondent used television or radio as the source of health information, and 0 if not; $KNOWLEDGE$ is a continuous variable that denotes the knowledge score of the respondent; $ATTITUDE$ is a continuous variable that denotes the attitude score of the respondent; $\beta_1 \ldots \beta_6$ denote the coefficients associated with the socio-demographic characteristics of the respondents; λ_1 and λ_2 denote coefficients associated with knowledge and attitude scores, respectively; and ε is the normally distributed error term with mean and zero variance σ^2 (~N (0, σ^2).

The data were initially examined using the regression diagnostics procedure in STATA to meet the underlying assumptions of OLS regression. The normality of residuals was checked using the quantile-quantile (Q-Q) plot, probability-probability (P-P) plots, and inter-quartile range test. The Breusch–Pagan test was used to check the homoscedasticity of the residual, and the variance inflation factor was used to test for multicollinearity among variables. Finally, the Chow test was applied to examine whether the independent variables had different effects on agricultural and non-agricultural workers. The null hypothesis assumed that the regression coefficients were equal for both agricultural and non-agricultural workers. If the test failed to reject the null hypothesis, then data from both groups could be pooled into a single model. The Chow test statistic is expressed as:

$$F = \frac{(S_c - (S_1 + S_2))/k}{(S_1 + S_2)/(N_1 + N_2 - 2k)} \quad (2)$$

where S_c is the error sums of squares when all the observations are used within the model; S_1 is the error sums of squares for the first group (agricultural workers); S_2 is the error sums of squares for the second group (non-agricultural workers); N_1 is the number of observations in the first group; N_2 is the number of observations in the second group; and k is the number of regressors, including the intercept.

2.3. Survey Administration

This cross-sectional survey was conducted from February to March 2015 in the municipalities of Calamba and Los Baños, Laguna, Philippines. The municipalities are located approximately 54 to 63 km south of Manila, and bordered on the north by Laguna de Bay, the largest freshwater lake in the country. Both municipalities are part of a region where leptospirosis incidence was reported at 143 cases per 100,000 population-year [32]. Prior to the survey, the questionnaire was pre-tested and translated into the local dialect to facilitate better understanding of the questions among the respondents. Approval to conduct the survey was obtained from the local government units of Calamba and Los Baños.

The survey followed a two-stage sampling methodology. The first stage involved the random selection of 10 lakeshore *barangays* (the smallest administrative division in the Philippines, and is the Filipino term for village or ward) along the Laguna de Bay. The selected *barangays* consisted of 15,052 households located near the lake and classified as agricultural and fisheries zones [33,34]. The second stage involved the random selection of sample households from the total number of eligible households (N = 15,052). The effective sample size of 267 was calculated to allow for the estimation of a 50% positive response frequency for leptospirosis prevention practice, with 95% confidence intervals and precision of $\pm$6%. The sample of households was obtained from each *barangay* proportional to their known household population. The sample households were drawn using a skip interval method from a random starting point. If a household could not be contacted, the next eligible household was substituted. One adult respondent was randomly selected from each sample household. All selected respondents were informed about the aspects of the research, and gave their consent to participate in the survey. Respondents were also assured of anonymity and confidentiality.

3. Results

3.1. Sociodemographic Characteristics of the Respondents

Table 1 shows that the majority of the 267 respondents were female (60%) and had attained a high school education (61.42%). This is similar to the reported population statistics for Laguna Province [35]. The mean age of the respondents was 42.46 years. The mean household income of the respondents was 8720 pesos ($183 USD) a month, much lower than the reported mean income of the province at 20,757 pesos a month [35]. This is expected considering that the survey was conducted along the agricultural and fisheries zones of the lake, which typically consist of low-income residential communities. The 267 respondents were further categorized into agricultural (n = 152) and non-agricultural (n = 115) workers. The agricultural workers were engaged in activities such as fish culture and marketing, farming, raising livestock, and growing ornamental plants. More than half of the agricultural workers were female (59%), with a mean age of 41.06 years and a mean household income of 8170 pesos ($179 USD) per month; many had completed high school (63.15%). The non-agricultural workers were engaged in industrial, manufacturing, small retail business, and domestic services (such as security and janitorial activities). More than half of the non-agricultural workers were female (62.61%), with a mean age of 44.04 years and a mean household income of 9460 pesos ($199 USD) per month; more than half had completed high school (59.13%). Both agricultural and non-agricultural workers reported that they had heard of leptospirosis through broadcast media such as television and radio (87.27%). Both groups of respondents had also obtained information from local government health units (6.74%), relatives and neighbors (4.49%), and newspapers and brochures (1.50%).

Table 1. Sociodemographic characteristics of the respondent (n = 267).

Socio-Demographics	Agricultural Workers		Non-Agricultural Workers		All Respondents	
	n = 152		n = 115		n = 267	
	Mean	**S.D.**	**Mean**	**S.D**	**Mean**	**S.D**
Age (in years)	41.06	10.86	44.04	12.61	42.34	11.72
Household income ('000 pesos/month)	8.17	4.59	9.46	9.22	8.72	6.99
	Count	**%**	**Count**	**%**	**Count**	**%**
Gender						
Male	64	42.00	43	37.39	107	40.00
Female	88	59.00	72	62.61	160	60.00
Education						
Elementary	40	26.32	26	22.61	66	24.72
High school	96	63.15	68	59.13	164	61.42
College	16	10.53	21	18.26	37	13.86
Source of health information						
Broadcast media (TV/Radio)	131	86.18	102	88.70	233	87.27
Local Health Unit	13	8.55	5	4.35	18	6.74
Relative/Neighbors	7	4.61	5	4.34	12	4.49
Newspapers/brochures	1	0.66	3	2.61	4	1.50

3.2. Knowledge, Attitude, and Practices of Leptospirosis

Table 2 presents the knowledge, attitude, and practices percentage scores for all respondents categorized by occupation. The total mean knowledge score for all respondents was 68.50%. The questions on leptospirosis transmission had the highest mean score at 81.38%, followed by questions related to disease prevention, with a mean score of 77.43%. The questions on the signs and symptoms of leptospirosis had the lowest mean score at 44.32%. Agricultural workers had a total mean knowledge score of 67.70%, while non-agricultural workers scored 69.26%. However, the difference in their mean knowledge score was not statistically significant at 0.05 level. There were also no significant differences between both groups' responses to questions on leptospirosis transmission, signs and symptoms, and disease prevention at 0.05 level. In terms of attitudes about leptospirosis, the total mean attitude score for all respondents was 80.89%. Agricultural workers obtained a mean score of 79.97%, while non-agricultural workers scored 82.12%. The difference in their mean attitude score was not statistically significant at 0.05 level. In terms of prevention practices related to leptospirosis, the total mean practice score for all respondents was 61.26%. The rat control prevention practice had a mean score of 67.31%, while the use of protective gear and safety measures practice had a lower mean score of 56.68%. The total mean practice score obtained by non-agricultural workers (66.35%) was significantly higher than that of agricultural workers (57.50%) at 0.05 level. With regard to item-specific practices, non-agricultural workers obtained a significantly higher mean practice score (61.22%) for the use of protective gear and safety measures, compared with agricultural workers (53.26%) at 0.05 level. Non-agricultural workers also obtained a significantly higher mean score for rat control measures (73.16%) compared with agricultural workers (62.89%) at 0.05 level.

Table 2. Knowledge, attitude, and practice percentage scores of all respondents categorized by occupation.

	Agricultural Workers		Non-Agricultural Workers		Difference [1]	All Respondents	
	n = 152		n = 115			n = 267	
	Mean	**S.D.**	**Mean**	**S.D.**		**Mean**	**S.D.**
Total Knowledge Score	**67.70**	**21.97**	**69.26**	**19.26**	**1.56**	**68.50**	**20.82**
Mode of Transmission	79.61	26.59	83.77	20.87	4.16	81.39	35.38
Signs & Symptoms	44.52	36.38	44.06	37.86	0.46	44.32	36.95
Disease prevention	75.56	25.96	79.56	25.56	4.00	77.43	25.81
Total Attitude Score	**79.97**	**15.49**	**82.12**	**16.28**	**1.15**	**80.89**	**15.84**
Total Practice Score	**57.40**	**14.57**	**66.35**	**18.10**	**8.95 ****	**61.26**	**16.75**
Protective gears & safety measures	53.26	16.68	61.22	22.58	7.96 **	56.68	19.79
Rat Control Measures	62.89	20.25	73.16	18.98	10.27 **	67.31	20.32

[1] Significant difference in the responses between agricultural and non-agricultural workers were determined using t-test statistics; ** Significant *p-value* at 0.05 level.

3.3. Factors Affecting Leptospirosis Prevention Practice

Regression analysis indicated that the data satisfied the underlying assumption of OLS regression. The residuals of the regression were close to normal distribution, with no presence of severe or mild outliers, and with homoscedastic distribution. The variance inflation factor was below 10, indicating low collinearity of the predictive variables. The value of the Chow test comparing the pooled model (Model 3) against the separate models for agricultural (Model 1) and non-agricultural (Model 2) workers was estimated at 2.52, which exceeded the critical value F (9, 249) of 1.88 at 0.05 level of significance. Based on these results, we rejected the null hypothesis of equal coefficients for both agricultural and non-agricultural workers, thereby justifying the use of separate models for the two groups instead of pooling them together. For brevity, Table 3 presents only the final results of the OLS models, which determine the factors affecting leptospirosis prevention practices.

Table 3. Results of the OLS regression model to determine the factors affecting leptospirosis prevention practice.

	Model 1:		**Model 2:**		**Model 3:**	
Variables	**Agricultural Workers**		**Non-Agricultural Workers**		**Pooled: All Respondents**	
	Coeff.	**Std. Err.**	**Coeff.**	**Std. Err.**	**Coeff.**	**Std. Err.**
CONSTANT	24.88 ***	7.41	15.14 **	7.45	16.23 ***	5.29
AGE	0.06	0.09	0.22 **	0.10	0.17 ***	0.07
GENDER	−9.63 ***	2.05	−12.49 ***	2.87	−11.18 ***	1.69
HIGHSCHOOL	4.93 **	2.33	2.78	3.27	4.78 **	1.97
COLLEGE	11.87 **	3.01	3.66	4.03	8.20 ***	2.67
INCOME	0.17	0.23	0.65 ***	0.10	0.54 ***	0.11
BROADCASTMEDIA	6.44 **	3.17	8.98 **	4.04	7.26 ***	2.53
KNOWLEDGE	0.14 ***	0.05	0.14 **	0.07	0.14 ***	0.04
ATTITUDE	0.17 **	0.07	0.24 ***	0.08	0.21 ***	0.05
R^2	0.31		0.47		0.40	
No. of samples	152		115		267	

*** Significant *p-value* at 0.01 level, and ** at 0.05 level.

Table 3 shows that for Model 1, the higher leptospirosis prevention practice score among agricultural workers was significantly associated with female respondents, a higher level of education, use of broadcast media as a source of health information, and with higher knowledge and attitude scores. Other variables related to age and household income were not significant predictors of leptospirosis prevention practices. For Model 2, the higher leptospirosis prevention practice score among non-agricultural workers was significantly associated with female respondents, older age, higher household income, use of broadcast media as a source of health information, and higher knowledge and attitude scores. Other variables, related to high school and college level of educational attainment, were not significant predictors of leptospirosis prevention practices.

4. Discussion

This study is the first attempt to describe the knowledge, attitude and prevention practices of leptospirosis among agricultural and non-agricultural workers living in the coastal communities of Calamba and Los Baños, Laguna, Philippines. The total mean attitude score (80.89%) of all respondents was higher than their total mean knowledge (68.50%) and practice (61.28%) scores. The results may imply that a highly positive attitude toward one's ability to control the disease is not sufficient alone to transform behavioral practices. Positive attitude should be complemented with knowledge to enhance the ability of individuals to integrate prevention measures into practice.

The study found significant difference on the leptospirosis practice score between agricultural and non-agricultural workers. Agricultural workers scored lower than non-agricultural workers

on items related to the use of protective gear and safety measures, as well as rat control measures. Previous studies cited limited funds as one reason for poor usage of personal protective equipment and poor rat control practices among farmers in the Philippines [36–39]. This could be one possible explanation, considering that the mean income of agricultural workers was lower than that of non-agricultural workers. Ensuring access to relevant personal protective equipment and pest control programs could encourage the adoption of health and safety measures within the community, and more specifically, among agricultural workers. Recent government health interventions providing protective boots during heavy flooding and implementing community-based rat control measures could be further expanded to those communities or occupations with higher risk of leptospirosis to facilitate prevention and control practices [38,40,41]. Encouraging the private sector to support these programs as part of corporate social responsibility policies would also be beneficial in managing the costs of implementation. Additionally, worker education and safety training on zoonotic disease prevention could be incorporated into the occupational health and safety program of the agricultural sector, and implemented in partnership with various farming groups or cooperatives.

The regression analysis indicated that gender, broadcast media, and knowledge and attitudes about leptospirosis were significant factors for leptospirosis prevention practices that were common to both agricultural and non-agricultural workers. Male respondents were less likely than female respondents to engage in leptospirosis prevention practices. This finding supports previous claims that leptospirosis is less prevalent in women because they engage in less risky behavior than men [42]. Being male is commonly cited as a risk factor for leptospirosis, and an excess of leptospirosis cases in men were often observed in previous studies [43,44]. Encouraging men to adopt healthy practices may help in reducing the risk of leptospirosis. The positive association between broadcast media and leptospirosis prevention practices is consistent with previous findings indicating that mass media can produce positive changes or prevent negative changes in health-related behaviors [45,46]. The finding emphasizes the importance of developing tailored media-based health promotion programs. Considering that only 6.74% of the respondents were familiar with the health information, education, and communication programs available from the local government health units, the study suggests that improving the direct engagement between local health workers and the community would be beneficial in both increasing positive health behaviors, and increasing public trust in local health authorities [47,48].

The causal associations of knowledge, attitudes, and leptospirosis prevention practices were not explored in previous KAP studies [19,26,27,30,49]. Literature on zoonotic disease prevention practices shows varying relationships between knowledge, attitude, and prevention practices. Some studies on dengue fever reported finding a non-significant relationship between knowledge about a disease and preventive practices [50,51] or attitudes about a disease and preventive practices [52]. Other studies on rabies and dengue fever indicated significant associations between knowledge and attitudes and prevention practices [53–55]. The findings from this study are consistent with the latter findings, indicating that knowledge and attitudes about a zoonotic disease are significant predictors of preventive practices. Our study findings further suggest that increasing one's knowledge and attitude towards leptospirosis may be likely to increase one's engagement in prevention practices. These findings reiterate the importance of education and behavioral health interventions to improve knowledge and attitude about leptospirosis. Nonetheless, it also important to determine how these health interventions should be delivered. This study suggests that public health officials may be able to take advantage of the highly positive attitude among respondents as a good indication of a welcoming disposition towards health intervention initiatives. It was also found that respondents scored low (below 50%) on questions related to the signs and symptoms of leptospirosis. Health education efforts should address this gap, considering that poor knowledge of the signs and symptoms of the disease has serious implications for an individual's help-seeking behaviors, thereby delaying early detection and treatment of the disease [56].

This study found that leptospirosis prevention practice scores increased significantly with increasing age and household income among non-agricultural workers. The risk of leptospirosis infection is commonly reported among younger and low-income groups [57–59]. Considering that younger and lower-income groups were less likely to engage in leptospirosis prevention practices, a more concerted effort of changing the health behavior of these groups would be beneficial in reducing the risk and potential economic burden of leptospirosis. The findings also indicated that agricultural workers who attained high school and college levels of education were more likely to engage in leptospirosis prevention practices. One possible explanation could be that individuals with higher education are in a better position to gather, process, and interpret information on healthy behaviors [60]. The risk of leptospirosis is often associated with a lower educational level [61], and hence the delivery of health information should be tailored to those agricultural workers with a low level of literacy in accessible and easy-to-understand formats.

This study has some limitations worth noting. First, the study did not cover the range of reasons for engaging or not engaging in specific prevention practices. Future studies may attempt to address this limitation using open-ended qualitative questionnaires to explore in detail the reasons for respondents' choices. Second, the study did not examine individual perceptions of leptospirosis risk. Although risk perception is an entire field of study in its own right, its influence on leptospirosis prevention practices could be examined in future research. Third, the respondents in this study were adults. While leptospirosis is more common and more severe in adults, it also known to affect children [62,63]. Future research may examine the knowledge, attitudes, and practices among children.

5. Conclusions

The present study surveyed the knowledge, attitudes, and prevention practices of leptospirosis among agricultural and non-agricultural workers living in lakeshore communities in the Philippines. Apart from prevention practices, no significant differences were found for the knowledge and attitude scores between agricultural and non-agricultural workers. While both groups of respondents had highly positive attitude scores, their knowledge and practice scores were lower compared with those in the literature. A highly positive attitude score is not sufficient alone to transform behavioral practices. Community-based health education and promotion activities are needed to increase knowledge about leptospirosis, and subsequently improve prevention practices. Potential delivery strategies could include using broadcast media to disseminate well defined, behaviorally focused disease prevention messages, and improving the capacity of local government health units to conduct health promotion activities. Although leptospirosis prevention programs should generally be designed for a broad audience, a more concerted effort is needed to target younger and low-income male non-agricultural workers, as well as less-educated male agricultural workers, who are the groups with highest risk of contracting leptospirosis, and are less likely to engage in prevention practices. Health communications tailored to agricultural workers with low literacy should be designed in easily understandable formats. The occupational health and safety entities in the agricultural sector should be strengthened by incorporating measures to prevent and control leptospirosis and other zoonotic diseases, providing health and safety and pest control training programs, and encouraging collaboration between health and agriculture policymakers, local governments, the private sector, and farmers' organizations and cooperatives.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix 1. List of questions on knowledge, attitude, practices about leptospirosis.

Knowledge Questions
Mode of transmission
Leptospirosis is caused by bacteria
Rat can transmit leptospirosis
Floodwater can transmit leptospirosis
Signs and symptoms
Infected person may have difficulty in urinating
Infected person may have jaundice
Infected person may have red eyes
Disease prevention
Avoid wading in the floods can prevent leptospirosis
Maintaining clean surrounding can prevent leptospirosis
Avoiding contact with rats can prevent leptospirosis
Wearing boots during floods can prevent leptospirosis
Attitude Questions
I believe leptospirosis is a serious illness
I believe that medicine can treat leptospirosis
I believe I can do something to prevent myself from being infected with leptospirosis
It is important to control rat population
It is important to follow health advisories during rainy season
Practices Questions
Protective gears and safety measures
I wade in the flood water
I wear waterproof boots when wading on flood water
I walk barefooted on soil
I wear rubber globes when cleaning/working in muddy water or damp soil
Rat Control Measures
I use poison or traps to eradicate rats
I store food in in sealed or rat proof containers

References

1. Bharti, A.; Nally, J.; Ricaldi, J.; Matthias, M.; Diaz, M.; Lovett, M. Leptospirosis: A zoonotic disease of global importance. *Lancet Infect. Dis.* **2003**, *3*, 757–771. [CrossRef]
2. Levett, P. Leptospirosis. *Clin. Microbiol. Rev.* **2001**, *14*, 296–326. [CrossRef] [PubMed]
3. Levett, P.N. Leptospirosis: A forgotten zoonosis? *Clin. Appl. Immunol. Rev.* **2004**, *4*, 435–448. [CrossRef]
4. Victoriano, A.; Smythe, L.; Gloriani-Barzaga, N.; Cavinta, L.; Kasai, T.; Limpakarnjanarat, K.; Ong, B.; Gongal, G.; Hall, J.; Coulombe, C.; *et al.* Leptospirosis in the asia pacific region. *BMC Infect. Dis.* **2009**, *9*, 147. [CrossRef] [PubMed]
5. Yanagihara, Y.; Villanueva, S.; Yoshida, S.; Okamoto, Y.; Masuzawa, T. Current status of leptospirosis in japan and philippines. *Comp. Immunol. Microbiol. Infect. Dis.* **2007**, *30*, 399–413. [CrossRef] [PubMed]
6. Padre, L.; Watt, G.; Tuazon, M.; Gray, M.; Laughlin, L. A serologic survey of rice field leptospirosis in central luzon, philippines. *Southeast Asian J. Trop. Med. Public Health* **1988**, *19*, 197–199. [PubMed]
7. Arambulo, P.V., 3rd; Topacio, T.M., Jr.; Famatiga, E.G.; Sarmiento, R.V.; Lopez, S. Leptospirosis among abattoir employees, dog pound workers, and fish inspectors in the city of manila. *Southeast Asian J. Trop. Med. Public Health* **1972**, *2*, 212–220.
8. Basaca-Sevilla, V.; Cross, J.; Pastrana, E. Leptospirosis in the philippines. *Southeast J. Trop. Med. Public Health* **1986**, *17*, 71–74.

9. Velasquez, C. Health Constraints to Integrated Animal-Fish Farming in the Philippines. In *Integrated Agriculture-Aquaculture Farming Systems*, Proceedings of the ICLARM-SEARCA Conference on Integrated Agriculture-Aquaculture Farming Systems, Manila, Philippines, 6–9 August 1979; Pullin, R.S.V., Shehadeh, Z.H., Eds.; International Center for Living Aquatic Resources Management and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture: Manila, Philippines, 1980; pp. 103–111.
10. PhilChest. Leptospirosis, Philippine Clinical Practice Guidelines. Available online: http://philchest.org/v3/wp-content/uploads/2013/05/Leptospirosis-CPG-2010.pdf (accessed on 2 February 2015).
11. Borja, M. Burden of Disease Study: Leptospirosis in an Urban Setting, Metro Manila. Available online: http://www.upm.edu.ph/cph/Lepcon Web/GroupB.htm (accessed on 12 May 2012).
12. Schneider, M.C.; Jancloes, M.; Buss, D.F.; Aldighieri, S.; Bertherat, E.; Najera, P.; Galan, D.I.; Durski, K.; Espinal, M.A. Leptospirosis: A silent epidemic disease. *Int. J. Environ. Res. Public Health* **2013**, *10*, 7229–7234. [CrossRef] [PubMed]
13. Kolwijck, E.; Dofferhoff, A.; van de Leur, J.; Meis, J. Leptospirosis in a dutch catfish farm. *Neth. J. Med.* **2011**, *69*, 201–204. [PubMed]
14. Dreyfus, A.; Benschop, J.; Collins-Emerson, J.; Wilson, P.; Baker, M.G.; Heuer, C. Sero-prevalence and risk factors for leptospirosis in abattoir workers in new zealand. *Int. J. Environ. Res. Public Health* **2014**, *11*, 1756–1775. [CrossRef] [PubMed]
15. McLean, M.; Ruscoe, Q.; Kline, T.; King, C.; Nesdale, A. A cluster of three cases of leptospirosis in dairy farm workers in new zealand. *N. Zeal. Med. J.* **2014**, *127*, 13–20.
16. Saitoh, H.; Koizumi, N.; Seto, J.; Ajitsu, S.; Fujii, A.; Takasaki, S.; Yamakage, S.; Aoki, S.; Nakayama, K.; Ashino, Y. Leptospirosis in the tohoku region: Re-emerging infectious disease. *Tohoku J. Exp. Med.* **2015**, *236*, 33–37. [CrossRef] [PubMed]
17. Watt, G.; Jongsakul, K.; Suttinont, C. Possible scrub typhus coinfections in thai agricultural workers hospitalized with leptospirosis. *Am. J. Trop. Med. Hyg.* **2003**, *68*, 89–91. [PubMed]
18. Sharma, S.; Vijayachari, P.; Sugunan, A.; Natarajaseenivasan, K.; Sehgal, S. Seroprevalence of leptospirosis among high-risk population of andaman islands, india. *Am. J. Trop. Med. Hyg.* **2006**, *74*, 278–283. [PubMed]
19. Wiwanitkit, V. A note from a survey of some knowledge aspects of leptospirosis among a sample of rural villagers in the highly endemic area, thailand. *Rural Remote Health* **2006**, *6*, 526. [PubMed]
20. Escalada, M.; Heong, K. Methods for research on farmers' knowledge, attitudes, and practices in pest management. In *Pest Management of Rice Farmers in Asia*; Heong, K., Escalada, M., Eds.; International Rice Research Institute: Los Banos, Philippines, 1997; pp. 1–34.
21. Askarian, M.; Danaei, M.; Vakili, V. Knowledge, attitudes, and practices regarding pandemic H1N1 influenza among medical and dental residents and fellowships in shiraz, iran. *Int. J. Prev. Med.* **2013**, *4*, 396. [PubMed]
22. Qiu, R.M.; Lo, E.C.; Zhi, Q.H.; Zhou, Y.; Tao, Y.; Lin, H.C. Factors related to children's caries: A structural equation modeling approach. *BMC Public Health* **2014**, *14*, 1071. [CrossRef] [PubMed]
23. Masuku, S.K.; Lan, S.-J.J. Nutritional knowledge, attitude, and practices among pregnant and lactating women living with hiv in the manzini region of swaziland. *J. Health Popul. Nutr.* **2014**, *32*, 261. [PubMed]
24. Bashar, K.; Al-Amin, H.; Reza, M.S.; Islam, M.; Ahmed, T.U. Socio-demographic factors influencing knowledge, attitude and practice (kap) regarding malaria in bangladesh. *BMC Public Health* **2012**, *12*, 1084. [CrossRef] [PubMed]
25. Win, T.; Rungsrihirunrat, K.; Siriwong, W. Association of environmental and socio-economic factors with dengue prevention practice related to dengue outbreak in mae la temporary shelter in tak province, thailand. *J. Health Res.* **2012**, *26*, 221–225.
26. Agampodi, S.B.; Agampodi, T.C.; 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*, 158–163. [PubMed]
27. Quina, C.R.; Almazan, J.U.; Tagarino, J.B. Knowledge, attitudes, and practices of leptospirosis in catbalogan city, samar, philippines. *Am. J. Public Health Res.* **2014**, *2*, 91–98. [CrossRef]
28. Reis, R.B.; Ribeiro, G.S.; Felzemburgh, R.D.M.; Santana, F.S.; Mohr, S.; Melendez, A.X.T.O.; Queiroz, A.; Santos, A.C.; Ravines, R.R.; Tassinari, W.S.; *et al.* Impact of environment and social gradient on *leptospiral* infection in urban slums. *PLoS Negl. Trop. Dis.* **2008**, *2*, e228. [CrossRef] [PubMed]

29. de Araújo, W.N.; Finkmoore, B.; Ribeiro, G.S.; Reis, R.B.; Felzemburgh, R.D.; Hagan, J.E.; Reis, M.G.; Ko, A.I.; Costa, F. Knowledge, attitudes, and practices related to leptospirosis among urban slum residents in brazil. *Am. J. Trop. Med. Hyg.* **2013**, *88*, 359–363. [CrossRef] [PubMed]
30. Mohd Rahim, S.; Aziah, B.; Mohd Nazri, S.; Azwany, Y.; Habsah, H.; Zahiruddin, W.; Zaliha, I.; Mohamed Rusli, A. Town service workers' knowledge, attitude and practice toward leptospirosis. *Brunei Darussalam J. Health* **2012**, *5*, 1–12.
31. StataCorp. *Stata Statistical Software: Release 13*; StataCorp LP.: College Station, TX, USA, 2013.
32. DOH-NEC. The 2010 Philippine Health Statistics. Available online: http://www.doh.gov.ph/sites/default/files/PHS2010_March13.pdf (accessed on 14 July 2015).
33. Balota, J.; Santos-Remo, A. Assessing Current and Future Groundwater Supply vis-a-vis Water Demand of Households in Los Banos, Laguna. Available online: https://www.academia.edu/12043708/Assessing_current_and_future_groundwater_supply_vis-a-vis_water_demand_of_households_in_Los_Banos_Laguna (accessed on 4 February 2015).
34. Calamba-ICT. Barangay Profile- City Goverment of Calamba. Available online: http://www.calambacity.gov.ph/index.php (accessed on 4 February 2015).
35. PSA. Quickstat Laguna. Available online: https://psa.gov.ph/ (accessed on 10 January 2016).
36. Lu, J.L. Total pesticide exposure calculation among vegetable farmers in benguet, philippines. *J. Environ. Public Health* **2009**, *2009*, 1–5. [CrossRef] [PubMed]
37. Lu, J.L.; Cosca, K.Z.; Del mundo, J. Trends of pesticide exposure and related cases in the philippines. *J. Rural Med. JRM* **2010**, *5*, 153–164. [CrossRef] [PubMed]
38. Flor, R.J.; Singleton, G. Analysis of communication pathways and impacts of the boo! Boo! Rat! Campaign. In *Rodent Outbreak: Ecology and Impacts*; Singleton, G., Belmain, S., Brown, P., Hardy, B., Eds.; International Rice Research Institute: Los Banos, Philippines, 2013; pp. 191–204.
39. Stuart, A.M.; Prescott, C.V.; Singleton, G.R.; Joshi, R.C. Knowledge, attitudes and practices of farmers on rodent pests and their management in the lowlands of the sierra madre biodiversity corridor, philippines. *Crop Prot.* **2011**, *30*, 147–154. [CrossRef]
40. PhilippineStar. Ratattack Goes to Davao City Barangay. Available online: http://www.philstar.com/science-and-technology/2012/10/11/858162/ratattack-goes-davao-city-barangay (accessed on 2 July 2015).
41. DOH-NCR. Doh- ncr Distributes Medicines to Evacuation Centers for Prevention of Leptospirosis. Available online: http://www.doh.gov.ph/content/doh-ncr-distributes-medicines-evacuation-centers-prevention-leptospirosis.html (accessed on 5 July 2015).
42. Cacciapuoti, B.; Ciceroni, L.; Pinto, A.; Apollini, M.; Rondinella, V.; Bonomi, U.; Benedetti, E.; Cinco, M.; Dessì, S.; Dettori, G.; *et al.* Survey on the prevalence of leptospira infections in the italian population. *Eur. J. Epidemiol.* **1994**, *10*, 173–180. [CrossRef] [PubMed]
43. Al-shere, T.A.; Ujiie, M.; Suzuki, M.; Salva, E.; Belo, M.C.P.; Koizumi, N.; Yoshimatsu, K.; Schmidt, W.-P.; Marte, S.; Dimaano, E.M. Outbreak of leptospirosis after flood, the philippines, 2009. *Emerg. Infect. Dis.* **2012**, *18*, 91.
44. Arbiol, J.; Yabe, M.; Nomura, H.; Borja, M.; Gloriani, N.; Yoshida, S.-I. Using discrete choice modeling to evaluate the preferences and willingness to pay for leptospirosis vaccine. *Hum. Vaccines Immunother.* **2015**, *11*, 1046–1056. [CrossRef] [PubMed]
45. Wakefield, M.A.; Loken, B.; Hornik, R.C. Use of mass media campaigns to change health behaviour. *Lancet* **2010**, *376*, 1261–1271. [CrossRef]
46. Flynn, B.S.; Worden, J.K.; Secker-Walker, R.H.; Badger, G.J.; Geller, B.M.; Costanza, M.C. Prevention of cigarette smoking through mass media intervention and school programs. *Am. J. Public Health* **1992**, *82*, 827–834. [CrossRef] [PubMed]
47. Tindana, P.O.; Singh, J.A.; Tracy, C.S.; Upshur, R.E.; Daar, A.S.; Singer, P.A.; Frohlich, J.; Lavery, J.V. Grand challenges in global health: Community engagement in research in developing countries. *PLoS Med.* **2007**, *4*, e273. [CrossRef] [PubMed]
48. Michener, J.L.; Yaggy, S.; Lyn, M.; Warburton, S.; Champagne, M.; Black, M.; Cuffe, M.; Califf, R.; Gilliss, C.; Williams, R.S. Improving the health of the community: Duke's experience with community engagement. *Acad. Med.* **2008**, *83*, 408–413. [CrossRef] [PubMed]

49. Sakinah, S.; Suhailah, S.; Jamaluddin, T.; Norbaya, S.; Malina, O. Seroprevalence of leptospiral antibodies and knowledge, attitude, and practices of leptospirosis to non-high risk group in selangor. *Int. J. Public Health Clin. Sci.* **2015**, *2*, 92–104.
50. Shuaib, F.; Todd, D.; Campbell-Stennett, D.; Ehiri, J.; Jolly, P.E. Knowledge, attitudes and practices regarding dengue infection in westmoreland, jamaica. *West Indian Med. J.* **2010**, *59*, 139. [PubMed]
51. Yboa, B.C.; Labrague, L.J. Dengue knowledge and preventive practices among rural residents in samar province, philippines. *Am. J. Public Health Res.* **2013**, *1*, 47–52. [CrossRef]
52. Abedi, A.; Khan, Z.; Ansari, A.; Amir, A. Sp5-23 is knowledge and attitude correlating with practices? A kap study on dengue fever. *J. Epidemiol. Community Health* **2011**, *65*, A451–A451. [CrossRef]
53. Ali, A.; Ahmed, E.Y.; Sifer, D. A study on knowledge, attitude and practice of rabies among residents in addis ababa, ethiopia. *Ethiop. Vet. J.* **2014**, *17*, 19–35. [CrossRef]
54. Dhimal, M.; Aryal, K.K.; Dhimal, M.L.; Gautam, I.; Singh, S.P.; Bhusal, C.L.; Kuch, U. Knowledge, attitude and practice regarding dengue fever among the healthy population of highland and lowland communities in central nepal. *PLoS ONE* **2014**, *9*, e102028. [CrossRef] [PubMed]
55. Sambo, M.; Lembo, T.; Cleaveland, S.; Ferguson, H.M.; Sikana, L.; Simon, C.; Urassa, H.; Hampson, K. Knowledge, attitudes and practices (kap) about rabies prevention and control: A community survey in tanzania. *PLoS Negl. Trop. Dis.* **2014**, *8*, e3310. [CrossRef] [PubMed]
56. Werner, P. Knowledge about symptoms of alzheimer's disease: Correlates and relationship to help-seeking behavior. *Int. J. Geriatr. Psychiatry* **2003**, *18*, 1029–1036. [CrossRef] [PubMed]
57. Felzemburgh, R.D.; Ribeiro, G.S.; Costa, F.; Reis, R.B.; Hagan, J.E.; Melendez, A.X.; Fraga, D.; Santana, F.S.; Mohr, S.; dos Santos, B.L. Prospective study of leptospirosis transmission in an urban slum community: Role of poor environment in repeated exposures to the leptospira agent. *PLoS Negl. Trop. Dis.* **2014**, *8*, e2927. [CrossRef] [PubMed]
58. Yabe, M.; Nomura, H.; Arbiol, J.; Quijano, Z.; Borja, M.; Gloriani, N.; Yoshida, S.-I. *Socioeconomic Study on the Burden of Leptospirosis*; Kyushu University Press: Fukuoka, Japan, 2014.
59. Brown, P.; McKenzie, M.; Pinnock, M.; McGrowder, D. Environmental risk factors associated with leptospirosis among butchers and their associates in jamaica. *Int. J. Occup. Environ. Med.* **2010**, *2*, 47–57.
60. Groot, W.; van den Brink, H.M. What does education do to our health? Measuring the effects of education on health and civic engagement. In Proceedings of the Copenhagen Symposium, Amsterdam, The Netherlands, 1 Janaury 2006; Desjardins, R., Schuller, T., Eds.; OECD: Amsterdam, The Netherlands, 2006; pp. 355–361.
61. Dias, J.P.; Teixeira, M.G.; Costa, M.C.N.; Mendes, C.M.C.; Guimarães, P.; Reis, M.G.; Ko, A.; Barreto, M.L. Factors associated with leptospira sp infection in a large urban center in northeastern brazil. *Rev. Soc. Bras. Med. Trop.* **2007**, *40*, 499–504. [CrossRef] [PubMed]
62. Zaki, S.; Shanbag, P. Clinical manifestations of dengue and leptospirosis in children in mumbai: An'observational study. *Infection* **2010**, *38*, 285–291. [CrossRef] [PubMed]
63. Vijayachari, P.; Sugunan, A.; Murhekar, M.; Sharma, S.; Sehgal, S. 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*, 1115–1120. [PubMed]