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Household Environmental Conditions Associated with Leptospirosis in the Tilango Community Health Center Area, Gorontalo, Indonesia

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ABSTRACT

Leptospirosis is a zoonotic disease caused by pathogenic *Leptospira* species. Household environmental conditions may contribute to transmission, making them relevant to prevention in communities at elevated risk. This study examined the associations of household sanitation, waste management, standing water, and drainage with laboratory-confirmed leptospirosis in the catchment area of Tilango Community Health Center, Gorontalo Regency, Indonesia. This analytical cross-sectional study was conducted from July to September 2025. Purposive sampling was used to recruit 88 respondents from villages considered at high risk for leptospirosis. Data were collected through structured interviews, direct observation of household environmental conditions, and laboratory confirmation of cases. Descriptive statistics summarised the study variables, and chi-square tests assessed bivariate associations. Odds ratios (ORs) and 95% confidence intervals (CIs) quantified the associations. Statistical significance was set at $p < 0.05$. Among 88 respondents, 21 (23.86%) had laboratory-confirmed leptospirosis. Higher odds of leptospirosis were observed among respondents with poor household sanitation (OR 3.11, 95% CI 1.13–8.58, $p = 0.025$), poor waste management (OR 4.78, 95% CI 1.69–13.50, $p = 0.002$), standing water (OR 6.93, 95% CI 2.37–20.29, $p < 0.001$), and poor drainage (OR 9.17, 95% CI 3.05–27.58, $p < 0.001$). Poor drainage had the largest estimated association among the four conditions examined. The cross-sectional design limits causal inference, and purposive sampling limits generalisability beyond the study population. The bivariate estimates may reflect uncontrolled confounding. The findings identify household sanitation, waste management,

standing water, and drainage as priorities for local environmental assessment and leptospirosis prevention.

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Keywords
Environmental Sanitation
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Waste Management

Introduction

Leptospirosis is a zoonotic disease caused by pathogenic Leptospira spp. and remains an important public health problem, particularly in tropical and subtropical regions. Human infection can occur through direct or indirect contact with water or soil contaminated with urine from infected animals [1]-[3]. Environmental conditions may facilitate transmission by increasing opportunities for human exposure to contaminated environmental media. Persistent moisture, standing water, inadequate household sanitation, improper waste management, and poorly functioning drainage systems may contribute to environmental conditions favorable for exposure to pathogenic Leptospira [4], [5]. Because several of these conditions are potentially modifiable, identifying their associations with leptospirosis is important for developing locally appropriate environmental health interventions.

In Indonesia, leptospirosis continues to require attention from public health authorities, particularly in areas affected by flooding and inadequate environmental infrastructure. The re-emergence of reported leptospirosis in Gorontalo Province in 2024, following no reported cases in 2022 and 2023, highlights the importance of strengthening local surveillance and prevention efforts [6], [7]. According to the Gorontalo Provincial Health Office, 61 leptospirosis cases and five deaths were reported in 2024. From January to July 2025, a further 11 cases and one death were reported [7]. These reports demonstrate the public health significance of leptospirosis in the province and underscore the need for preventive strategies that extend beyond clinical case management. In particular, household environmental conditions warrant attention because sanitation, waste disposal, standing-water control, and drainage maintenance can be addressed through coordinated household and community-level interventions [8], [9].

Previous studies have examined environmental and behavioral factors associated with leptospirosis, including sanitation, flooding, waste management, and contact with potentially contaminated environmental media [5], [10]. Nevertheless, the relative importance and distribution of specific household environmental conditions may differ across settings because of variations in settlement characteristics, infrastructure, local environmental management,

and patterns of human exposure. In the Tilango Community Health Center service area, locally specific evidence is needed to characterize the associations between environmental sanitation, household waste management, standing water, drainage conditions, and laboratory-confirmed leptospirosis. Evidence from other geographical settings cannot automatically be assumed to represent the environmental and epidemiological circumstances of this population [8].

The contribution of the present study is its simultaneous examination of four potentially modifiable household environmental conditions in relation to laboratory-confirmed leptospirosis within a local primary healthcare service area in Gorontalo, Indonesia. By examining these conditions within the same study population, this research provides context-specific evidence that may help inform the prioritization of household and community environmental health interventions. Rather than establishing a causal relationship, the study evaluates the statistical associations between the selected environmental conditions and leptospirosis occurrence. This distinction is important for interpreting the findings within the limitations of an analytical cross-sectional design.

Accordingly, this study aimed to analyze the associations between household environmental sanitation, waste management, the presence of standing water, drainage conditions, and laboratory-confirmed leptospirosis among respondents in the Tilango Community Health Center service area, Gorontalo Regency, Indonesia. The findings are intended to support locally targeted environmental health planning and provide a basis for future studies incorporating longitudinal observations, quantitative environmental measurements, and additional epidemiological risk factors.

Material and Methods

A. Study Design and Setting

This study employed an analytical cross-sectional design and was conducted from July to September 2025 in the service area of Tilango Community Health Center, Gorontalo Regency, Gorontalo Province, Indonesia. The study examined the associations between household environmental conditions and laboratory-confirmed leptospirosis.

B. Study Population and Sampling

The study included 88 respondents selected using purposive sampling from households located in villages considered to be at high risk for leptospirosis within the Tilango Community Health Center service area. The selection of respondents was based on the study criteria and the epidemiological context of the study area.

C. Data Collection and Study Variables

Primary data were collected through structured questionnaire interviews and direct observation of household environmental conditions. The environmental exposure variables analyzed in this study were environmental sanitation, household waste management, standing

water, and drainage condition. Leptospirosis occurrence was assessed as the outcome variable. Environmental conditions were assessed at the household level based on information obtained through interviews and direct observation.

D. Data Analysis

Data were analyzed using univariate and bivariate analyses. Univariate analysis was performed to describe the distribution of leptospirosis occurrence and the household environmental variables using frequencies and percentages. Bivariate analysis was conducted to examine the association between each environmental exposure and leptospirosis occurrence using the Chi-square test. Statistical significance was determined at a p-value of <0.05. The results were interpreted as associations because of the cross-sectional study design and purposive sampling approach, and no causal inference was made.

E. Ethical Approval

Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Public Health, Hasanuddin University, Makassar, Indonesia (Approval No. 1323/UN4.14.1/TP.01.02/2025), dated July 22, 2025. The study protocol was reviewed under the expedited review procedure and was approved for implementation in the Tilango Community Health Center service area.

Results and Discussions

Among the 88 respondents, 21 (23.86%) reported leptospirosis, while 67 (76.14%) did not. As presented in Table 1, good environmental sanitation was observed in 52 households (59.10%), whereas 36 (40.90%) had poor sanitation. Good waste management was reported in 58 households (65.91%), while 30 (34.09%) had poor waste management. Standing water was absent in 59 households (67.05%) and present in 29 (32.95%). Good drainage conditions were observed in 62 households (70.45%), while 26 (29.55%) had poor drainage conditions.

Table 1. Distribution of leptospirosis and household environmental conditions (n=88)

Variable	Category	n	%
Leptospirosis	Yes	21	23.86
	No	67	76.14
Environmental sanitation	Good	52	59.10
	Poor	36	40.90
Waste management	Good	58	65.91
	Poor	30	34.09
Standing water	Absent	59	67.05
	Present	29	32.95
Drainage condition	Good	62	70.45
	Poor	26	29.55

Table 2. Association between household environmental conditions and leptospirosis in the Tilango Community Health Center area

Environmental condition	Leptospirosis Yes, n (%)	Leptospirosis No, n (%)	OR	95% CI	χ^2	p-value
Environmental sanitation						
Good	8 (38.10)	44 (65.67)	1.00	Reference	5.030	**0.025**
Poor	13 (61.90)	23 (34.33)	**3.11**	1.13–8.58		
Waste management						
Good	8 (38.10)	50 (74.63)	1.00	Reference	9.497	**0.002**
Poor	13 (61.90)	17 (25.37)	**4.78**	1.69–13.50		
Standing water						
Absent	7 (33.33)	52 (77.61)	1.00	Reference	14.188	**<0.001**
Present	14 (66.67)	15 (22.39)	**6.93**	2.37–20.29		
Drainage condition						
Good	7 (33.33)	55 (82.09)	1.00	Reference	18.259	**<0.001**
Poor	14 (66.67)	12 (17.91)	**9.17**	3.05–27.58		

Note: OR, odds ratio; CI, confidence interval

All four household environmental conditions were significantly associated with leptospirosis in the bivariate analysis (Table 2). Poor environmental sanitation was associated with higher odds of leptospirosis compared with good sanitation (OR=3.11, 95% CI: 1.13–8.58; p=0.025). Poor waste management was also associated with increased odds of leptospirosis (OR=4.78, 95% CI: 1.69–13.50; p=0.002). The presence of standing water was associated with approximately seven-fold higher odds of leptospirosis (OR=6.93, 95% CI: 2.37–20.29; p<0.001). Poor drainage showed the strongest association, with approximately nine-fold higher odds of leptospirosis compared with good drainage (OR=9.17, 95% CI: 3.05–27.58; p<0.001).

Among the 21 leptospirosis cases, 13 (61.90%) occurred among respondents living in households with poor environmental sanitation, 13 (61.90%) among those with poor waste management, 14 (66.67%) among those exposed to standing water, and 14 (66.67%) among those living in households with poor drainage.

Discussion

This study identified statistically significant associations between four household environmental conditions environmental sanitation, household waste management, the presence of standing water, and drainage conditions and laboratory-confirmed leptospirosis in the Tilango Community Health Center area. Among the four variables examined, poor drainage had the largest observed odds ratio, followed by the presence of standing water, poor household waste management, and poor environmental sanitation. These findings indicate that unfavorable household environmental conditions were associated with leptospirosis in the study population. However, because the study employed a cross-sectional design, the results do not establish temporal relationships or demonstrate that these conditions caused the disease [11], [12].

Poor environmental sanitation was associated with higher odds of leptospirosis than good sanitation (OR = 3.11; 95% CI: 1.13–8.58; p = 0.025). Among the 21 laboratory-confirmed cases, 13 (61.90%) were identified among respondents living in households classified as having poor sanitation. This association suggests that household sanitation conditions may be relevant indicators for identifying environments in which exposure to pathogenic Leptospira could occur. Nevertheless, the study did not directly measure environmental contamination or establish the specific pathways through which exposure occurred. The observed association should therefore be interpreted as evidence of a relationship between sanitation classification and leptospirosis status in the sampled population. Previous research has also identified environmental sanitation as a relevant factor in leptospirosis epidemiology [13], [14].

Poor household waste management was associated with higher odds of leptospirosis (OR = 4.78; 95% CI: 1.69–13.50; p = 0.002). Of the 21 cases, 13 (61.90%) occurred among respondents whose households had poor waste management. This finding highlights the potential relevance of household waste management as an environmental health indicator in the study area. Improper waste storage and disposal may be associated with environmental conditions that favor rodent activity; however, rodent abundance and contamination of household environments were not directly quantified in this study. Consequently, the proposed relationship between waste management and rodent-related exposure remains a plausible explanation rather than a mechanism demonstrated by the present data. The finding is broadly consistent with previous literature emphasizing the relevance of environmental and behavioral conditions to leptospirosis transmission [3]-[5].

The presence of standing water was associated with substantially higher odds of leptospirosis compared with its absence (OR = 6.93; 95% CI: 2.37–20.29; p < 0.001). Standing water was observed in 29 households (32.95%), and 14 of the 21 laboratory-confirmed cases (66.67%) occurred among respondents whose households had standing water. The magnitude of this association suggests that standing water may be a useful household-level environmental indicator for local leptospirosis prevention activities. Water accumulation could provide opportunities for human contact with contaminated environmental media, particularly when contamination by infected animals is present. However, because the study did not test standing water for pathogenic Leptospira, it cannot establish that the observed water was contaminated or that contact with it preceded infection. The finding should therefore be understood as an association between the observed presence of standing water and leptospirosis status. Previous studies have likewise highlighted the relevance of flooding and water-related environmental exposure in leptospirosis epidemiology [14], [15].

Poor drainage demonstrated the largest observed odds ratio among the four environmental variables (OR = 9.17; 95% CI: 3.05–27.58; p < 0.001). Fourteen of the 21 cases

(66.67%) occurred among respondents living in households with poor drainage. This result identifies drainage condition as an important environmental indicator in the study population. Poor drainage and standing water may represent related aspects of the same residential environment because inadequate water flow can coincide with water accumulation and persistent soil moisture. Nevertheless, the present analysis assessed these variables separately and did not determine whether their associations were independent of one another. The larger observed odds ratio for drainage should also be interpreted cautiously because its confidence interval is relatively wide and overlaps with the confidence interval for standing water. Therefore, the results do not establish that drainage is statistically more strongly associated with leptospirosis than standing water. Instead, both indicators warrant consideration in local environmental health assessment. The findings are consistent with broader evidence concerning environmental conditions and opportunities for leptospiral exposure [16], [17].

Taken together, the findings show that all four household environmental indicators were associated with laboratory-confirmed leptospirosis in the bivariate analyses. Their co-occurrence may reflect shared residential conditions. Previous studies have linked inadequate sanitation, accumulated refuse, and exposure to standing water or poorly drained areas with leptospirosis, although the relative importance of these conditions varies across settings [18], [19], [20]. In Tilango, these conditions may coexist within the same household or neighbourhood. Because the analyses did not adjust for confounding or account for correlations among the indicators, the independent association of each condition with leptospirosis remains uncertain. Larger studies should prespecify potential confounders and use multivariable methods to examine these relationships [21], [22].

From a public health perspective, household sanitation, waste management, standing-water control, and drainage maintenance are reasonable priorities for environmental assessment in the Tilango Community Health Center catchment area. Attention to these conditions could complement surveillance, community education, and coordinated prevention efforts described in Indonesian and international guidance [23], [24]. The observed associations can help guide local assessments. The effectiveness of specific interventions in reducing leptospirosis incidence remains to be evaluated.

Several limitations should guide interpretation. First, the cross-sectional design leaves uncertain whether the observed household conditions preceded illness onset [21]. Second, purposive recruitment from villages considered at high risk limits the applicability of the findings to other populations and settings [22]. Third, although cases were laboratory-confirmed, interpretation of the case and non-case groups depends on the tests, specimen timing, and documentation used to classify respondents [24], [25]. Fourth, interviews and household observations characterised environmental conditions. The presence of pathogenic

Leptospira in local water or soil was unverified because environmental samples were not tested [26]. Finally, the bivariate estimates may reflect confounding by behaviours, occupational exposures, rainfall or flooding, and rodent exposure, all of which have been identified as relevant in prior research [18], [27]. The reported odds ratios therefore quantify unadjusted associations.

The study provides local evidence that can inform which household conditions to investigate in Tilango. Future longitudinal studies could assess these conditions before illness onset, record relevant exposures at the household and neighbourhood levels, and account for them in multivariable models. Quantitative environmental assessment and rodent surveillance could also help investigate possible transmission pathways [23], [26], [28].

Conclusion

Environmental sanitation, household waste management, standing water, and drainage conditions were significantly associated with leptospirosis among respondents in the Tilango Community Health Center area. The findings highlight the importance of household environmental management as an integral component of local leptospirosis prevention. Strengthening sanitation practices, improving household waste management, eliminating standing water, and maintaining functional drainage systems should be prioritized as practical environmental health interventions. Future research should incorporate quantitative environmental measurements, climatic and behavioral factors, and rodent-related indicators to provide a more comprehensive understanding of leptospirosis transmission pathways.

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Conflict of Interest

The authors declare no conflict of interest.

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