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Association between Household Waste Management on the Presence of Disease Vectors in Residential Environments

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ABSTRACT

Improper household waste management is a major risk factor for the presence of disease vectors in residential environments. This study aimed to analyze the association between household waste management and the presence of disease vectors in residential areas in Medan Marelan Subdistrict, Medan City, Indonesia. This research employed a quantitative analytic design with a cross-sectional approach. A total of 120 households were selected using simple random sampling. Data were collected through structured interviews and environmental observations. Data analysis was conducted using univariate and bivariate methods, including the Chi-square test with a 95% confidence level and Odds Ratio (OR) analysis. The results showed that the majority of respondents had poor waste management practices (61.7%), and disease vectors were present in 65.0% of households. Statistical analysis indicated a significant association between household waste management and the presence of disease vectors (p = 0.001), with an OR value of 6.67 (95% CI: 2.85–15.62). This finding suggests that households with poor waste management were 6.67 times more likely to have disease vectors compared to those with proper waste management. It can be concluded that household waste management has a significant association with the presence of disease vectors in residential environments. Therefore, strengthening community education regarding waste management, improving sanitation facilities, and increasing collaboration between health workers and local communities are important to support environmental sanitation and reduce vector-related health risks.

Keywords: *Waste Management, Disease Vectors, Residential Environment, Sanitation, Environmental Health*

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INTRODUCTION

The management of household waste is a key aspect of maintaining environmental quality and public health, particularly in densely populated residential areas. Waste that is not managed properly can become a breeding ground for various disease vectors such as flies, mosquitoes and rats, which have the potential to transmit environment-borne diseases (Ministry of Health of the Republic of Indonesia, 2017; World Health Organization, 2021). This situation is a serious concern in developing countries, including Indonesia, where waste management systems still face various structural challenges and issues related to public behaviour. Globally, a report by the World Health Organization states that poor sanitation, including inadequate domestic waste management, contributes significantly to an increased risk of diseases such as diarrhoea, dengue fever and leptospirosis (World Health Organization, 2021). Furthermore, global studies indicate that unhealthy environmental factors remain a significant contributor to the global disease burden, particularly those related to sanitation and waste management (Prüss-Ustün et al., 2019).

In Indonesia, waste management issues are regulated under Law No. 18 of 2008 on Waste Management, which emphasises the importance of waste reduction and management in a systematic, comprehensive, and sustainable manner. Furthermore, the Community-Led Total Sanitation (CLTS) approach, as set out in Minister of Health Regulation No. 3 of 2014 on CLTS, emphasises that household waste management is a key pillar in efforts to create a healthy environment. Nevertheless, the implementation of these policies at the community level continues to face various challenges, such as low public awareness, limited infrastructure, and a lack of oversight. According to the Indonesian Ministry of Environment and Forestry, Indonesia generated approximately 68.5 million tons of waste in 2023, with household waste contributing the largest proportion. In Medan City, waste management remains a significant environmental issue due to increasing population density, limited waste collection facilities, and low community participation in waste segregation practices. Field observations in several residential areas indicated that unmanaged household waste was frequently found in open containers, drainage channels, and vacant land, potentially increasing the risk of disease vector breeding.

Household waste that piles up and is not properly managed can become an ideal breeding ground for disease vectors. Organic waste such as food scraps decomposes rapidly, making it a breeding ground for flies, whilst inorganic waste such as plastic and used cans can collect rainwater, which serves as a breeding site for mosquitoes (Fathi et al., 2018; Gubler, 2011). Furthermore, unmanaged waste can also attract rats, which act as reservoirs of diseases dangerous to humans (Centers for Disease Control and Prevention, 2020). Several studies indicate a significant association between waste management and the presence of disease vectors. Recent studies indicate that households with poor waste management face a higher risk of increased vector density compared to those with good waste management (Hasyim et al., 2018; Ferronato & Torretta, 2019). This highlights that waste management is a key factor in controlling disease vectors within residential environments.

Furthermore, population growth and rapid urbanisation are exacerbating waste management issues in residential areas. Population growth that is not matched by an adequate waste management system will significantly increase the volume of household waste, thereby potentially creating an unhealthy environment (United Nations Environment Programme, 2021). The World Health Organization also emphasises that residential areas with suboptimal waste management face a higher risk of environmental health issues (World Health Organization, 2021).

From an environmental health perspective, waste management is an integral part of efforts to prevent environment-based diseases. Poorly managed waste can become a critical point in the disease transmission chain as it increases interaction between humans, the environment, and disease agents

(Prüss-Ustün et al., 2019). Therefore, good waste management can serve as a primary prevention measure in controlling vector-borne diseases. Furthermore, an environment-based vector control approach is considered more effective and sustainable than a purely chemical approach. The World Health Organization, through its Integrated Vector Management (IVM) strategy, emphasises the importance of environmental management as a key component of disease vector control (World Health Organization, 2020). This approach also emphasises community involvement in maintaining environmental hygiene as part of promotive and preventive efforts.

On the other hand, challenges in waste management are not only related to technical aspects but also to social and behavioural aspects of the community. Low public awareness, limited waste management facilities, and the habit of littering remain dominant factors affecting the quality of the residential environment (Ferronato & Torretta, 2019; United Nations Environment Programme, 2021). Climate change also influences the dynamics of disease vector populations. Changes in temperature and rainfall patterns can accelerate the life cycle of vectors and expand their range of distribution, thereby increasing the risk of vector-borne diseases in residential environments (Intergovernmental Panel on Climate Change, 2022). This situation can be exacerbated by poor waste management, which provides an optimal habitat for vectors to breed.

Taking these various factors into account, this study is highly relevant to supporting the achievement of the Sustainable Development Goals (SDGs), particularly Goal 3 (Good Health and Well-being) and Goal 6 (Clean Water and Sanitation) (United Nations, 2020). Although various studies have examined the relationship between environmental sanitation and vector-borne diseases, studies specifically linking household waste management to the presence of disease vectors at the micro-level (households) remain limited. Therefore, this study is important for providing an empirical understanding of this relationship, as well as serving as a basis for formulating more effective environmental health policies and interventions.

Although several studies have examined the relationship between environmental sanitation and vector-borne diseases, most previous studies focused broadly on sanitation conditions or specific vector-borne diseases without specifically assessing household-level waste management practices and direct observation of vector presence simultaneously. Furthermore, studies investigating this issue in densely populated residential areas in Medan remain limited. This study differs from previous studies because it specifically analyzes household waste management behavior and directly observes the presence of disease vectors at the household level using environmental observation methods. The study also focuses on residential areas in Medan, Indonesia, where household waste management problems remain common in urban settlements. Against this background, this study aims to analyse the impact of household waste management on the presence of disease vectors in residential environments. The findings are expected to contribute to the development of environment-based vector control strategies and the sustainable improvement of community sanitation standards.

METHODS

This study employed an analytical quantitative design with a cross-sectional approach, in which the independent variable, household waste management, and the dependent variable, the presence of disease vectors, were measured simultaneously at a single point in time. This design was selected because it is effective for identifying associations between environmental risk factors and health-related outcomes in community settings (Wang & Cheng, 2020). However, because the measurements were conducted simultaneously, this study cannot establish a causal relationship between poor household waste management and the presence of disease vectors. Therefore, the Odds Ratio (OR) obtained in this

study should be interpreted as a measure of association rather than causation, and stronger study designs such as longitudinal studies are recommended for future research to better determine temporal relationships between variables.

This design was selected because it is considered effective for analyzing the relationship between environmental risk factors and the occurrence or presence of disease vectors in the community (Wang & Cheng, 2020). The study was conducted in several densely populated residential areas in Medan Marelan Subdistrict Medan City, North Sumatra, Indonesia, from January to March 2026. The population in this study consisted of all households within the residential area of the research site. The sample was a subset of the population selected using a simple random sampling technique, ensuring that each household had an equal probability of being chosen as a respondent The sample size was determined using the Lemeshow formula for cross-sectional studies, which is widely applied in modern epidemiological research (Charan & Biswas, 2019), resulting in a total of 120 households considered representative of the population.

The variables in this study consisted of independent and dependent variables. The independent variable was household waste management, categorized as good or poor, with indicators including waste segregation, storage practices, disposal frequency, and waste processing methods such as burning, improper disposal, or proper management. The assessment of this variable referred to the standards outlined in the Regulation of the Minister of Health No. 3 of 2014 concerning Community-Based Total Sanitation (STBM). The dependent variable was the presence of disease vectors, including flies, mosquitoes, and rats, categorized as present or absent, and measured through direct observation using an environmental checklist.

The questionnaire and observation checklist were adapted from previously validated and reliable instruments that had been widely used in similar environmental health studies. The instruments were further reviewed and contextually adjusted based on relevant literature related to household waste management and environmental sanitation without altering the core constructs of the original instruments. Data collection was carried out through direct interviews with respondents using the questionnaire, as well as environmental observations to evaluate waste management practices and the presence of disease vectors.

Data analysis was conducted in stages, including univariate and bivariate analyses. Univariate analysis was used to describe the frequency distribution of each research variable. Furthermore, bivariate analysis was performed to determine the relationship between household waste management and the presence of disease vectors using the Chi-square (χ^2) test with a 95% confidence level ($\alpha = 0.05$) (McHugh, 2019).

$$\chi^2 = \sum \frac{(O-E)^2}{E} \qquad (1)$$

In addition, to determine the magnitude of the risk of poor waste management on the presence of disease vectors, the Odds Ratio (OR) analysis was conducted as a measure of association in epidemiological studies (Szumilas, 2019).

$$OR = \frac{a \times d}{b \times c} \qquad (2)$$

The Odds Ratio value was interpreted as a risk factor if greater than one, no association if equal to one, and a protective factor if less than one. This study also considered research ethics, including obtaining informed consent from respondents, maintaining the confidentiality of respondent data, and ensuring that the study did not cause any harm to the participants.

RESULTS

The study findings are presented in the form of univariate and bivariate analyses. Univariate analysis was conducted to describe the distribution of research variables and respondent characteristics, while bivariate analysis was used to assess the association between household waste management and the presence of disease vectors.

Characteristics of Respondents

Table 1. Characteristics of Respondents

Characteristics	Frequency (n)	Percentage (%)
Age		
≤40 years	52	43.3
>40 years	68	56.7
Gender		
Male	49	40.8
Female	71	59.2
Education Level		
Elementary School (SD)	24	20.0
Junior High School (SMP)	28	23.3
Senior High School (SMA)	35	29.2
Diploma	14	11.7
Bachelor's Degree (S1)	16	13.3
Master's Degree (S2)	3	2.5
Household Members		
>4 members	65	54.2
≤4 members	55	45.8
Total	**120**	**100**

1. Univariate Analysis

a. Household Waste Management

Table 2 presents the distribution of household waste management practices among respondents in the study area.

Table 2. Distribution of Household Waste Management

Waste Management	Frequency (n)	Percentage (%)
Good	46	38.3
Poor	74	61.7
Total	**120**	**100**

Based on Table 1, the majority of respondents had poor household waste management, accounting for 74 households (61.7%).

b. Disease Vector Presence

Table 3 presents the distribution of disease vector presence in the residential environments of the respondents.

Table 3. Distribution of Disease Vector Presence

Vector Presence	Frequency (n)	Percentage (%)
Present	78	65.0
Absent	42	35.0
Total	**120**	**100**

Table 2 shows that the majority of households had the presence of disease vectors, with 78 households (65.0%).

2. Bivariate Analysis

Table 4 shows the association between household waste management and the presence of disease vectors in residential environments.

Table 4. Association Between Household Waste Management and the Presence of Disease Vectors

Waste Management	Vector Present (n)	Vector Absent (n)	Total	p-value	OR (95% CI)
Poor	60	14	74	**0.001**	**6.67 (2.85–15.62)**
Good	18	28	46		
Total	**78**	**42**	**120**		

Based on Table 3, it was found that of the 74 households with poor waste management, disease vectors were detected in 60 households (81.1%). Meanwhile, of the 46 households with good waste management, disease vectors were detected in only 18 households (39.1%). The results of the statistical test using the Chi-square test showed a p-value of 0.001 ($p < 0.05$), indicating a significant association between household waste management and the presence of disease vectors in the residential environment. The calculated Odds Ratio (OR) was 6.67 (95% CI: 2.85–15.62), indicating that households with poor waste management had a 6.67 times greater risk of disease vectors being found compared to households with good waste management.

DISCUSSION

The results showed that poor household waste management was still common among respondents, and disease vectors were found in most residential environments. Statistical analysis also indicated a significant association between household waste management and the presence of disease vectors. These conditions suggest that inadequate waste management may create environmental conditions that support vector breeding and increase environmental health risks in residential areas. This finding is in line with a study by Sari et al. (2022), which reported that inadequate household waste management in urban settlements was associated with increased environmental sanitation problems and vector breeding risks. These findings are consistent with previous studies reporting that unmanaged household waste can increase the density of flies, mosquitoes, and rats in residential environments (Ferronato & Torretta, 2019; World Health Organization, 2021). Similar studies conducted in urban settlements also found that poor sanitation conditions and waste accumulation were strongly associated with a higher risk of vector-borne diseases. Research conducted by Putri and Handayani (2021) in Indonesia also found that poor household sanitation behavior contributed significantly to the presence of mosquitoes and flies in densely populated residential areas. This finding reinforces the importance of proper household waste management as part of environmental health control efforts.

From a theoretical perspective, organic waste accumulation can provide food sources and breeding media for flies, while inorganic waste such as plastic containers and used cans that collect rainwater may become mosquito breeding sites. In addition, unmanaged waste may attract rats that act as reservoirs of infectious diseases. These environmental conditions increase interactions between humans, vectors, and disease agents, thereby increasing the potential for disease transmission in residential environments. Similar findings were reported by Rahmawati et al. (2023), who explained that unmanaged waste and poor drainage systems significantly contribute to vector proliferation in tropical residential environments.

Besides waste management practices, several social and environmental factors may also influence the presence of disease vectors, including educational level, public awareness, housing density, drainage conditions, and access to sanitation facilities. Households with limited environmental health knowledge and inadequate infrastructure may experience greater difficulty in maintaining proper waste management practices. Hidayat et al. (2020) reported that low educational level and limited environmental awareness were associated with poor sanitation behavior among households. Likewise, Nugroho et al. (2024) emphasized that population density and inadequate sanitation facilities remain major contributors to vector-related environmental health risks in Indonesian urban communities. Therefore, these factors should also be considered in future studies to provide a more comprehensive understanding of the relationship between waste management and vector presence.

The results of this study highlight the importance of strengthening environmental health programs, particularly community-based waste management education aimed at improving public awareness regarding waste segregation, safe storage, and proper disposal practices. In addition, collaboration between local governments, health centers, environmental agencies, and community leaders is needed to support sustainable neighborhood waste management systems and routine environmental sanitation activities. Integrated vector management strategies that emphasize environmental improvement and community participation should also be strengthened to reduce vector breeding sites in residential areas. This recommendation is supported by Pratama et al. (2022), who highlighted that community participation and cross-sector collaboration are essential components of sustainable environmental sanitation programs in Indonesia.

This study has several limitations. The use of a cross-sectional design limits the ability to establish causal relationships between household waste management and disease vector presence. In addition, several potential confounding variables were not analyzed using multivariate analysis, and vector observations may have been influenced by environmental conditions during data collection. Therefore, future studies are recommended to use longitudinal designs and include additional environmental and socioeconomic variables to strengthen the understanding of environmental health risk factors related to disease vectors.

CONCLUSIONS

This study showed that poor household waste management was still commonly found in residential areas, with 61.7% of households categorized as having poor waste management practices. Statistical analysis also demonstrated a significant association between household waste management and the presence of disease vectors, indicating that inadequate waste handling may contribute to environmental conditions that support vector breeding in residential environments. These findings highlight the importance of maintaining proper environmental sanitation, particularly household waste management, to reduce environmental health risks within the community. Improving household waste management practices requires not only adequate sanitation facilities but also active community

participation and continuous education regarding proper waste handling. Collaboration between local governments, health workers, and the community is essential to support sustainable environmental sanitation programs and reduce the risk of vector-related diseases. Future studies are recommended to include additional environmental and socioeconomic factors to provide a more comprehensive understanding of disease vector risks.

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