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Determinants of Household Waste Management Behavior in Urban Slum Communities: Evidence from Makassar City, Indonesia

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ABSTRACT

Household solid waste management in urban slum settlements remains an important environmental and public health concern in developing countries. This study analyzed sociodemographic, environmental, and social factors associated with household waste management practices in an urban slum area of Makassar City, Indonesia. A cross-sectional survey was conducted among 106 households in Maccini Sombala Village using structured interviews and field observations. Data were analyzed using chi-square tests and binary logistic regression. Results showed that 61.3% of households had poor waste management practices, particularly in waste separation and household-scale processing/recycling. In the multivariable model, secondary education and elderly age were significantly associated with better household solid waste management practices ($p < 0.05$). Respondents with secondary education were nearly three times more likely to report good practices (OR = 2.92; 95% CI: 1.18–7.25), while elderly respondents were more than four times more likely to do so (OR = 4.59; 95% CI: 1.17–17.99). The measured environmental and social factors, including household sanitation, domestic wastewater drainage, clean water quality based on basic physical criteria, and perceived community clean-up activities, were not statistically significant. These findings suggest that household-level behavior change, particularly through practical environmental education, may be important for improving waste management practices in low-resource urban settings.

1. INTRODUCTION

Household solid waste management represents one of the most pressing environmental challenges worldwide, growing increasingly complex alongside rapid urbanization and population expansion in metropolitan areas (Naghel et al. 2022). Global estimates indicate that more than 2.2 billion tons of waste were generated annually in 2020, a figure projected to rise by approximately 73% to 3.88 billion tons by 2050. Of this total, around 23% remains uncollected, while 33% is still disposed of through open dumping, particularly in developing nations (Zhang et al. 2025). Inefficient waste management contributes to soil, water, and air pollution, heightening public health risks through the proliferation of disease vectors such as flies and mosquitoes (Umunnakwe et al. 2021). Within the framework of sustainable development, waste management is directly linked to the Sustainable Development Goals (SDGs), specifically Goal 11 on sustainable cities and communities, and Goal 12 on responsible consumption and production (Adande et al. 2022). Thus, strengthening household-level waste management practices constitutes a strategic component of environmental health protection and the promotion of urban livability.

This issue is particularly evident in densely populated and slum settlements, where inadequate infrastructure, high population density, and poor sanitation-related behaviors exacerbate solid waste management challenges (Jagun et al. 2023, Thapaliya et al. 2024). Slum areas are typically characterized by limited waste collection services, insufficient wastewater drainage, and widespread open dumping in vacant lots, drainage channels, or nearby water bodies (Mugambe et al. 2022). Such practices not only degrade the physical environment but also facilitate the transmission of environment-related diseases, including diarrhea, dengue fever, and skin infections (Dagnaw et al. 2025). Empirical studies from developing countries have shown that solid waste management is a multidimensional issue, shaped by the interaction of social, economic, and behavioral determinants (Gharagozloo & Ghazizade 2023, Ukpangyang et al. 2022). Evidence highlights that cooperative-based door-to-door collection, enabled by municipal governance arrangements, can enhance source segregation at the household level (Saifi & Jha 2024).

Makassar City, one of the major metropolitan centers in eastern Indonesia, faces similar challenges. According to the Makassar City Government, as of December 2024, the total slum area reached approximately 299 hectares (Aminah 2025). Rapid population growth and economic expansion have increased household waste volumes, while the city's collection capacity has lagged behind waste generation rates (Palakurthy Ravinder & Kesari 2021). In several slum neighborhoods, residents still rely on traditional disposal practices, such as burning waste in household yards or dumping it into nearby rivers and drainage systems (Thapaliya et al. 2024). These practices contribute to unsanitary living conditions, surface water pollution, and increased vector-borne disease risks. Therefore, understanding the determinants of household waste management behavior is essential for designing effective community-based interventions in urban slum settings.

Previous research has emphasized that the effectiveness of household waste management depends not only on infrastructural support but also on behavioral factors at both the individual and community levels (Chengqin et al. 2022, Thakur & Onwubu 2024). Behavioral health perspectives suggest that individual decisions regarding waste management are influenced by personal factors (e.g., knowledge, education, age), social factors (e.g., norms, community support), and environmental conditions (e.g., access to facilities) (Fuadiyah Haq Zilfani 2024, Zheng et al. 2020). Supporting evidence from Makassar further indicates that knowledge and the social environment are significantly associated with household waste management behavior,

underscoring the relevance of examining individual and social-level determinants in Indonesian settings (Natsir et al. 2024). Within this context, the Ecological Model of Health Behavior (EMHB) provides a useful theoretical framework, positing that health-related environmental behaviors result from multi-level interactions among individual, social, and physical environmental domains (Moeini et al. 2023). Applying this model facilitates a comprehensive examination of the determinants of household waste management practices, integrating sociodemographic characteristics, environmental infrastructure (e.g., sanitation, water quality, wastewater drainage), and social perceptions related to collective environmental activities.

Despite the growing body of literature on household waste management in Indonesia, most studies have primarily focused on technical and institutional dimensions, such as waste collection efficiency, source segregation, and integrated waste management policies (Ferdinan et al. 2022). Few studies have simultaneously analyzed sociodemographic, environmental, and social perception factors within slum communities (Sai et al. 2020, Soesilo & Alfarizi 2024). Moreover, there remains a paucity of empirical research integrating these multi-level variables into a single analytical framework that can explain variations in household waste management practices (Cheng et al. 2022).

Accordingly, this study aims to examine the sociodemographic, environmental, and social determinants of household solid waste management practices in the slum areas of Makassar City. The study contributes to the advancement of behavior-based environmental health research grounded in the Ecological Model of Health Behavior (Salmon et al. 2020) and provides an empirical foundation for community-based waste management policies. Practically, the findings are expected to inform local governments and stakeholders in developing participatory strategies to improve community engagement in household waste management, particularly in areas with limited infrastructure and high population density.

2. MATERIALS AND METHODS

This study employed a cross-sectional design and was conducted between July and September 2025 in an urban slum settlement in Makassar City, South Sulawesi, Indonesia. The study site was purposively selected at the community level in Maccini Sombala Village, Tamalate District, because the area represents typical characteristics of urban slum settlements, including high population density, limited solid waste management infrastructure, and constrained community engagement in environmental sanitation activities. The selected community unit (*Rukun Warga*, RW) consisted of six neighborhood units (*Rukun Tetangga*, RT),

which formed the sampling frame for this study. The study population comprised 482 households distributed across the six RTs. A total of 106 households were selected using proportionate systematic random sampling. The sample was allocated proportionally to each RT based on the number of households in that RT. Within each RT, households were selected using systematic random sampling by choosing a random starting household, followed by selection of subsequent households using a fixed sampling interval (k) calculated as the ratio between the number of households in the RT and the allocated sample size. Eligible respondents were the household head or an adult household member (≥ 18 years) knowledgeable about daily household waste practices and residing in the area for at least six months.

Data were collected using a structured interviewer-administered questionnaire and an observation checklist. Direct observation was used to verify physical conditions where feasible (e.g., presence of a household waste container, type/availability of sanitation facility, and visible domestic wastewater drainage condition). Behavioral items that could not be directly verified (e.g., routine waste separation and processing/recycling at the household level before disposal) were obtained via respondent report. Enumerators were trained using standardized instructions and field protocols to ensure consistency in interviewing and observation procedures.

The dependent variable, household solid waste management practice (HSWM), was measured using a brief three-item index intended to capture minimum household-level practices feasible to assess in resource-constrained slum settings: (i) presence of a household waste container (observed), (ii) routine separation of waste at the household level (self-report), and (iii) any form of waste processing/recycling at the household level prior to disposal (self-report). In this study, 'processing/recycling' was operationally defined as household-scale composting of organic waste and reuse/repurposing of materials. The term does not refer to industrial recycling processes. Each affirmative response was scored as 1 (range 0–3), and the total score was dichotomized into poor (0–1) and good (2–3) for regression analysis. This index does not capture several context-specific practices (e.g., open burning, frequency of disposal, use of informal collectors, payment for collection services, or distance to disposal points), which may lead to misclassification and limited variability; therefore, findings should be interpreted as associations based on available proxy measures.

Independent variables were grouped into sociodemographic, physical environmental, and social factors. Sociodemographic variables included age, gender, education level, and occupation. Physical environmental variables

were assessed using predefined operational criteria based on observation and respondent report: household sanitation was classified as adequate if the household had access to an improved latrine with safe excreta containment/disposal (e.g., a sealed septic tank or other safe containment system); otherwise it was classified as inadequate. Domestic wastewater drainage condition was classified as proper if a visible wastewater drainage channel was present and appeared functional at the time of observation (i.e., not causing stagnant wastewater); otherwise it was classified as improper. Clean water quality was categorized as meeting basic physical criteria when no abnormalities were identified during field inspection and respondent report (color and visually assessed turbidity by observation; odor and taste by respondent report); the presence of any abnormality was categorized as not meeting criteria. This assessment represents a physical-parameter screening and does not replace laboratory verification against regulatory standards. Social factors were measured as respondents' perceptions of community clean-up activities (positive vs negative perception), reflecting perceived collective action rather than directly observed participation.

Descriptive statistics summarized frequencies and percentages. Bivariate associations were examined using the chi-square test. Variables were entered into the multivariable binary logistic regression model based on theoretical relevance and bivariate screening, and backward likelihood-ratio (LR) elimination was applied to obtain the final model. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test, and classification performance (sensitivity and specificity) was reported. Statistical significance was set at $p < 0.05$, and results are presented as ORs with 95% CIs.

Ethical clearance was obtained from the Health Research Ethics Committee, Faculty of Public Health, Hasanuddin University (Approval No.: 1537/UN4.14.1/TP.01.02/2025). Participation was voluntary. Enumerators provided study information, explained objectives and procedures, and emphasized the right to refuse or withdraw at any time without consequences. Written informed consent was obtained before data collection. Data were anonymized using unique codes and stored securely, accessible only to the research team.

3. RESULTS AND DISCUSSION

3.1. Descriptive Characteristics of Respondents

Table 1 presents the respondents' sociodemographic characteristics. Most respondents were female (94.3%), aged 35–54 years (50.0%), had a medium level of education (69.8%), and were unemployed (72.6%). The predominance

Table 1: Sociodemographic characteristics of respondents (n = 106).

Variable	Category	n	%
Age	Young (≤ 34 years)	33	31.1
	Adult (35–54 years)	53	50.0
	Elderly (≥ 55 years)	20	18.9
Gender	Male	6	5.7
	Female	100	94.3
Education	Low (elementary school or below)	32	30.2
	Medium (junior–senior high school)	74	69.8
Occupation	Unemployed	77	72.6
	Informal sector	27	25.5
	Formal sector	2	1.9

of female respondents likely reflects daytime household visits, during which adult women were more frequently available to participate. Overall, the sample reflects the socioeconomic profile of households in the selected slum area.

3.2. Distribution of Household Solid Waste Management Practices

Table 2 presents the distribution of household solid waste management practices across three indicators: presence of a household waste container, routine waste separation, and household-scale waste processing/recycling (composting or reuse). Based on the composite three-item index, 61.3% of households were categorized as having poor HSWM practices, while 38.7% were categorized as good. Overall, the findings indicate limited uptake of the assessed minimum household-level practices in the study area.

3.3. Physical Environmental and Social Conditions

Table 3 presents the distribution of physical environmental conditions and social perceptions among households in the study area. Overall, 48.1% of households had adequate sanitation, and 32.1% had proper domestic wastewater drainage conditions. Regarding access to clean water,

Table 2: Distribution of household solid waste management practices (n = 106).

Indicator	Category	n	%
Ownership of waste bin	Yes	74	69.8
	No	32	30.2
Waste sorting	Yes	55	51.9
	No	51	48.1
Waste processing/recycling (household-scale composting or reuse)	Yes	53	50.0
	No	53	50.0
Household waste management practice	Good	41	38.7
	Poor	65	61.3

Table 3: Distribution of physical environmental and social characteristics (n = 106).

Variable	Category	n	%
Household sanitation	Adequate	51	48.1
	Inadequate	55	51.9
Domestic wastewater drainage condition	Proper	34	32.1
	Improper	72	67.9
Clean water quality (basic physical criteria; organoleptic screening)	Meets criteria	71	67.0
	Does not meet criteria	35	33.0
Perceived community clean-up activities	Positive	26	24.5
	Negative	80	75.5

67.0% of households met the basic physical criteria based on organoleptic screening (color and visually assessed turbidity by observation; odor and taste by respondent report). In the social domain, 24.5% of respondents reported a positive perception of community clean-up activities. These descriptive distributions demonstrate the extent of within-area variability in environmental conditions and perceived collective action, providing context for subsequent association analyses with household solid waste management practices.

3.4. Association Between Sociodemographic, Environmental, and Social Factors and Household Waste Management

Bivariate associations between sociodemographic factors and the HSWM practice index are presented in Table 4. Education level was significantly associated with HSWM practices ($\chi^2 = 4.033$, $df = 1$, $p = 0.045$; $\phi = 0.195$). In contrast, age ($\chi^2 = 3.760$, $df = 2$, $p = 0.153$; $V = 0.188$), gender (Fisher's exact test, $p = 0.203$; $\phi = 0.141$), and occupation (Fisher–Freeman–Halton exact test, $p = 1.000$; $V = 0.037$) were not significantly associated with HSWM practices.

Table 5 shows the bivariate associations between environmental/social factors and the HSWM practice index. None of the variables reached statistical significance ($p > 0.05$). Clean water quality based on basic physical criteria (organoleptic screening) showed a non-significant trend ($\chi^2 = 3.581$, $df = 1$, $p = 0.058$; $\phi = 0.184$) and should be interpreted cautiously given the proxy nature of the measure and the absence of laboratory verification. Perceived community clean-up activities, household sanitation, and domestic wastewater drainage condition were not significantly associated with HSWM practices.

3.5. Multivariable Analysis

Table 6 presents the multivariable binary logistic regression results. Elderly respondents had higher odds of good

Table 4: Association between sociodemographic factors and household waste management practice index (n = 106).

Sociodemographic Variable	Statistical test	χ^2	df	p-value	Effect size (ϕ/V)
Age	Pearson's chi-square	3.760	2	0.153	V = 0.188
Gender	Fisher's exact test	-	-	0.203	ϕ = 0.141
Occupation	Fisher–Freeman–Halton exact test	-	-	1.000	V = 0.037
Education level	Pearson's chi-square	4.033	1	0.045*	ϕ = 0.195

Note: Pearson's χ^2 test was used when expected-count assumptions were met; Fisher's exact and Fisher–Freeman–Halton exact tests were used for gender and occupation, respectively. Effect sizes are reported as ϕ for 2×2 tables and Cramer's V for larger tables. All p-values are two-sided; $p < 0.05$.

Table 5: Association between environmental and social factors and household waste management practice index (n = 106).

Variable	χ^2	df	p-value	Effect size
Household sanitation	0.258	1	0.611	ϕ = 0.049
Domestic wastewater drainage condition	0.624	1	0.429	ϕ = 0.077
Clean water quality	3.581	1	0.058	ϕ = 0.184
Perceived community clean-up activities	0.909	1	0.340	ϕ = 0.093

Note: chi-square test was used. Effect size is reported as Phi (ϕ) for 2×2 tables.

Table 6: Factors associated with household waste management practices (binary logistic regression, n = 106; method: backward LR, final step).

Variable (reference category)	B	SE	Wald	p-value	OR (Exp(B))	95% CI for OR
Adult age vs. young	0.347	0.467	0.551	0.458	1.415	0.566–3.534
Elderly vs. young	1.523	0.698	4.764	0.029*	4.585	1.168–17.994
Secondary education vs. low	1.072	0.464	5.342	0.021*	2.922	1.177–7.254

Model fit statistics: Omnibus $\chi^2(3) = 9.570$, $p = 0.023$; -2 Log Likelihood = 131.900; Cox–Snell $R^2 = 0.086$; Nagelkerke $R^2 = 0.117$; Hosmer–Lemeshow $\chi^2(4) = 1.910$, $p = 0.752$; Accuracy = 67.0%; Sensitivity = 86.2%; Specificity = 36.6%.

Note: Backward LR method, final step. OR = odds ratio; CI = confidence interval. * $p < 0.05$.

HSWM practices than younger respondents (OR = 4.585, 95% CI: 1.168–17.994, $p = 0.029$), and respondents with secondary education had higher odds of good HSWM practices than those with lower education (OR = 2.922, 95% CI: 1.177–7.254, $p = 0.021$). Adult age was not statistically significant ($p = 0.458$). The overall model was significant (Omnibus $\chi^2 = 9.570$, $p = 0.023$), with limited explanatory power (Nagelkerke $R^2 = 0.117$) and modest classification performance (Accuracy 67.0%; Sensitivity 86.2%; Specificity 36.6%).

3.6. Discussion

The findings of this study indicate that household solid waste management practices in the selected urban slum area of Makassar City remain limited. Multivariable analysis showed that age and education were associated with better HSWM practices, whereas the measured environmental and social variables were not statistically significant. However, these findings should be interpreted cautiously because the model showed limited explanatory power, indicating that a substantial proportion of variability in HSWM practices was not captured by the variables included in the analysis. Similar evidence has been reported in other contexts, where individual characteristics such as age and education were

found to influence household waste sorting behavior (Toledo et al. 2025).

Education was associated with better household solid waste management practices in this study. Respondents with secondary education had higher odds of engaging in good HSWM practices compared with those with lower educational attainment. One possible explanation is that education may improve environmental knowledge and awareness of health risks related to improper waste handling, which can support the adoption of simple household practices such as waste separation and small-scale recycling or reuse. Similar associations between education and household waste sorting behaviors have been reported in studies conducted in other urban settings in developing countries (Khairunnisa et al. 2023, Thakur et al. 2023, Usha Rani et al. 2022). In low-resource urban environments, where formal waste infrastructure may be limited, educational attainment may therefore play an important role in shaping household routines related to waste handling and disposal.

Age was also associated with household solid waste management practices in this study, with elderly respondents showing higher odds of good HSWM practices than younger respondents. Older adults may have more established

household routines and longer experience in managing domestic responsibilities, which can contribute to more consistent waste handling behaviors. Similar patterns have been reported in previous studies showing that older individuals tend to demonstrate greater engagement in environmentally relevant household practices and recycling behaviors (Lin & Fung 2024, Omotayo et al. 2020). Similar evidence has also been reported in Indonesia, where age was associated with household waste management behavior (Fuadiyah Haq Zilfani 2024).

In contrast to some previous studies reporting that household environmental conditions and community participation can shape waste-related practices, the present study did not identify statistically significant associations for the measured environmental and social variables. This should not be interpreted as evidence that these factors are unimportant. Rather, the non-significant findings may reflect the limited sensitivity of the measures used in this study. Environmental conditions were assessed using brief binary indicators, while clean water quality was evaluated through basic physical criteria based on organoleptic screening rather than laboratory verification. Similarly, the social variable captured respondents' perceptions of community clean-up activities rather than observed participation. These proxy measures may not have been sufficiently detailed to detect more nuanced associations in the study setting. Previous studies have also highlighted the role of household socioeconomic characteristics and contextual factors in shaping recycling behavior (Omotayo et al. 2020, Sultana et al. 2024).

The findings of this study suggest that improving household waste management in urban slum settings may require greater attention to practical household-level behavior change. Programs that strengthen basic knowledge and skills related to waste separation, household-scale composting, and material reuse may therefore be particularly relevant. Environmental education and participatory community programs have been shown to encourage pro-environmental behavior and increase public willingness to engage in recycling activities (Owojori et al. 2022). In addition, the age-related pattern observed in this study indicates that younger households or younger adult members may require more targeted engagement to encourage consistent waste handling practices. Community-based education, training programs, and local participation mechanisms have also been reported to improve awareness and behavioral change in waste management initiatives (Mubarak et al. 2024). From a broader behavioral perspective, education and social norms play an important role in shaping environmental behavior and strengthening intentions to adopt sustainable waste management practices (Al Mamun et al. 2022).

This study has several limitations that should be considered when interpreting the findings. The cross-sectional design limits the ability to infer causal relationships between the examined factors and household waste management practices. In addition, the study was conducted within a single community unit in an urban slum area of Makassar City, which may restrict the generalizability of the findings to other urban or rural contexts with different environmental and socioeconomic characteristics. Some behavioral indicators, including waste sorting and recycling practices, were measured using respondent self-reports and may therefore be subject to reporting bias. Furthermore, the assessment of clean water quality relied on basic physical screening rather than laboratory verification. The relatively modest explanatory power of the regression model also suggests that additional determinants of household waste behavior may not have been captured in the current analysis, including socioeconomic and service-related factors such as household income, household size, waste collection frequency, and accessibility to disposal facilities.

Future studies should incorporate a broader range of socioeconomic and service-related variables, such as household income, waste collection frequency, and accessibility to waste management facilities, to better understand the determinants of household waste practices in urban slum environments. Longitudinal or mixed-method approaches may also provide deeper insights into behavioral dynamics and community participation in waste management programs. Expanding the study to multiple communities or cities could further improve the external validity of findings and support the development of more context-sensitive waste management interventions.

4. CONCLUSIONS

This study shows that household solid waste management practices in the selected urban slum area of Makassar City remain limited, with most households categorized as having poor HSWM practices. In the multivariable model, elderly age and secondary education were significantly associated with better HSWM practices, whereas the measured environmental and social variables were not statistically significant. These findings suggest that improving household waste management in low-resource urban settings may require greater emphasis on practical environmental education and routine-based behavior change at the household level. Further studies incorporating broader socioeconomic and service-related variables and involving multiple urban communities are needed to better understand the determinants of household waste management practices.

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