Original Article

Knowledge, Attitudes, and Practices Regarding Improper Solid Waste Disposal and Associated Health Risks in Peri-Urban Community in Cameroon: Mixed-Methods Cross-Sectional Study

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Abstract

Background
Sub-Saharan Africa bears a disproportionate share of the global solid waste burden, yet community-level evidence on knowledge, attitudes and practices remains scarce in peri-urban Cameroon.

Objectives
To measure knowledge, attitudes and practices regarding solid waste disposal and associated health risks in Muea, Cameroon, and identify factors associated with inappropriate disposal.

Methods
A convergent parallel mixed-methods cross-sectional study among 249 adult residents, conducted during February to March 2025. Responses from the structured questionnaire were analysed using chi-square tests followed by multivariable logistic regression. An observational checklist with photographic documentation provided qualitative data.

Results
Knowledge was good in 79.9% and attitude positive in 57.8%, and only 51.0% disposed of waste appropriately; open dumping accounted for 41.8% and burning 22.5%. Nine factors were associated with inappropriate disposal on chi-square testing and four survived mutual adjustment: reported waste-related illness (aOR 3.71, 95% CI 1.38–9.98), inadequate facilities (aOR 2.56, 95% CI 1.07–6.11), and absent enforcement (aOR 18.90, 95% CI 3.44–103.93) named as the main obstacle, dumping seen weekly rather than daily (aOR 3.22, 95% CI 1.39–7.48), and preferring structural to community-led remedies (aOR 5.08, 95% CI 1.37–18.81). Age, occupation, education, and length of residence did not. Observation confirmed absent bins, standing water, and open burning beside dwellings.

Conclusions
A substantial knowledge-to-practice gap was identified in Muea. Independent correlates of inappropriate disposal were structural and contextual rather than sociodemographic, making infrastructure provision and enforcement the priority interventions.

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Keywords: Solid waste management, Knowledge, attitudes and practices, Environmental health, Peri-urban population, Cameroon

Introduction

The rapid increase in solid waste generation has emerged as a major environmental and public health challenge in the 21st century. Estimates from the United Nations Environment Programme Global Waste Management Outlook 2024 indicate that around 2.3 billion tonnes of municipal solid waste (MSW) are produced worldwide each year, projected to escalate to approximately 3.8 billion tonnes by 2050 in the absence of coordinated intervention.[1] An estimated one-third of this waste stream is inadequately managed, often disposed of through open dumping or indiscriminate burning, posing substantial risks to public health and the environment.[2]

Sub-Saharan Africa (SSA) bears a disproportionate share of this burden. Despite generating approximately 9% of global waste by volume, the region had an estimated MSW collection coverage of just 44% in 2018, with rates in low-income neighbourhoods substantially lower. [2,3] Waste generation in SSA is projected to more than triple by 2050, driven by population growth, urbanisation, and expanding economic activity.[4] Solid waste management problems are particularly pronounced in peri-urban settings, which are transitional areas characterised by limited municipal services and closely clustered socioeconomic groups.[5]

The public health impacts of inadequate waste management are well established. Improper disposal creates favourable conditions for vectors responsible for malaria, dengue, typhoid, and cholera.[6] In shanty towns across Tanzania, inadequate waste management was significantly associated with increased incidence of diarrhoeal diseases, malaria, and respiratory conditions, with nearly half of residents attributing respiratory symptoms to waste burning.[7] Beyond communicable diseases, open burning releases particulate matter, dioxins, and carbon monoxide, elevating cancer risk in chronically exposed populations.[6,7] Children and pregnant women face heightened risk, with waste exposure associated with developmental impairments and adverse birth outcomes.[8]

In Cameroon, waste management deficits are systemic. A study in the Northwest Region documented inadequate awareness of waste disposal consequences among healthcare workers, reflecting institutional weaknesses across the waste management system.[9] Rapid urbanisation has intensified residential waste accumulation in Cameroonian cities, with municipal collection services failing to keep pace with population growth.[10] Studies assessing community attitudes and behaviour towards household waste management have been conducted in Douala, in the Littoral Region,[11] and in Limbe, which lies within Fako Division, the same division as the present study area.[12] National legislation, specifically the Environmental Framework Law (Law No. 96/12 of 5 August 1996), mandates proper waste disposal and environmental protection,[13] yet enforcement in peri-urban communities remains inconsistent. Despite this evidence base, structured KAP surveys focused on peri-urban residential communities remain insufficiently explored in the South West Region, where no published KAP study of this design currently exists. This gap matters, since KAP findings from other geographical and socioeconomic contexts cannot be readily extrapolated to populations with distinct cultural, infrastructural, and demographic characteristics.[14]

The Muea community, situated in Fako Division, South West Region of Cameroon, exemplifies the peri-urban profile at highest risk. Its position along major transport corridors linking Buea, Limbe, and Kumba has accelerated population influx while municipal waste services have not expanded commensurately. Muea lies within the Buea Health District, where malaria transmission is perennial and where stagnant water in peri-urban communities, Muea among them, has been identified as a breeding habitat for Anopheles vectors.[15]

No published study has characterised waste disposal knowledge, attitudes and practices in this community or their correlates.

This study aimed to assess KAP regarding improper solid waste disposal and associated health risks among inhabitants of Muea, and to identify the sociodemographic and contextual factors associated with inappropriate disposal practices, with a view to generating actionable evidence for public health intervention and policy dialogue.

Methods

Study design and setting

This study employed a convergent parallel mixed-methods cross-sectional design.[16] The quantitative strand used a structured interviewer-administered questionnaire to assess KAP and their sociodemographic and contextual correlates, reported in accordance with the STROBE checklist for cross-sectional studies.[17,18] The qualitative strand employed a systematic observational checklist with photographic documentation and thematic analysis of open-ended responses, reported according to the research team, study design, and analysis and findings domains of the Consolidated Criteria for Reporting Qualitative Research (COREQ).[19]

The study was conducted in the Muea community, Fako Division, South West Region of Cameroon. Muea is a rapidly growing peri-urban settlement lacking a formal municipal waste collection system, which makes it an epidemiologically relevant setting for this investigation. Data were collected from February to March 2025.

Study population and eligibility criteria

The target population comprised all adult residents of Muea aged 18 years and above. Participants were eligible if they had resided continuously in the community for at least one month prior to enrolment and provided voluntary informed consent. Participants were excluded if they were temporarily present without established household residence, withdrew consent after commencing the interview, or were unable to complete the interview owing to a language or comprehension barrier.

Sample size determination

The minimum required sample size was calculated using the Cochran formula for estimating proportions in cross-sectional studies: $n = Z^2P(1-P) / e^2$.[20] Using $Z = 1.96$, $P = 0.80$ (prevalence of improper disposal reported in Ethiopia),[14] and $e = 0.05$, the calculated minimum was 246. Three additional participants were enrolled to allow for potential data quality loss during processing, giving a final sample of 249 with a 100% completion rate. The Cochran formula for infinite populations was applied because no validated population register exists for the Muea community.

Sampling techniques

Purposive sampling selected Muea as the study site on the basis of its documented waste management challenges and its position within a health district of perennial malaria transmission.[15] Convenience sampling recruited accessible participants at identified household sites during the data collection period. Snowball sampling supplemented recruitment in areas of limited accessibility. These techniques were selected as the most pragmatically appropriate approach available, given the absence of a comprehensive household sampling frame for Muea and the resource constraints of the study setting.

Data collection instruments and procedures

The primary instrument was a structured interviewer-administered questionnaire developed by the research team and informed by thematic domains identified in the KAP literature on solid waste management, covering disposal behaviours, health risk awareness, and attitudinal dimensions. Existing KAP instruments from comparable settings were consulted as conceptual references, but the final questionnaire was independently constructed to reflect the cultural, linguistic, and environmental context of Muea. It comprised six sections: sociodemographic characteristics

(Section A); knowledge (Section B, five items); attitudes (Section C, five Likert-scale items); practices (Section D, five items); risk factors and community challenges (Section E); and open-ended recommendations (Section F).

Each of the five knowledge items was scored 1 for a correct response and 0 for an incorrect response, giving a composite knowledge score ranging from 0 to 5. Participants scoring 3 or above, equivalent to at least 60% correct, were classified as having good knowledge. Attitude items were rated on a five-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree), giving composite attitude scores ranging from 5 to 25, with scores of 15 or above classified as positive attitudes. Practice items were scored on the same binary basis as knowledge items, giving composite practice scores from 0 to 5, with scores of 3 or above classified as appropriate practice. All cut-off thresholds were determined a priori and are consistent with established KAP survey methodology.

The secondary instrument was a systematic observational checklist applied by the primary researcher at four purposively selected sites representing the principal waste-generating environments in Muea: public roadways, market areas and access routes, residential zones, and roadside drainage points. The checklist comprised twelve binary items across three domains: waste accumulation and disposal practices (five items, covering uncollected waste piles, availability and overflow of public waste bins, dumping in unauthorised locations, and open burning sites); environmental and public health risk indicators (four items, covering pungent odour, fly density, mosquito breeding in stagnant water, and rodent presence); and community or government response (three items, covering visible waste management activity, public awareness materials, and warning or penalty signage). Each item was recorded as present or absent at the time of observation. The photographic protocol specified documentation of the date, approximate time, and general location of each observation site; the waste type, volume, and disposal method observed; and any environmental health risk indicators present. Photographs were taken using a smartphone camera under a standardised protocol. Approximately five photographs were taken at each site, from which one representative image per site was selected for inclusion, giving four images in total, presented as Figures 3 and 4. Global positioning coordinates were not recorded; site location was documented descriptively by zone. Photographs were analysed descriptively rather than through formal image coding or content analysis. Each retained image was examined against the checklist items recorded for that site, and the features it showed were described in relation to those items, so that the photographic record functions as visual corroboration of the checklist rather than as an independent data source.

Prior to fieldwork, the questionnaire was reviewed by the supervising faculty member and pretested among residents of the neighbouring Molyko community, outside the formal sample, to assess clarity, cultural appropriateness, and completion time. Refinements were incorporated before formal data collection commenced.

Data management and analysis

Completed questionnaires were reviewed for completeness and consistency, assigned unique participant codes, and entered into Microsoft Excel 2021 before import into R version 4.5.2. Categorical variables were summarised as frequencies and percentages; continuous variables as means and standard deviations. Chi-square tests assessed bivariate associations between sociodemographic and contextual variables and overall disposal practice scores. Fisher's exact test was applied where expected cell frequencies fell below five. Statistical significance was set at $p < 0.05$.

Multivariable binary logistic regression was subsequently performed to identify factors independently associated with inappropriate waste disposal practices. All variables achieving statistical significance at $p < 0.05$ in bivariate analysis were

entered simultaneously into a single logistic regression model, with inappropriate practice coded 1 and appropriate practice coded 0. Crude odds ratios (cOR) were obtained from univariable models and adjusted odds ratios (aOR) with 95% confidence intervals from the multivariable model. Multicollinearity was assessed using the Variance Inflation Factor (VIF), with values below 5.0 considered acceptable. Model fit was evaluated using the Hosmer-Lemeshow goodness-of-fit test, discriminative ability using the Area Under the Receiver Operating Characteristic Curve (AUC), and explained variance using the Nagelkerke R^2.

Qualitative data from observational field notes and open-ended questionnaire responses were analysed using Braun and Clarke's six-phase reflexive thematic analysis framework.[21] The six phases comprised familiarisation with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the written report. Analysis was conducted by the primary researcher. The systematic observational checklist served as the primary qualitative data source, with open-ended questionnaire responses used as supplementary material for triangulation. Consistent with Braun and Clarke's guidelines for reflexive thematic analysis, inter-rater reliability was not applied as a validity criterion, since this approach prioritises the researcher's interpretive engagement with the data over inter-coder agreement metrics.[21] Thematic saturation was not assessed because the qualitative component consisted of a single round of structured site observations rather than iterative participant recruitment. Qualitative findings were triangulated with quantitative results to provide a fuller characterisation of waste management conditions in Muea.

Potential sources of bias

Social desirability bias was addressed through interviewer training, emphasis on anonymity and voluntary participation, and the use of an independent observational checklist to cross-validate self-reported practices. Recall bias in self-reported health outcomes was minimised by framing questions around recent and directly experienced events. Selection bias inherent to non-probability sampling was mitigated by employing three complementary sampling techniques to broaden community coverage. Residual bias cannot be excluded and findings should be interpreted accordingly.

Ethical Considerations

This study was conducted in accordance with the World Medical Association Declaration of Helsinki.[22] Ethical clearance was obtained from the Regional Delegation of Public Health for the South West Region of Cameroon (Reference Number: P42/MINSANTE/SWR/RDPH/CB.PT/633/513). Administrative authorization was obtained from the Biaka University Institute of Buea, the Muea Health Centre, and the traditional authority of the Muea community prior to data collection. Verbal informed consent was obtained from all participants. No personally identifying information was collected, and data were stored in password-protected files accessible only to the research team.

Results

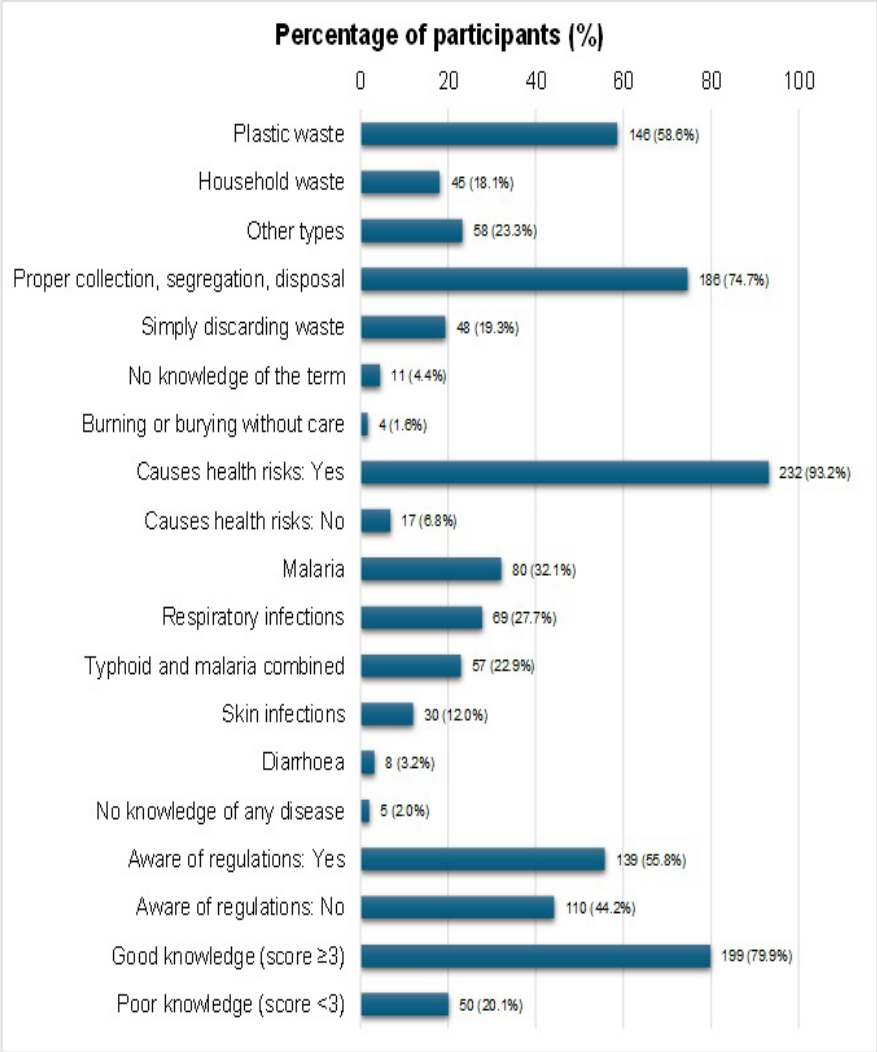
Sociodemographic Characteristics

A total of 249 participants were enrolled and all completed the interview, giving a 100% completion rate. Ages ranged from 18 to 65 years, with a mean of 33.6 years and a standard deviation of 10 years. Most participants were aged 18 to 34 years (138; 55.4%), female (163; 65.5%) and single (156; 62.7%). Self-employment was the predominant occupational category (92; 36.9%) and tertiary education the most common level of attainment (111; 44.6%). Most had lived in Muea for more than one year (213; 85.5%) and belonged to households of three or more members (203; 81.5%). Full sociodemographic data are presented in Table 1.

Table 1. Sociodemographic Characteristics of Study Participants, Muea Community, February to March 225 (n = 249)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	18–34	138	55.4
	35–50	85	34.1
	51–65	26	10.4
Gender	Female	163	65.5
	Male	86	34.5
Occupation	Self-employed	92	36.9
	Student	77	30.9
	Unemployed	51	20.5
	Employed	29	11.6
Level of education	Tertiary	111	44.6
	Secondary	87	34.9
	Primary	51	20.5
Marital status	Single	156	62.7
	Married	93	37.3
Religion	Christian	237	95.2
	Muslim	12	4.8
Duration of residence	More than 5 years	110	44.2
	1–5 years	103	41.4
	Less than 1 year	36	14.5
Household size	3 or more members	203	81.5
	Fewer than 3 members	46	18.5

Knowledge Toward Waste Management



Plastic waste was the most identified waste type (146; 58.6%). Majority of the participants (186; 74.7%) correctly defined waste management as the proper collection, segregation, and disposal of waste, while 232 (93.2%) acknowledged that improper disposal leads to health risks. Malaria was the most frequently cited associated disease (80; 32.1%). Awareness of community waste disposal regulations was reported by 139 participants (55.8%). The mean knowledge score was 3.97 ± 0.85 on a scale of 0 to 5, with 199 participants (79.9%) demonstrating good knowledge. Knowledge data are presented in Figure 1.

Figure 1. Knowledge of waste management and associated health risks among study participants (n = 249).

Knowledge items are grouped by domain in questionnaire order. Bars show percentages; labels give n (%). Overall knowledge was a five-item composite (range 0–5, mean 3.97 ± 0.85 standard deviation), with scores ≥3 classified as good.

Attitudes toward waste management

Attitudes were assessed across five Likert-scale dimensions and are presented in full in Figure 2. Near-universal agreement was recorded on the importance of proper waste disposal for community health, with 141 participants (56.6%) strongly agreeing and 96 (38.6%) agreeing. A majority agreed that waste management is a shared responsibility between government and individuals (195; 78.3%) and that proper sorting and recycling can reduce health hazards (179; 71.9%). However, 155 participants (62.3%) agreed or strongly agreed that waste sorting and recycling are too difficult to practise, which represents a substantial perceived behavioural barrier. Community-led waste management initiatives were viewed as effective by 233 participants (93.6%). Overall, 144 participants (57.8%) demonstrated good attitudes and 105 (42.2%) demonstrated poor attitudes.

Bars show the percentage of participants selecting each response; labels give n (%). Segments below 6% are unlabelled. Item 4 is negatively worded, so agreement indicates a perceived barrier. Overall attitude was a five-item composite (range 5–25), with scores ≥15 classified as positive.

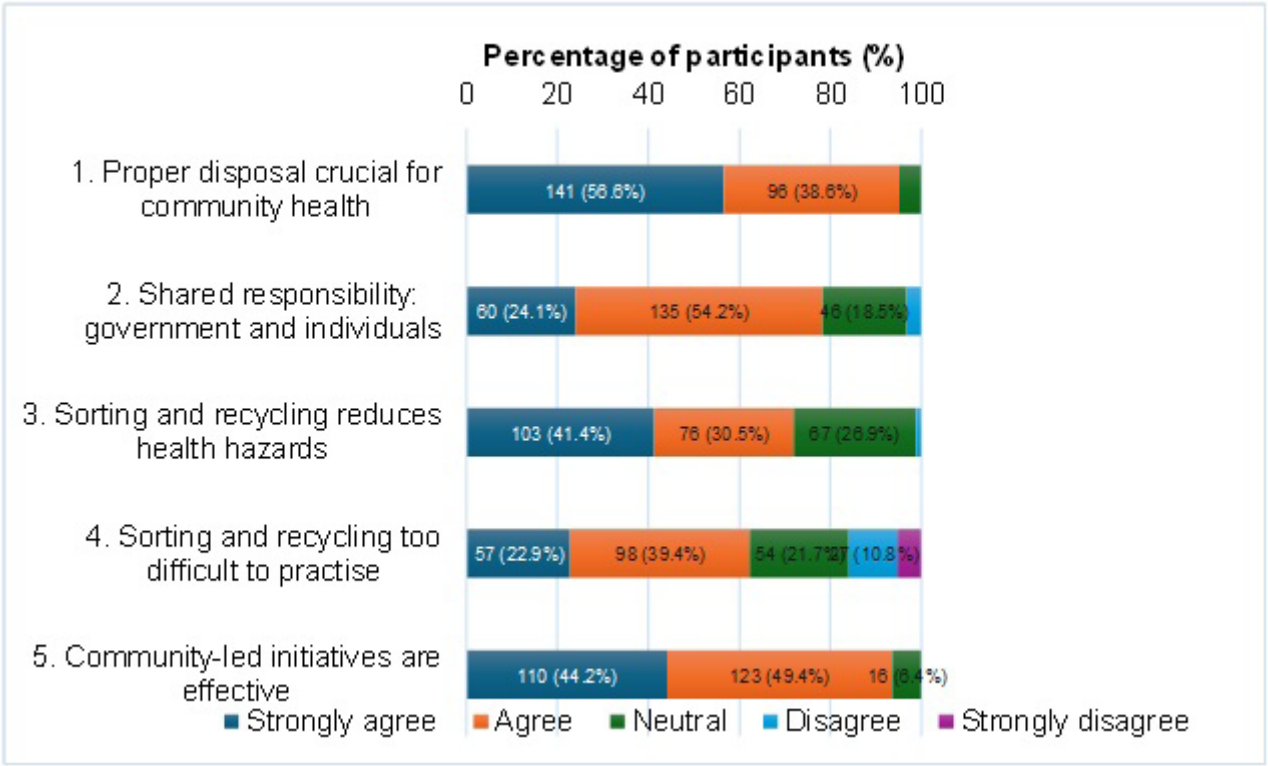


Figure 2. Attitudes toward waste management among study participants (n = 249)

Waste disposal practices

Open dumping in public spaces was the most prevalent disposal method (104; 41.8%), followed by use of a designated waste collection system (69; 27.7%), burning (56; 22.5%), burying (17; 6.8%), and disposal in water bodies (3; 1.2%). Waste collection was described as rare by 101 respondents (40.6%), monthly by 54 (21.7%), never by 43 (17.3%), weekly by 42 (16.9%), and daily by only 9 (3.6%). Recycling or composting was never practised by 98 participants (39.4%), practised sometimes by 111 (44.6%), and practised consistently by only 40 (16.1%). Most participants (180; 72.3%) reported participating in community waste management programmes. The local market area was characterised as dirty by 154 participants (61.8%). Overall, 127 participants (51.0%) demonstrated appropriate disposal practices and 122 (49.0%) demonstrated inappropriate practices. Practice data are presented in Table 2.

Table 2. Waste disposal practices among study participants (n = 249)

Practice Item	Response	n	%
Primary method of household waste disposal	Open dumping in public spaces	104	41.8
	Designated waste collection system	69	27.7
	Burning	56	22.5
	Burying	17	6.8
	Disposal in water bodies	3	1.2
Frequency of waste collection in area	Rarely	101	40.6
	Monthly	54	21.7
	Never	43	17.3
	Weekly	42	16.9
	Daily	9	3.6
Practises recycling or composting	Sometimes	111	44.6
	Never	98	39.4
	Consistently	40	16.1
Participates in community waste programmes	Yes	180	72.3
	No	69	27.7
Perceived cleanliness of local market area	Dirty	154	61.8
	Clean	77	30.9
	Frequent waste deposition site	18	7.2

Overall practice (composite score range 0–5): Appropriate practice (score ≥3): 127 (51.0%); Inappropriate practice (score <3): 122 (49.0%)

Bivariate analysis of factors associated with disposal practices

Chi-square analysis identified nine variables significantly associated with inappropriate disposal practices: age group ($x^2 = 19.964$, $p = 0.001$), occupational category ($x^2 = 14.142$, $p = 0.003$), educational level ($x^2 = 13.283$, $p = 0.001$), duration of residence ($x^2 = 8.151$, $p = 0.017$), health problems linked to waste disposal ($x^2 = 8.911$, $p = 0.003$), type of health problem reported ($x^2 = 8.238$, $p = 0.041$), primary waste management challenge ($x^2 = 13.823$, $p = 0.003$), frequency of observed unauthorised dumping ($x^2 = 8.742$, $p = 0.033$) and perceived most effective solution ($x^2 = 24.873$, $p = 0.001$). Gender, marital status, and household size showed no significant association ($p > 0.05$). Bivariate results are presented in Table 3.

Table 3. Sociodemographic and contextual factors associated with waste disposal practices among study participants (n = 249)

Variable	Category	Appropriate n (%)	Inappropriate n (%)	x^2	p-value
Sociodemographic factors					
Age group (years)	18–34	68 (49.3)	70 (50.7)	19.964	**0.001**
	35–50	51 (60.0)	34 (40.0)		
	51–65	25 (96.2)	1 (3.8)		
Gender	Female	83 (50.9)	80 (49.1)	1.325	0.250
	Male	44 (51.2)	42 (48.8)		
Occupation	Employed	19 (65.5)	10 (34.5)	14.142	**0.003**
	Self-employed	60 (65.2)	32 (34.8)		
	Student	31 (40.3)	46 (59.7)		
	Unemployed	34 (66.7)	17 (33.3)		

Table 3. Continued

Variable	Category	Appropriate n (%)	Inappropriate n (%)	x^2	p-value
Sociodemographic factors					
Level of education	Primary	38 (74.5)	13 (25.5)	13.283	**0.001**
	Secondary	55 (63.2)	32 (36.8)		
	Tertiary	51 (45.9)	60 (54.1)		
Marital status	Single	79 (50.6)	77 (49.4)	1.915	0.166
	Married	48 (51.6)	45 (48.4)		
Duration of residence	Less than 1 year	13 (36.1)	23 (63.9)	8.151	**0.017**
	1–5 years	63 (61.2)	40 (38.8)		
	More than 5 years	68 (61.8)	42 (38.2)		
Household size	Fewer than 3	23 (50.0)	23 (50.0)	0.214	0.644
	3 or more	104 (51.2)	99 (48.8)		
Contextual factors					
Health problems linked to waste disposal	No	29 (80.6)	7 (19.4)	8.911	**0.003**
	Yes	115 (54.0)	98 (46.0)		
Types of health problems reported[a]	Malaria only	15 (83.3)	3 (16.7)	8.238	**0.041**
	Malaria and typhoid	66 (61.1)	42 (38.9)		
	Skin infections	25 (50.0)	25 (50.0)		
	Two or more conditions	27 (49.1)	28 (50.9)		
Primary challenge in waste management	Inadequate facilities	23 (65.7)	12 (34.3)	13.823	**0.003**
	Lack of public awareness	26 (70.3)	11 (29.7)		
	Lack of regular collection	85 (50.9)	82 (49.1)		
	No enforcement of rules	10 (100.0)	0 (0.0)		
Frequency of unauthorised dumping	Daily	111 (63.8)	63 (36.2)	8.742	**0.033**
	Weekly	22 (44.9)	27 (55.1)		
	Monthly	7 (46.7)	8 (53.3)		
	Rarely	4 (36.4)	7 (63.6)		
Perceived most effective solution	Community-led initiatives	14 (82.4)	3 (17.6)	24.873	**0.001**
	Public education	77 (56.6)	59 (43.4)		
	Government intervention	24 (80.0)	6 (20.0)		
	Improved infrastructure	29 (51.8)	27 (48.2)		
	Financial incentives	0 (0.0)	5 (100.0)		
	Infrastructure and incentives	0 (0.0)	5 (100.0)		

χ^2 = Pearson chi-square statistic. Percentages are row percentages within each category. Statistically significant associations

($p < 0.05$) are shown in bold. Fisher's exact test was applied where expected cell counts were below five.

[a]Reported only among the 213 participants who indicated health problems linked to waste disposal; the category total of 231 reflects participants reporting more than one co-occurring condition. All other variables have a denominator of 249.

Multivariable logistic regression analysis

Variable	Category	cOR (95% CI)	p	aOR (95% CI)	p
Age group (years)	51–65 (ref)	1.00 (ref)	—	1.00 (ref)	—
	18–34	1.33 (0.81–2.20)	0.264	0.82 (0.22–3.02)	0.761
	35–50	0.83 (0.49–1.40)	0.479	1.18 (0.42–3.32)	0.760
Occupation	Employed (ref)	1.00 (ref)	—	1.00 (ref)	—
	Student	1.73 (1.01–2.99)	**0.047**	1.50 (0.45–4.98)	0.507
	Self-employed	0.70 (0.42–1.18)	0.183	1.44 (0.51–4.05)	0.495
	Unemployed	1.00 (0.54–1.85)	0.997	1.67 (0.54–5.16)	0.373
Level of education	Primary (ref)	1.00 (ref)	—	1.00 (ref)	—
	Secondary	0.54 (0.32–0.92)	**0.022**	0.98 (0.40–2.38)	0.966
	Tertiary	2.15 (1.29–3.57)	**0.003**	3.32 (0.83–13.23)	0.088
Duration of residence	More than 5 years (ref)	1.00 (ref)	—	1.00 (ref)	—
	1–5 years	1.04 (0.63–1.72)	0.891	0.86 (0.38–1.98)	0.730
	Less than 1 year	1.78 (0.86–3.66)	0.119	0.87 (0.26–2.91)	0.821
Health problems linked to waste	No (ref)	1.00 (ref)	—	1.00 (ref)	—
	Yes	3.39 (1.52–7.55)	**0.003**	**3.71 (1.38–9.98)**	**0.009**
Primary challenge	Lack of regular collection (ref)	1.00 (ref)	—	1.00 (ref)	—
	Inadequate facilities	1.68 (0.81–3.47)	0.163	**2.56 (1.07–6.11)**	**0.035**
	Lack of public awareness	1.27 (0.63–2.56)	0.505	1.66 (0.70–3.96)	0.254
	No enforcement of rules[b]	2.52 (0.64–9.96)	0.189	**18.90 (3.44–103.93)**	**0.001**
Frequency of unauthorised dumping	Daily (ref)	1.00 (ref)	—	1.00 (ref)	—
	Weekly	3.67 (1.84–7.34)	**<0.001**	**3.22 (1.39–7.48)**	**0.007**
	Monthly	0.50 (0.17–1.51)	0.218	0.71 (0.20–2.54)	0.594
	Rarely	1.87 (0.53–6.56)	0.327	1.93 (0.49–7.64)	0.351
Perceived most effective solution	Community-led initiatives (ref)	1.00 (ref)	—	1.00 (ref)	—
	Public education	1.24 (0.75–2.05)	0.392	3.64 (0.98–13.55)	0.054
	Government intervention	0.33 (0.14–0.78)	**0.012**	1.45 (0.33–6.34)	0.619
	Structural solutions[c]	1.60 (0.91–2.82)	0.105	**5.08 (1.37–18.81)**	**0.015**

cOR = crude odds ratio; aOR = adjusted odds ratio; CI = confidence interval; ref = reference category. Adjusted odds ratios are mutually adjusted for all variables in the model.

[b]Estimate based on a small category (n = 10); the wide confidence interval indicates limited precision and the value should be interpreted as directional.

[c]Structural solutions combines the improved infrastructure and financial incentive categories to ensure adequate cell sizes for regression modelling.

Model diagnostics: Hosmer-Lemeshow $x^2 = 17.865$, df = 8, p = 0.022; AUC = 0.761; Nagelkerke $R^2 = 0.270$; overall model $p < 0.001$.

Eight of the nine variables significant in bivariate analysis were entered simultaneously into a multivariable binary logistic regression model. Type of health problem reported was excluded, as it was administered only to the subset reporting health problems (n = 213) and is a sub-question of that variable rather than an independent exposure. Four of the eight variables retained independent significance after mutual adjustment, yielding five significant category contrasts, since two categories of the primary challenge variable differed significantly from the reference. Crude and adjusted odds ratios are presented in Table 4.

Reporting health problems linked to waste disposal carried the most robust independent association (aOR = 3.71, 95% CI: 1.38 to 9.98, p = 0.009). Among the waste management challenges cited by participants, two were independently associated with inappropriate practice relative to lack of regular collection: inadequate disposal facilities (aOR = 2.56, 95% CI: 1.07 to 6.11, p = 0.035) and absence of enforcement of waste management rules (aOR = 18.90, 95% CI: 3.44 to 103.93, p = 0.001). The confidence interval for the latter estimate is wide, reflecting the small number of participants in that category (n = 10), and the point estimate should therefore be read as indicating direction rather than magnitude. Observing unauthorised dumping weekly rather than daily was associated with higher odds of inappropriate practice (aOR = 3.22, 95% CI: 1.39 to 7.48, p = 0.007), as was preferring structural solutions over community-led initiatives (aOR = 5.08, 95% CI: 1.37 to 18.81, p = 0.015).

Age group, occupational category, educational level, and duration of residence did not retain independent significance after adjustment, despite their bivariate associations. Model diagnostics indicated acceptable discriminative ability (AUC = 0.761) and explained variance (Nagelkerke $R^2 = 0.270$), with overall model significance at $p < 0.001$. The Hosmer-Lemeshow statistic ($x^2 = 17.865$, df = 8, p = 0.022) fell below the conventional threshold for adequate fit, which is attributable to the number of parameters in the full eight-variable model relative to the sample size; this is reported among the study limitations. VIF values ranged from 1.10 to 5.84, with three category-level dummies marginally exceeding 5.0.

Qualitative findings

Theme 1: Waste accumulation and inadequate disposal infrastructure

Substantial accumulations of mixed solid waste, including plastics, biodegradable matter, and household refuse, were observed along major roadways, market access routes, and within residential drainage channels. The absence or severe inadequacy of waste bins across most public areas limited residents' capacity to dispose of waste appropriately, irrespective of their knowledge or attitudes. Indiscriminate disposal in gutters, open spaces, and along roadsides was frequently observed, consistent with the 41.8% prevalence of open dumping recorded in the quantitative data. Figure 3A documents accumulation at a roadside site, showing mixed household refuse, organic matter and plastics deposited directly on the ground surface with no containment of any kind, a pattern indicating habitual rather than occasional use of the location. Figure 3B records the same practice at the periphery of the market area, where waste was deposited against a boundary wall within metres of food vending activity, extending the exposure pathway beyond the household. Open burning of both plastic and organic material was directly observed. Figure 3C captures an active burn in a residential zone, with smoke visibly drifting toward adjacent dwellings, corresponding to the 22.5% of participants who reported burning as their primary disposal method.

Theme 2: Environmental and health risk indicators

Clear indicators of ongoing health risk were evident across the community. Stagnant water collecting within and around waste piles constituted a likely mosquito breeding ground.

Figure 3D documents one such site, where solid waste had obstructed a roadside drainage channel and produced a standing pool with floating debris across its surface, conditions that sustain Anopheles breeding between rainfall events. This provides a direct environmental pathway for malaria transmission in a district where stagnant water is a documented vector breeding habitat.[15]

Large numbers of flies were observed around waste accumulation points and rodents were seen near disposal areas, reflecting conditions associated with leptospirosis and salmonellosis. A persistent strong odour from decomposing organic waste was noted in both market and residential areas, while open burning further degraded local air quality.



Figure 3. Waste accumulation and open dumping in the Muea community, 2025

A. Visible waste accumulation along a public road, with mixed household refuse, organic matter and plastics deposited directly on the ground surface and no containment of any kind.

B. Open dumping at the periphery of the market area, where waste was deposited against a boundary wall within metres of food vending activity.

C. Open burning of solid waste in a residential zone, with smoke drifting toward adjacent dwellings.

D. Stagnant water at an obstructed roadside drainage channel, producing a standing pool with floating debris across its surface.

Theme 3: Awareness without enabling conditions

Open-ended responses consistently reflected awareness of appropriate disposal norms alongside a stated sense of personal responsibility. Participants articulated an understanding of the health consequences of improper disposal, yet identified structural barriers, principally the absence of waste bins and infrequent or absent collection services, as the fundamental constraint on changing their behaviour.This theme corroborates the quantitative finding that contextual and structural factors, rather than attitudinal deficits, were the variables independently associated with inappropriate practice.

Mixed-methods integration

Quantitative and qualitative findings were compared at the interpretation stage to assess convergence. Self-reported disposal behaviour was corroborated by direct observation. Open dumping, reported by 41.8% of participants, and burning, reported by 22.5%, were both observed directly at the community sites visited, as described in Theme 1.

The regression findings concerning infrastructure converged with the observational record. Two-thirds of participants (167; 67.1%) identified lack of regular collection as their primary challenge, and citing inadequate facilities rather than irregular collection carried higher adjusted odds of inappropriate disposal (aOR 2.56, 95% CI 1.07 to 6.11). Field observation found waste bins absent or overflowing across all sites and recorded no municipal collection activity during any visit, providing independent corroboration that the structural deficit participants described was present on the ground.

The association between reported waste-related illness and inappropriate disposal (aOR 3.71, 95% CI 1.38 to 9.98) was contextualised by Theme 3. Participants who articulated an understanding of the health consequences of improper disposal identified the absence of bins and collection services, rather than any deficit of knowledge or concern, as the constraint on changing their behaviour. The quantitative association and the qualitative accounts therefore point to the same interpretation, that awareness of risk does not translate into altered practice where the means of compliance are unavailable.

One point of divergence merits note. While 72.3% of participants reported taking part in community waste management activities such as clean-up campaigns, field observation recorded no waste management infrastructure at any site. This suggests that episodic community activity, whatever its social value, has not produced durable environmental change in Muea.

Discussion

This study examined knowledge, attitudes, and practices regarding improper solid waste disposal among 249 adult inhabitants of the peri-urban Muea community in South West Cameroon, using a convergent parallel mixed-methods design with multivariable logistic regression to identify factors independently associated with inappropriate disposal practice.

The logistic regression analysis yielded a finding that bivariate testing alone could not establish. Chi-square analysis identified nine significantly associated variables spanning both sociodemographic and contextual domains. After simultaneous adjustment, however, none of the sociodemographic variables retained independent significance, while four of the five surviving predictors concerned structural conditions or their consequences. This pattern suggests that sociodemographic characteristics function as markers of structural deprivation rather than as independent behavioural correlates. Within this community, the locus of the knowledge to practice gap appears to sit with the conditions residents face rather than with who they are.

A large proportion of participants (79.9%) exhibited adequate knowledge of waste management, consistent with findings from comparable peri-urban settings across sub-Saharan Africa. High knowledge coexisting with suboptimal practice has been reported in Gelemso, Ethiopia, and in Accra, Ghana, with the gap attributed primarily to infrastructural deficiency rather than attitudinal failure.[14,23] A systematic review found that nearly 40% of waste in low-income settings is openly dumped or burned, largely as a consequence of insufficient infrastructure.[24] The present analysis extends these observations by demonstrating that the variable capturing structural absence, namely inadequate disposal facilities, retained independent significance after adjustment for individual characteristics.

Health problems linked to waste disposal emerged as the most robust independent correlate (aOR = 3.71, 95% CI: 1.38 to 9.98, p = 0.009). Participants who had experienced waste-related illness were nearly four times more likely to practise inappropriate disposal than those who had not, after controlling for all other measured factors. Read through the Health Belief Model,[25] this pattern is consistent with the construct of perceived barriers outweighing perceived susceptibility. Illness experience raises awareness of risk, but where the structural means of compliance are unavailable, that awareness does not translate into behavioural change. The result points to a self-efficacy deficit that is structural in origin rather than psychological, and it offers a mechanistic reading of why health education alone has limited traction in settings of this kind.

The finding that the type of challenge participants identified was itself independently associated with practice carries direct policy relevance. Participants citing inadequate disposal facilities had 2.56 times higher adjusted odds of inappropriate disposal than those citing irregular collection (95% CI: 1.07 to 6.11, p = 0.035). Those citing absent enforcement of waste management rules showed a substantially stronger association (aOR = 18.90, 95% CI: 3.44 to 103.93, p = 0.001), although the width of that confidence interval, arising from a category of only 10 participants, means the estimate establishes direction rather than magnitude. Taken together, these two findings locate the constraint on compliance in the absence of both the physical means and the regulatory pressure to comply. Intervention frameworks built primarily around awareness campaigns are unlikely to address either.

The association between observed dumping frequency and disposal practice requires careful reading. On multivariable analysis, the significant contrast lay between weekly exposure (aOR = 3.22, 95% CI: 1.39 to 7.48, p = 0.007) and the daily reference category, rather than following a monotonic gradient from low to high exposure. Participants in the daily exposure group recorded the lowest inappropriate practice rate. One plausible interpretation is that communities experiencing daily unauthorised dumping have developed informal, de facto disposal points that, while not sanctioned, concentrate waste and reduce the extent of genuinely dispersed disposal. Communities with intermittent dumping may lack even these informal arrangements. Comparable behavioural adaptation has been documented in low-income communities in Johannesburg, where prolonged exposure to inadequate waste infrastructure produced accommodation rather than escalation. [26] This interpretation should be regarded as provisional and warrants dedicated investigation.

Preference for structural solutions was independently associated with inappropriate disposal relative to preference for community-led initiatives (aOR = 5.08, 95% CI: 1.37 to 18.81, p = 0.015). Rather than a contradiction, this reflects revealed preference under constraint: participants who most acutely experience structural barriers are simultaneously those most likely to practise inappropriately and those most likely to nominate structural intervention as the remedy. A parallel pattern has been observed in participatory waste management programmes in Brazil and Kenya, where communities most dependent on structural provision showed the greatest improvement in practice once that provision was made. [27]

The failure of educational level to retain significance after adjustment merits comment, given that it had appeared among the stronger bivariate correlates ($x^2 = 13.283$, p = 0.001). A systematic review has shown that educational attainment in developing settings frequently raises environmental awareness withoutproducing corresponding improvements in practice, a gap attributed to the absence of enabling infrastructure and institutional enforcement.[28] A similar pattern has been reported at the University of Lagos, where recycling policy and

infrastructure coexisted with largely unsorted campus waste.[29] The present analysis quantifies the point: once structural and contextual factors were accounted for, educational level was no longer independently associated with practice. A comparable conclusion has been reached regarding age in a systematic review of waste separation behaviour, where apparent age effects frequently reflected differences in residential stability and infrastructure access rather than generational attitude. [30]

Field observations corroborated and contextualised the quantitative findings. Widespread waste accumulation along roadways and market areas, the near-complete absence of waste bins across residential zones, active mosquito breeding sites within waste piles, and ongoing open burning close to residential structures provided direct visual evidence of the environmental health risk pathways contributing to the disease burden in Muea. These observations align with published vector ecology for this health district[15] and with the regression finding that environmental exposure, operationalised through the dumping frequency variable, was independently associated with disposal behaviour.

Strengths and limitations

Strengths

This study makes several contributions. To the authors' knowledge it is the first structured, community-level mixed-methods study of knowledge, attitudes and practices on solid waste management conducted in a peri-urban community of the South West Region of Cameroon, addressing a documented evidence gap in a region carrying a substantial waste-related disease burden. The convergent parallel design permitted triangulation of self-reported behaviour against independent field observation, which surveys alone cannot achieve, and photographic documentation of all observation sites provides verifiable corroboration of the environmental conditions described.

The application of multivariable logistic regression, rather than bivariate testing alone, allowed genuine independent correlates to be distinguished from confounded associations, and it is this analysis that identified the structural character of the knowledge to practice gap. Full model diagnostics are reported, including a Hosmer-Lemeshow statistic that fell below the conventional threshold, rather than reducing the model to improve the fit statistic at the cost of the analytical question.

Limitations

Several constraints bear on the interpretation of these findings. The non-probability sampling approach precludes statistical generalisation beyond Muea, and even within Muea the findings should be read as indicative of conditions in the areas visited rather than representative of the entire community. No validated census figure exists for the Muea community, so the infinite-population form of the Cochran formula was applied and no finite population correction could be calculated.

The cross-sectional design precludes causal inference, and the adjusted associations reported here describe independent statistical relationships rather than demonstrated causal effects. Self-reported practice carries social desirability bias, which the independent observational checklist partially but not fully offsets, since the checklist was applied at site rather than individual participant level; observational coverage was in turn limited to four community sites selected to represent the principal waste-generating environments, and a larger number of sites would have permitted greater confidence in the generalisability of these observations within Muea.

Qualitative analysis was conducted by a single researcher, which, while consistent with reflexive thematic analysis, limits the range of interpretive perspectives brought to the data. Two features of the regression model also warrant note:

the Hosmer-Lemeshow statistic (p = 0.022) fell below the conventional threshold, reflecting the number of parameters relative to the sample size, although discriminative ability remained acceptable (AUC = 0.761); and Variance Inflation Factor values for three category-level dummies marginally exceeded 5.0, reflecting correlation among sociodemographic categories in the full model. Both are reported transparently rather than addressed by reducing the model to improve the statistics. Finally, the two-month data collection window may not capture seasonal variation in disposal behaviour, and the absence of direct income measurement limits the extent to which socioeconomic position can be separated from education and occupation.

Conclusion

Knowledge of waste management in the Muea community is high, but it is not translating into appropriate disposal practice. The factors independently associated with inappropriate disposal were structural and contextual rather than sociodemographic, relating to the facilities available to residents, the enforcement they experience and the conditions they observe around them, rather than to age, occupation, education or length of residence.

This locates the constraint on appropriate disposal in the conditions residents face rather than in what they know or believe. This carries a specific implication for intervention. Where knowledge is already high and the means of compliance are absent, awareness campaigns address a deficit that does not exist. Municipal authorities should therefore treat the provision of waste disposal infrastructure, specifically bins and regular collection, as a precondition for compliance rather than as a complement to health education. Consistent enforcement of the existing provisions of the Environmental Framework Law is equally necessary. Community-led initiatives, which participants rated highly, warrant formal institutional support and coordination rather than being left to operate informally.

Future research in comparable peri-urban settings should adopt longitudinal designs capable of establishing whether infrastructure provision and enforcement produce the behavioural change that a cross-sectional analysis can only associate them with.

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Authors' contributions

HMK conceived and designed the study, supervised data collection, performed the statistical analysis, and drafted the manuscript. PM contributed to the study design and data collection. TMF, ASB, JRN, YLM, and EJE contributed to the interpretation of the findings and discussion. All authors contributed to the interpretation of the findings, critically revised the manuscript for important intellectual content, approved the final version, and agree to be accountable for all aspects of the work.

Conflicts of interest

The authors declare no conflicts of interest.

Use of Artificial Intelligence

The authors declare that artificial intelligence tools were used to assist with manuscript formatting, including support with language editing and structural organisation of the text. No artificial intelligence tool was used to generate, analyse, or interpret the study data.

All content was independently reviewed, verified, and approved by the authors, who take full and sole responsibility for the scientific accuracy, integrity, and conclusions of the published work.

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