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HOUSEHOLD PLASTIC WASTE MANAGEMENT AND DISPOSAL BEHAVIORS IN PERI-URBAN ZAMBIA: A QUANTITATIVE CASE STUDY OF NDEKE CHANGA CHANGA, KITWE TOWNSHIP

By

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ABSTRACT

The study examined household plastic waste disposal behaviours, sorting practices, and perceptions of collection system effectiveness among 150 households in Ndeke Changa Changa, a peri-urban township in Kitwe, Zambia. Structured questionnaires captured demographic characteristics and waste management practices, and chi-square tests of independence were used to examine associations between demographic variables and household behaviours. Throwing waste into regular trash bins (42.0%, n = 63) and burning (40.7%, n = 61) emerged as the two dominant disposal methods, while 16.0% (n =24) of households reported dumping plastic waste in open areas; recycling was practised by only 1.3% (n = 2) of households. Nearly half of respondents (49.3%, n = 74) reported never sorting their plastic waste, and two-thirds (66.7%, n = 100) regarded the existing collection system as ineffective. Education level was significantly associated with both disposal method ($\chi^2 = 16.010$, df = 6, p = .014) and sorting frequency ($\chi^2 = 17.934$, df = 6, p = .006). Combined, burning and open dumping accounted for 56.7% of household disposal behaviours. Respondents most frequently called for more collection points (52.7%) and greater community education on plastic waste (34.7%). These findings underscore the urgent need for integrated interventions combining infrastructure expansion, targeted education for less-educated households, and formal recycling programmes to curb environmentally harmful plastic disposal practices in peri-urban Zambian townships.

Keywords: Plastic waste management; Household disposal; Waste burning; Open dumping; Peri-urban settlements.

1.0 Introduction

Plastic pollution has become one of the defining environmental problems of the twenty-first century (Adeniran *et al.*, 2022; Kibria, *et al.*, 2023; Macheca *et al.*, 2024). Plastics are present in various forms in means of transportation (e.g., planes, cars, ships, motorbikes, bicycles, etc.), in hospitals, homes, household utensils, furniture, computers, cellphones, clothes, electrical and electronic goods, as well as in the food supply chain (e.g., packaging) (Geyer *et al.*, 2017; Macheca *et al.*, 2024). As a result of their role in human life's daily activities, plastic materials are the most widely produced and used when compared to other barrier materials (Macheca *et al.*, 2024). The global production of plastics has increased twenty-fold since the 1960s (Plastics—The Facts, 2020). In 2022, for instance, the world registered a global plastic production of about 400.3 million (Statista, 2021; Hira, *et al.*, 2021). Other studies have argued that if this production trend continues, it is expected to double by 2035, and almost quadruple by 2050 (Chaudhry, 2018; Ho Rouch, 2021; Rafey and Siddiqui, 2023).

The aquatic environment appears to be the biggest destination for plastic waste (Wang, *et al.*, 2018; Thushari and Senevirathna, 2020). Some studies suggest that between 7 and 13 million metric of plastic waste, which corresponds to about 3% of global plastic production, may be entering the oceans per year (Jambeck, *et al.*, 2015; Jambeck *et al.*, 2018; Gibovic, and Bikfalvi, 2021). This amount, which accounts for over 80% of marine litter (Jambeck, *et al.*, 2018), is undoubtedly very large and is pointed out as being responsible for the death of 20–30% of marine life. If the global plastic production trend continues to grow in the current rhythm, the sea would have more plastics than fish and over 97% of the seabirds would have consumed them (Lavers and Bond, 2017; Kehinde, *et al.*, 2020). According to Dutta, and Choudhury (2018), at a global level, the damage and negative impacts to marine environments caused by plastic pollution are enormous, and this accounts for around USD 13 billion per year, which essentially includes losses incurred by fisheries and tourism due to plastic littering, as well as beach clean-up costs. According to recent study, a global explosion of plastic production and its massive use is driven by its remarkable combination of properties and characteristics (Macheca, *et al.*, 2024).

Unlike many other forms of waste, plastic resists degradation for centuries once discarded, so that even modest annual increases in mismanaged waste accumulate into environmental burdens that outpace the remediation capacity of most waste management systems a mismatch that is especially pronounced in low- and middle-income countries.

Sub-Saharan Africa illustrates this mismatch starkly. Rapid urbanization, population growth, and rising plastic consumption have converged with chronically under-resourced municipal waste systems to produce some of the world's most acute plastic waste management challenges. In many African cities, waste collection coverage falls below 50 percent in peripheral areas, leaving informal settlements and peri-urban townships largely outside the reach of formal services (World Bank, 2012). Where formal collection is absent, irregular, or simply unreliable, households are compelled to devise disposal strategies of their own, and these coping strategies typically burning

or open dumping tend to carry environmental and public health costs that far exceed those of managed disposal.

The health implications of these informal disposal methods are well documented. Open burning releases a mixture of toxic air pollutants, including carbon monoxide, volatile organic compounds, polycyclic aromatic hydrocarbons, and dioxins, compounds that have been linked to respiratory disease, cardiovascular dysfunction, cancer, and immune impairment (Srinivasan and Divahar, 2025). Open dumping, meanwhile, allows plastic to fragment into microplastics and leach chemical additives into soil and groundwater, contaminating water sources and agricultural land. Plastic debris that accumulates in drainage channels can also obstruct water flow, creating standing water that serves as breeding habitat for malaria-carrying mosquitoes and other disease vectors an indirect but consequential pathway through which mismanaged plastic contributes to disease burden in affected communities.

Zambia, a rapidly urbanizing southern African nation of more than 18 million people, exemplifies many of these regional dynamics. Municipal waste services remain concentrated in central urban areas, leaving peripheral townships with limited and often inconsistent coverage. Kitwe, the country's second-largest city and a historical centre of copper mining in Copperbelt Province, has grown substantially in recent decades, and this expansion has outpaced the corresponding growth of waste management infrastructure. Ndeke Changa Changa, a peri-urban township within Kitwe, reflects this pattern: irregular collection, inadequate collection frequency, and limited access to formal disposal facilities characterize the setting in which residents make day-to-day waste disposal decisions—decisions that, in the absence of viable alternatives, often default to burning or dumping.

Despite growing recognition of these challenges, empirical evidence on household-level plastic waste behaviour remains scarce for specific Zambian townships. Much of the existing literature addresses larger African cities or generalizes across developing-country contexts, with comparatively little attention paid to the local conditions, constraints, and decision-making processes that shape household disposal choices in smaller peri-urban settlements. This gap in locally grounded evidence limits the ability of policymakers and municipal planners to design interventions genuinely responsive to community circumstances.

Closing this gap requires primary data collection at the community level data that capture not only current disposal methods but also sorting practices, perceptions of existing collection systems, and the improvements that residents themselves consider most urgent. Such evidence can help ground policy and programme design in the realities and priorities of the communities they are meant to serve. Accordingly, this study examined household plastic waste disposal behaviour in Ndeke Changa Changa, Kitwe Township, with the aim of generating locally grounded evidence to inform waste management policy and practice in similar peri-urban Zambian settings.

2.0. Materials and Methods

2.1 Study Setting

Ndeke Changa Changa is a peri-urban residential area within Kitwe Township, located in Zambia's Copperbelt Province (Figure 1). Kitwe, Zambia's second-largest city with a population exceeding 500,000, developed historically around copper mining operations and has experienced rapid population growth in recent decades, much of it concentrated in peripheral townships and informal settlements associated with mining activity. Ndeke Changa Changa typifies this pattern of peri-urban settlement: housing types range from formal structures to informal dwellings, access to municipal services is uneven, and the population is predominantly low- to middle-income.

Although Kitwe municipality maintains waste management services in the central city, coverage in peripheral townships such as Ndeke Changa Changa remains limited and irregular. Residents frequently report that collection vehicles do not reliably reach their area, or that collection frequency falls short of the rate at which household waste accumulates. This infrastructure gap leaves households with few formal alternatives when deciding how to dispose of plastic waste.

The area was selected for this study because it presents conditions well suited to examining household plastic waste management: the ward lacks dedicated waste disposal facilities and recycling operators, and community awareness of plastic waste issues appears limited. Ndeke Changa Changa lies between latitude 12°49'55" and 12°50'29" and longitude 28°13'30" and 28°14'41", within Bupe Ward, Kamfinsa Constituency, approximately 4 km southeast of Kitwe's central business district, Copperbelt Province. As one of Zambia's major urban and industrial centres, Kitwe has undergone substantial growth, and Ndeke Changa Changa a moderately to densely populated residential area faces both limited waste collection services and high rates of plastic waste generation.



Figure 1. Location of the study site.

2.2 Study Design

A cross-sectional quantitative survey design was used to capture household plastic waste management practices at a single point in time. This approach allows for description of current behaviours and examination of associations between demographic and behavioural variables, but it does not support causal inference or the assessment of temporal patterns.

2.3 Study Population and Sampling

The study population comprised all households in Ndeke Changa Changa, Kitwe Township. A sample of 150 households was selected using systematic random sampling: all residential blocks within the study area were first identified, after which households were selected at regular intervals determined by dividing the estimated total population by the target sample size of 150.

One adult respondent per household (aged ≥18 years) was interviewed, typically the household head or the person primarily responsible for waste disposal decisions. Inclusion criteria were: (1) age ≥18 years; (2) residence in Ndeke Changa Changa for ≥6 months; and (3) willingness to provide informed consent. Exclusion criteria were: (1) inability to communicate in English or Bemba; (2) cognitive impairment preventing informed participation; and (3) refusal to consent.

2.4 Data Collection Instrument

A structured questionnaire was developed to systematically collect data on household characteristics and plastic waste management practices. The instrument was pilot-tested with 20 households outside the study area to assess clarity, cultural appropriateness, and time requirements, and minor wording modifications were made following pilot feedback to improve comprehension and cultural relevance. The questionnaire captured the following variables:

Demographic and household characteristics: gender (male/female); household size (1–3, 4–6, or 7 or more people); education level (primary, secondary, tertiary).

Plastic waste management behaviours: primary method of disposing plastic waste (throw in regular trash bin, burn it, dump in open areas, recycle); types of plastic waste typically disposed (bottles, bags, packing materials and bottles, bottles and bags, bags and bottles, mixed); and frequency of sorting plastic waste before disposal (always, sometimes, rarely, never).

Perceptions and priorities: perceived effectiveness of the current plastic waste collection system (very effective, somehow effective, not effective, don't know); suggested improvements to waste management (more collection points, education on plastic waste, stricter regulations); and willingness to adopt strategies to reduce environmental pollution (yes, no, very much).

2.5 Data Collection Procedures

Data collection took place over a three-month period. Enumerators were trained community health workers and volunteers fluent in English and Bemba; training covered informed consent

procedures, questionnaire administration, ethical considerations, and non-directive interviewing techniques to minimize response bias.

Questionnaires were administered face-to-face during household visits, conducted primarily on weekends and evenings to maximize the availability of household members. All interviews took place in private household settings to protect privacy and reduce social desirability bias, and typically lasted 15–20 minutes. Responses were recorded on paper questionnaires and subsequently entered into Microsoft Excel spreadsheets by trained data entry personnel; double data entry was performed on 10% of questionnaires to verify accuracy and consistency.

2.6.Reliability and Validity of Research Instrument

The reliability of the research instrument was assessed using test-retest reliability. This involved administering the questionnaire to a sample of households twice with a time interval of two weeks. The results were analyzed using the test-retest correlation coefficient to determine the reliability of the questionnaire. The validity of the research instrument was assessed using content validity. This involved assessing the relevance and comprehensiveness of the questionnaire by experts in the field of environmental pollution.

2.7 Data Analysis

Data were analysed in Python 3.x using the pandas, scipy, and matplotlib libraries. Descriptive statistics frequencies and percentages were generated for all categorical variables to characterize the demographic profile of the sample and to describe current disposal methods, sorting behaviours, and perceptions of collection system effectiveness.

Chi-square (χ^2) tests of independence were used to examine associations between demographic variables (gender, education level, household size) and behavioural or perceptual variables (disposal method, sorting frequency, perceived collection effectiveness, suggested improvements), an approach well suited to categorical survey data of this kind. Statistical significance was set at $\alpha = 0.05$ (two-tailed).

2.8 Ethical Considerations

This study was conducted in accordance with ethical principles governing research involving human subjects. Written informed consent was obtained from all participants prior to questionnaire administration, after they had been informed of the study's purpose, procedures, potential risks and benefits, confidentiality protections, and the voluntary nature of participation. Participants were explicitly told that they could decline to answer any question or withdraw from the study at any time without penalty or loss of services.

Confidentiality was maintained through de-identification of all data; no names or other identifying information were recorded on questionnaires. All data were stored securely on password-protected

computers accessible only to the research team, and results are reported exclusively at the aggregate level, with no individual-level data presented that could identify participants.

3. Results

3.1 Sample Characteristics

A total of 150 households in Ndeke Changa Changa, Kitwe Township, were surveyed. Demographic characteristics of the sample are presented in Table 1.

Table 1. Demographic Characteristics of Survey Respondents (N = 150)

Characteristic	Category	n	%
Gender	Male	38	25.3
	Female	112	74.7
Household Size	1–3 people	39	26.0
	4–6 people	67	44.7
	7 or more people	44	29.3
Education Level	Primary	43	28.7
	Secondary	55	36.7
	Tertiary	52	34.7

The sample was predominantly female (74.7%, n = 112), consistent with the cultural pattern in this setting whereby household waste management typically falls to female household members. The modal household size category was 4–6 people (44.7%, n = 67), in line with typical household structures in the region, and education levels were fairly evenly distributed across primary (28.7%, n = 43), secondary (36.7%, n = 55), and tertiary (34.7%, n = 52) categories.

3.2 Household Plastic Waste Disposal Methods

Table 2. Household Plastic Waste Disposal Methods (N = 150)

Disposal Method	n	%
Throw in regular trash bin	63	42.0

Disposal Method	n	%
Burn it	61	40.7
Dump in open areas	24	16.0
Recycle	2	1.3

The two dominant disposal methods were nearly equally prevalent: throwing waste into regular trash bins (42.0%, n = 63) and burning (40.7%, n = 61). A further 16.0% (n = 24) of households reported disposing of plastic waste by dumping it in open areas, while recycling was virtually absent from household practice, reported by just 1.3% (n = 2) of respondents. Taken together, the environmentally harmful methods burning and open dumping accounted for 56.7% (n = 85) of all disposal behaviour, meaning that formal trash bin disposal, at 42.0%, was used by a smaller share of households than the combined informal alternatives, and formal recycling remained negligible.

3.3 Types of Plastic Waste Disposed

Respondents reported disposing of a range of plastic materials (Table 3).

Table 3. Types of Plastic Waste Typically Disposed (N = 150)

Plastic Type	n	%
Mixed plastics	54	36.0
Packing materials and bottles	35	23.3
Bags	23	15.3
Bottles and bags	19	12.7
Bags and bottles	15	10.0
Bottles	4	2.7

Mixed plastics were the most commonly reported category (36.0%, n = 54), likely reflecting the range of plastic products used in daily household activities, while packing materials combined with bottles accounted for a further 23.3% (n = 35). The prominence of mixed and combined plastic categories suggests that households undertake little sorting or segregation of plastic waste prior to disposal.

3.4 Plastic Waste Sorting Behaviour

Table 4. Frequency of Sorting Plastic Waste Before Disposal (N = 150)

Sorting Frequency	n	%
Always	30	20.0
Sometimes	37	24.7
Rarely	9	6.0
Never	74	49.3

Nearly half of respondents (49.3%, n = 74) reported never sorting plastic waste before disposal, and a further 6.0% (n = 9) did so only rarely; combined, 55.3% (n = 83) of households rarely or never sorted their plastic waste. By contrast, 20.0% (n = 30) reported always sorting and 24.7% (n = 37) sometimes sorting. This predominance of non-sorting behaviour represents a meaningful barrier to material recovery and recycling, contributing to the largely mixed plastic waste streams described above.

3.5 Perceived Effectiveness of the Plastic Collection System

Table 5. Perceived Effectiveness of Plastic Collection System (N = 150)

Effectiveness Rating	n	%
Very effective	19	12.7
Somehow effective	9	6.0
Not effective	100	66.7
Don't know	22	14.7

A clear majority of respondents (66.7%, n = 100) regarded the existing plastic waste collection system as "not effective," while only 12.7% (n = 19) rated it "very effective" and 6.0% (n = 9) "somehow effective." A further 14.7% (n = 22) reported that they "don't know" how effective the system is, possibly reflecting limited interaction with or awareness of formal collection services. This widespread perception of ineffectiveness is consistent with the infrastructure deficits, irregular collection, and inadequate service coverage that characterize this peri-urban township.

3.6 Community-Prioritized Improvements to Waste Management

Respondents were also asked what improvements should be made to plastic waste management (Table 6).

Table 6. Suggested Improvements to Plastic Waste Management (N = 150)

Suggested Improvement	n	%
More collection points	79	52.7
Education on plastic waste	52	34.7
Put strict regulations	19	12.7

Establishing more collection points was the most frequently suggested improvement (52.7%, n = 79), reflecting a community view that inadequate collection infrastructure is what drives households toward alternative disposal methods. Education on plastic waste management was proposed by 34.7% (n = 52) of respondents, pointing to a recognized knowledge gap around proper disposal, while only 12.7% (n = 19) called for stricter regulations—suggesting that residents view infrastructure, rather than enforcement, as the primary constraint.

3.7 Willingness to Adopt Environmental Pollution Reduction Strategies

Respondents were asked about their willingness to adopt strategies aimed at reducing environmental pollution. Responses were distributed as follows: 49.3% (n = 74) answered "no," 38.0% (n = 57) answered "yes," and 12.7% (n = 19) answered "very much." Combined, 50.7% (n = 76) of households expressed some willingness (yes or very much) to adopt pollution-reduction strategies, against 49.3% (n = 74) who were unwilling. This near-even split suggests that environmental concern, and openness to behaviour change, varies considerably across the community.

3.8 Chi-Square Analysis: Associations Between Demographic and Behavioural Variables

Chi-square tests of independence were conducted to examine associations between demographic variables (gender, education level, household size) and waste management behaviours and perceptions. Results are presented in Table 7.

Table 7. Chi-Square Test Results for Demographic and Behavioural Associations

Association	χ^2	df	p	Result
Disposal Method × Education Level	16.010	6	.014	Significant
Sorting Frequency × Education Level	17.934	6	.006	Significant
Disposal Method × Gender	2.197	3	.533	Not significant
Collection Effectiveness × Household Size	7.753	6	.257	Not significant
Suggested Improvements × Education Level	2.791	4	.593	Not significant
Disposal Method × Household Size	3.354	6	.763	Not significant

3.8.1 Education Level and Disposal Method

Disposal method was significantly associated with education level ($\chi^2 = 16.010$, df = 6, p = .014). Examination of the underlying contingency table showed that this association reflects a consistent gradient across education categories: respondents with only primary education were substantially more likely to dump plastic in open areas (32.6%) than those with secondary (12.7%) or tertiary education (5.8%), whereas burning was more common among secondary-educated (43.6%) and tertiary-educated respondents (50.0%) than among those with primary education (25.6%).

This pattern suggests that education is protective against the most visibly damaging disposal practice—open dumping—yet its relationship with burning runs in the opposite direction. A plausible explanation is that more educated residents, still lacking access to a genuinely better alternative such as recycling, gravitate toward burning as a less conspicuous, though not necessarily less harmful, substitute for dumping.

3.8.2 Education Level and Sorting Frequency

A stronger association was observed between education level and sorting frequency ($\chi^2 = 17.934$, df = 6, p = .006): tertiary-educated respondents were considerably more likely to be active sorters (sometimes or always sorting), at 61.5%, compared with 34.9% of primary-educated and 36.4% of secondary-educated respondents, while never sorting was most common among primary-educated respondents (60.5%), followed closely by secondary-educated respondents (60.0%), and least common among tertiary-educated respondents (38.5%).

This clear educational gradient suggests that formal education contributes to greater engagement with waste sorting, plausibly through heightened environmental awareness, better understanding of the benefits of waste reduction, or greater exposure to relevant information.

3.8.3 Non-Significant Associations

Several other associations did not reach statistical significance: gender was not a significant predictor of disposal method (Disposal Method × Gender: $\chi^2 = 2.197$, $p = .533$); household size did not significantly predict perceptions of collection effectiveness (Collection Effectiveness × Household Size: $\chi^2 = 7.753$, $p = .257$) or disposal method (Disposal Method × Household Size: $\chi^2 = 3.354$, $p = .763$); and education level did not significantly predict which improvements respondents prioritized (Suggested Improvements × Education Level: $\chi^2 = 2.791$, $p = .593$).

These null findings suggest that perceptions of collection system effectiveness and priorities for improvement are broadly shared across demographic subgroups, and that gender and household size are not, on their own, meaningful predictors of disposal method choice in this sample.

4. Discussion

4.1 Summary of Key Findings

This quantitative case study of 150 households in Ndeke Changa Changa, Kitwe Township, offers empirical insight into household plastic waste management in a peri-urban Zambian community confronting substantial waste management challenges. Several findings stand out:Burning (40.7%) and open dumping (16.0%) account for 56.7% of disposal.Only 1.3% of households recycle plastic waste recycling is nearly absent.Nearly half of households (49.3%) never sort their plastic waste.Two-thirds (66.7%) view the collection system as ineffective.Most-requested improvement (52.7%): more plastic collection points.Higher education correlates with less dumping, more waste sorting.

4.2 Infrastructure Deficits and Household Disposal Behaviour

The high prevalence of burning (40.7%) and open dumping (16.0%) observed in this study cannot be interpreted in isolation from the infrastructural conditions in which they occur. In peri-urban townships such as Ndeke Changa Changa, formal waste collection tends to be irregular, infrequent, and geographically restricted, leaving households with few viable alternatives once these services fail to meet demand.

Burning may be best understood as a household-level adaptation to this infrastructure gap. Although environmentally and health-damaging, burning may seem, from a household's perspective, preferable to letting waste accumulate on the premises or to the more visibly disorderly alternative of open dumping. Open dumping, in turn, likely reflects circumstances in which even burning is impractical or unavailable, pushing households toward disposal in vacant plots or informal dump sites.

Perhaps the most striking result in this respect is the near-parity between formal and informal disposal: 42.0% of households rely on trash bin disposal, compared with 40.7% who burn their

waste. This near-equivalence indicates that informal disposal is not confined to households lacking any access to collection services; rather, even where formal collection exists nominally, its shortcomings irregular frequency, poor accessibility, insufficient capacity appear sufficient to drive a large share of households toward burning regardless.

4.3 Education as a Behavioural Determinant of Waste Management

The significant associations between education level and both disposal method and sorting frequency point to education as a meaningful, if partial, determinant of waste management behaviour. The considerably lower rate of open dumping among tertiary-educated respondents (5.8%) relative to primary educated respondents (32.6%) is consistent with the possibility that education fosters greater understanding of environmental consequences, stronger internalization of social norms against visible dumping, or better access to information about disposal alternatives.

The education sorting relationship is similarly instructive: tertiary-educated respondents were considerably more likely to be active sorters (61.5%) than their primary-educated counterparts (34.9%), suggesting that education may cultivate greater engagement with waste-reduction practices and awareness of the value of material recovery.

Yet the finding that half of tertiary-educated respondents (50.0%) still burn their plastic waste complicates any straightforward narrative of education as a solution. It suggests, more precisely, that education is a necessary but not sufficient condition for environmentally sound disposal: even well-informed households, in the absence of adequate infrastructure, tend to fall back on burning. Sustained improvements in disposal practice are therefore unlikely to follow from educational interventions alone; they depend on education being paired with genuine improvements in collection infrastructure.

4.4 Environmental and Public Health Implications

The disposal practices documented here carry substantial environmental and public health implications. Incomplete combustion of plastic during open burning generates a complex mixture of pollutants, including carbon monoxide (a neurotoxin and asphyxiant), volatile organic compounds (many of which are carcinogenic), polycyclic aromatic hydrocarbons, and dioxins and furans, compounds that are highly toxic and prone to bioaccumulation in food chains (Srinivasan & Divahar, 2025). These emissions also generate particulate matter that deposits in the lungs, contributing to inflammation and impaired respiratory function; chronic exposure has been linked to respiratory disease, asthma exacerbation, cardiovascular disease, reduced lung function, and elevated cancer risk.

Given that 40.7% of households in this study report burning plastic waste, a considerable share of the community is likely subject to chronic exposure to these combustion products, with children, the elderly, and individuals with pre-existing respiratory or cardiovascular conditions facing disproportionate risk.

Plastic dumped in open areas presents a somewhat different but equally serious set of hazards. Over time, such waste fragments into microplastics, while additives such as phthalates, bisphenol-A, and heavy metal stabilizers and colorants leach into soil and groundwater (Mkhonza et al., 2026)a particularly concerning pathway in settings, such as this one, where groundwater constitutes an important water source. The 16.0% of households reporting open dumping, together with likely additional informal dumping at the community level, points to a diffuse and difficult-to-remediate contamination burden.

Plastic debris also has consequences beyond direct toxicity. Accumulation in drainage channels obstructs water flow and promotes flooding and erosion, while the resulting standing water creates breeding habitat for Anopheles mosquitoes, potentially contributing to the local burden of vector-borne disease. At the same time, open burning contributes to greenhouse gas emissions and black carbon, a potent short-lived climate forcer, adding a climate dimension to what is, at its core, a local waste management problem.

4.5 Implications for Waste Management Policy and Practice

4.5.1 Infrastructure Expansion as the Primary Intervention Priority

The community's clear preference for more collection points (52.7%), together with the overwhelming perception that the current system is ineffective (66.7%), provides strong grounds for treating infrastructure expansion as the primary intervention priority. Increasing the number, accessibility, and frequency of collection points could directly address the supply-side constraint that appears to be driving households toward burning and dumping. Effective expansion would likely require adequate geographic coverage, siting collection points within reasonable walking distance (an estimated 200–500 metres) of all households; sufficient collection frequency, scheduling collections regularly enough to prevent overflow and encourage sustained use of formal systems; equipment adequacy, providing bins that are sufficient in number and appropriately designed for community needs; and system reliability, maintaining consistent, predictable collection schedules to build community trust and long-term utilization.

Absent these improvements, other interventions—education, regulation—are unlikely to translate into lasting behaviour change, since households would still lack a viable formal alternative.

4.5.2 Targeted Community Education Programmes

The significant associations between education level and favourable waste management behaviours suggest that targeted community education could improve practices, particularly among the less-educated households that show the highest rates of open dumping. Education interventions are likely to be most effective if they target high-risk groups by prioritizing primary-educated households, given their comparatively high open dumping rate (32.6%) and low sorting engagement (60.5% never sort); emphasize health impacts by framing waste management as a health issue, given the salience of respiratory and waterborne disease risks to communities; use culturally appropriate formats such as community meetings, radio messaging, and peer or community health worker–led outreach rather than written materials that may not suit varied

literacy levels, and address practical constraints by presenting education as complementary to, rather than a substitute for, infrastructure improvement.

4.5.3 Formal Recycling Programme Development

The near-total absence of recycling (1.3%) represents both a shortcoming and an opportunity. Establishing accessible recycling infrastructure, supported by appropriate economic incentives, could create livelihood opportunities through buy-back centres or community recycling cooperatives that generate employment for waste pickers and recyclers; reduce environmental burden by diverting plastic away from burning and dumping into material recovery streams; engage communities, since economic incentives may motivate participation and encourage sustained behaviour change; and build social capital, as community-based recycling initiatives can strengthen social cohesion and collective efficacy.

Any such programme, however, would need to be designed with careful attention to local market structures for recovered materials and to overall economic feasibility, since an unsuccessful recycling scheme risks undermining community trust in future interventions.

4.5.4 An Integrated, Multi-Component Approach

Taken together, these findings suggest that no single intervention is likely to resolve plastic waste management challenges in Ndeke Changa Changa. An integrated approach that combines infrastructure expansion (a supply-side intervention addressing access and convenience), community education (a demand-side intervention addressing knowledge and motivation), formal recycling programmes (a value-creation intervention addressing economic incentives), and supportive regulation (a norms and accountability intervention) is more likely to yield sustained improvement than any one component pursued in isolation.

4.6 Study Limitations

Several limitations should be borne in mind when interpreting these findings. First, the cross-sectional design means data were collected at a single point in time, precluding assessment of temporal or seasonal variation, and the observed associations may reflect confounding or reverse causation rather than a clear causal pathway from education to behaviour. Second, disposal behaviours were self-reported and may be subject to social desirability bias, which would tend to understate the true prevalence of burning and dumping. Third, findings are specific to Ndeke Changa Changa and may not generalize fully to other Zambian townships with different demographic, socioeconomic, or infrastructural profiles. Fourth, the study did not measure quantities of plastic disposed, disposal frequency, household income or employment status, or awareness of the specific environmental and health consequences of different disposal methods, any of which could mediate or confound the associations reported here. Finally, perceived collection system "effectiveness" was self-reported without corroborating objective indicators (e.g., measured collection frequency or coverage), and "willingness" to adopt pollution-reduction strategies was captured as a categorical response that may not correspond to actual behaviour change.

4.7 Contributions to Knowledge and Evidence

Notwithstanding these limitations, the study makes several contributions. It provides rare, empirically grounded, household-level data on plastic waste management for a specific Zambian peri-urban township, addressing a gap in the sub-Saharan African literature; it quantifies the scale of harmful disposal practices, documenting burning at 40.7% and open dumping at 16.0%; and it captures community-identified priorities, grounding recommendations in local perceptions rather than external assumptions about appropriate interventions. The study also offers empirical evidence supportive of investment in community education, given its significant association with improved practices, and demonstrates a replicable quantitative methodology that could be applied to similar peri-urban settings elsewhere in Zambia and the wider region.

4.8 Future Research Directions

Building on these findings, future research could usefully pursue several directions.

1. Longitudinal assessment: prospective studies tracking households over time to examine temporal and seasonal patterns and responsiveness to intervention.

2. Quantitative waste characterization: direct measurement of plastic waste quantities generated, disposed, and recovered, to complement self-reported categorical data.

3. Health outcomes assessment: studies of respiratory function, disease prevalence, and biomarker exposure in communities with differing burning prevalence.

4. Intervention evaluation: randomized or quasi-experimental evaluations of infrastructure, education, and recycling interventions to assess their effectiveness, sustainability, and cost-effectiveness.

5. Upstream analysis: examination of household plastic consumption patterns and packaging choices that shape the volume and composition of waste generated.

6. Stakeholder perspectives: qualitative research with municipal authorities, waste collectors, informal sector workers, and community leaders to understand system-level constraints and feasible intervention pathways.

5. Conclusions

This quantitative case study of 150 households in Ndeke Changa Changa, Kitwe Township, provides empirical evidence of the scale and character of household plastic waste management challenges in a peri-urban Zambian community operating under substantial infrastructure constraints. More than half of surveyed households (56.7%) rely on environmentally damaging disposal practices—burning and open dumping—while recycling remains virtually absent (1.3%), sorting is limited (49.3% never sort), and two-thirds of residents regard the existing collection system as ineffective.

Education level emerged as a significant, though incomplete, determinant of household behaviour, shaping both disposal method ($p = .014$) and sorting frequency ($p = .006$). Its limits are equally

instructive: half of tertiary-educated respondents still burn their plastic waste, indicating that education alone cannot substitute for adequate collection infrastructure if environmental and health gains are to be realized.

The improvements most valued by the community expanded infrastructure (52.7%) and education (34.7%) align closely with the evidence-based recommendations set out above, offering a practical starting point for collaboration between residents and policymakers in designing interventions suited to local needs and capacities.

The scale of current disposal practices signals that plastic waste management in peri-urban Zambian townships is not simply an environmental concern; it constitutes a public health issue with implications for respiratory health, water security, agricultural productivity, and disease transmission. Evidence-based, community-engaged interventions combining infrastructure expansion, targeted community education, and the development of formal waste recovery programmes offer the most promising pathway toward more sustainable outcomes in this and comparable settings.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data Availability Statement

The dataset used in this study is available from the corresponding author upon reasonable request, subject to institutional data governance and participant privacy protections.

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