Occupational Injuries and use of Personal Protective Equipment among Casual Municipal Solid Waste Workers in the Informal Sector in Kampala: A Cross-Sectional Study.

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Abstract

Introduction:
The risk of occupational injuries in municipal solid waste workers in most low- and middle-income countries is increasing. This study sought to determine the use of PPE and its association with injuries among casual waste workers in a prototypical city.

Methods:
This was a cross-sectional study of casual waste workers at a large city landfill site in Kampala, Uganda. Structured questionnaires were used to obtain data on PPE use and occupational injuries within one year before the study. Multivariate logistic regression was used to determine the relationship between PPE use and occupational injury.

Results:
The study was conducted between May 2020 and December 2020 and enrolled 81 participants, 44 (54%) of whom were male. Overall, 27 (33%) reported not using PPE, while 53 (65%) reported experiencing injuries. In the multivariable logistic regression model, the use of PPE was associated with lower odds of injury (odds ratio [OR] 0.09, 95% 95% confidence interval [95% CI], 0.01–0.57; P=0.011). In contrast, perceived risk was associated with a greater risk of injury (OR 34.95; 95% CI, 7.00, 174.56; P<0.001). Prior training on PPE use (adjusted odds ratio, AOR 44.69; 95% CI 6.12–342.02; P=0.002), and older age (AOR 1.16; 95% CI 1.03–1.31; P=0.014), were associated with higher odds of PPE use. Additionally, waste pickers and sorters were more likely to use PPE than site traders.

Conclusions:
Among casual waste workers, there was suboptimal use of PPE and a high rate of occupational injuries. This study suggests that the non-use of PPE may be due to a lack of access and training.

Recommendations:[a]
We recommend surveillance of injuries among workers in the waste management sector as well as regular training in routine and proper use of PPEs.

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1 Introduction

Globally, occupational injuries are responsible for 2.3 million deaths [1] and more than 10 million disability-adjusted life years (DALYs) [2]. The waste management sector is now a significant labour industry because of rapid urbanization and population growth [3]. Annually, more than two billion metric tons of waste are generated globally [3], 62 million tons of which are in Sub-Saharan Africa [4]. This high rate of waste generation, including in resource-limited settings, suggests that the burden of occupational injuries in the municipal solid waste labour force will increase. Therefore, occupational safety is an increasingly global concern [5]. However, in most low- and middle-income countries (LMICs), waste management systems are not well planned [6], and there are gaps in occupational safety. The informal sector is a dominant player in the waste management sector in many LMICs [7, 8, 9, 10, 11] and enforcement of occupational safety is challenging.

Most studies have focused on occupational injuries caused by exposure to medical waste. However, in countries where waste segregation is poor, such studies may underestimate the burden of occupational injuries in waste workers. The prevalence of occupational injuries in waste workers in LMICs is estimated to be between 30% and 50% [12, 13]. Solid waste exposure is associated with a significant risk of occupational injury, infections, and chronic non-communicable diseases [14, 15]. The incidence of injuries is increasing globally and in developed countries [16]. The injuries are not only associated with significant morbidity [17, 18] but are also associated with work absenteeism [19]. Therefore, safe occupational safety practices are a priority across most low- and middle-income countries (LMICs). In other developing countries, accessibility to personal protective equipment (PPE) is limited, which exposes workers to occupational injuries [20]. Occupational injuries may occur in the entire continuum of the waste management cycle including collection or recycling to the point of ultimate disposal. Therefore, PPE must be worn by casual workers at each phase of the continuum.

The high rate of occupational injuries could be avoided by ensuring the proper use of effective PPE. However, waste management is dominated by poor individuals in the informal sector who have limited access to health services [21] as well as resources for occupational safety. As a result, the use of PPE is low in most LMICs; which leads to a high incidence of occupational injuries [5, 12, 13]. However, there are limited data on the relationship between PPE use and the risk of injury in LMICs. Data on the association between occupational injuries and specific occupational injuries are limited. In this study, we sought to determine the use of PPE and its association with occupational injuries among casual waste workers in the informal sector in a prototypical LMIC.

2 Materials and Methods

Study design and setting

This was an analytical cross-sectional study of casual waste workers at the Kitezi solid waste Landfill (GPS coordinates: 0.41149032624383264, 32.57617296125348), Kampala, Uganda. The Kitezi landfill site is owned and operated by the Kampala Capital City Authority (KCCA). It is the largest landfill site in the greater Kampala metropolitan area, serving Kampala City and the surrounding urban municipalities within a radius of approximately 30 km from the city centre. Although the landfill has administrative staff who enforce standards, all waste activities, including waste salvaging, sorting, and recycling are performed by private individual workers who subscribe to a community-based organization whose activities are overseen by KCCA; the individuals are responsible for their PPE.

Study population and sampling

The study population comprised garbage sorters, refuse pickers, and traders engaging in waste products. These worker categories are the major casual waste workers in the Ugandan context. Assuming a period prevalence of 44% over one year in non-PPE users [22], this study required sample size of 142 participants to determine a 50% lower injury rate among PPE users, assuming a power of 80% and α=0.05. However, due to funding limitations and some casual workers working in shifts, only 81 participants were accrued. Participants were consecutively enrolled. Selection bias was minimized by enrolment across all work shifts (Morning, afternoon, and night shifts). We recruited all waste workers who had worked at the landfill site for at least one year and were either engaged as waste pickers, sorters, or traders in waste products at the dumping site. We excluded children (<18 years) as

these could not be consented to participation since child labour is illegal in Uganda.

Definitions of terms

We defined occupational injury as any personal physical injury, disease or death resulting from waste management-related work [23]. In addition, Personal protective equipment (PPE) was defined as protective clothing, helmets, goggles, or equipment designed to protect a worker from injury or infection. Finally, we defined waste as garbage, sludge from treatment plants, other discarded material, resulting from industrial, commercial, mining, agricultural, and from community activities. Data on demographic characteristics, PPE use, and injuries were obtained using a translated administered questionnaire (in Luganda).

Data collection tool and data quality procedures

Data were collected using a structured questionnaire, translated into the local language, and administered by trained research assistants. The questionnaire was pretested among 20 respondents and Cronbach's alpha of 0.70 was deemed satisfactory reliability. Data were collected on sociodemographic characteristics, economics, current PPE use, and occupational-related injuries within one year before the study. Data were also obtained on self-reported PPE use, the type of PPE used, prior training on PPE use, reasons for not using PPE, and awareness of the prevailing administrative rules and guidelines for waste collectors. Finally, data were cleaned using SAS Enterprise Guide software version 9.4 (SAS Institute Inc., Cary, NC, USA) and analysed with Stata version 16.0 (StataCorp, College Station, Texas, USA).

Statistical analysis

Categorical characteristics of study participants were presented as frequencies while continuous variables were summarized as the median and interquartile range (IQR). Bar charts were used to describe injury rates and PPE use. Age, duration of employment and daily income were treated and analysed as continuous variables. The rest of the variables, including, education, marital status, waste type, job category, and prior training were analysed as categorical variables. Bivariate logistic regression was used to determine the unadjusted odds ratio of a prior injury and PPE use for all explanatory covariates. Variables with an overall p-value <0.2 (Wald test or trend test) were considered for multivariate regression. The backward elimination method was used to fit the final regression model. The Hosmer–Lemeshow Pearson $\chi 2$ goodness-of-fit test was used to test the fitness of the final multivariable regression models. To determine, the Goodness-of-fit test of the final model we used the Hosmer–Lemeshow procedure [24]. Accordingly, where the number of covariate patterns in the final model was close to the number of observations, the data were regrouped by ordering on the predicted probabilities.

3 Results

Demographic characteristics of the study respondents

The study was conducted between May 2020 and December 2020. Overall, this study reached out to 100 participants, 81(81%) accepted to participate. The participants were predominantly young respondents. The median (IQR) age was 30 (24, 36). Of these, 54 (67%) were waste pickers, and the majority were engaged in plastic and metal picking and sorting (Table 1). The majority of the respondents were male (54%), with an education level of at least the primary level (87%). Poverty was the main reason for engaging in waste activities (81%) and the median daily income was 2.51 (1.64, 2.70) United States dollars.

Use of protective equipment and occupational injuries to waste workers

Of the 81 respondents, 27 (33%) were not using any personal protective equipment at the time of the survey. In the 27 PPE nonusers, the main reasons for not using PPE were not owning one (n=22), unwillingness to use the PPE despite owning one (n=3) and believing that the PPE was not helpful (n=2). The most common PPE used by the respondents were gloves (32%) and gumboots (43%) (Figure 1).

Personal protective equipment used by waste workers (N=81)

Overall, 53 of the 81 participants (65%) reported occupational injuries within one year before the study. The commonest injuries were back pain (64%), cuts (54%), and skin injuries (12%) (Figure 2)

The injuries in the waste workers were associated with the non-use of personal protective equipment (PPE). Overall, there were fewer injuries in the participants who were using PPE than those who were not using PPE ($\chi 2$=7.98, P=0.005). The specific injuries, skin injuries, back pain, eye injury, hearing

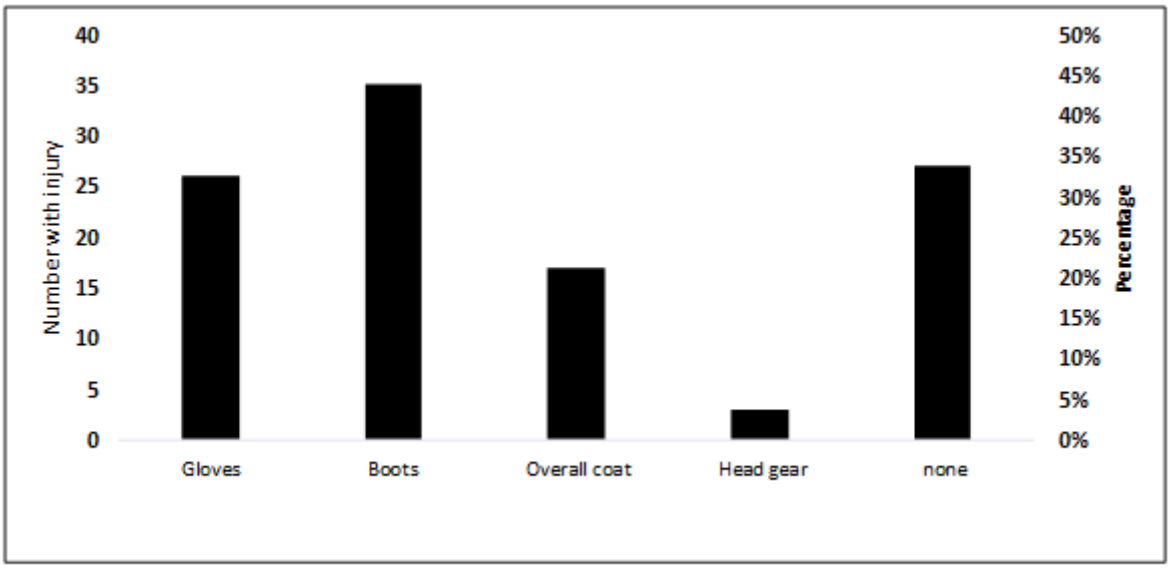

Figure 1. Personal protective equipment used by waste workers (N=81)

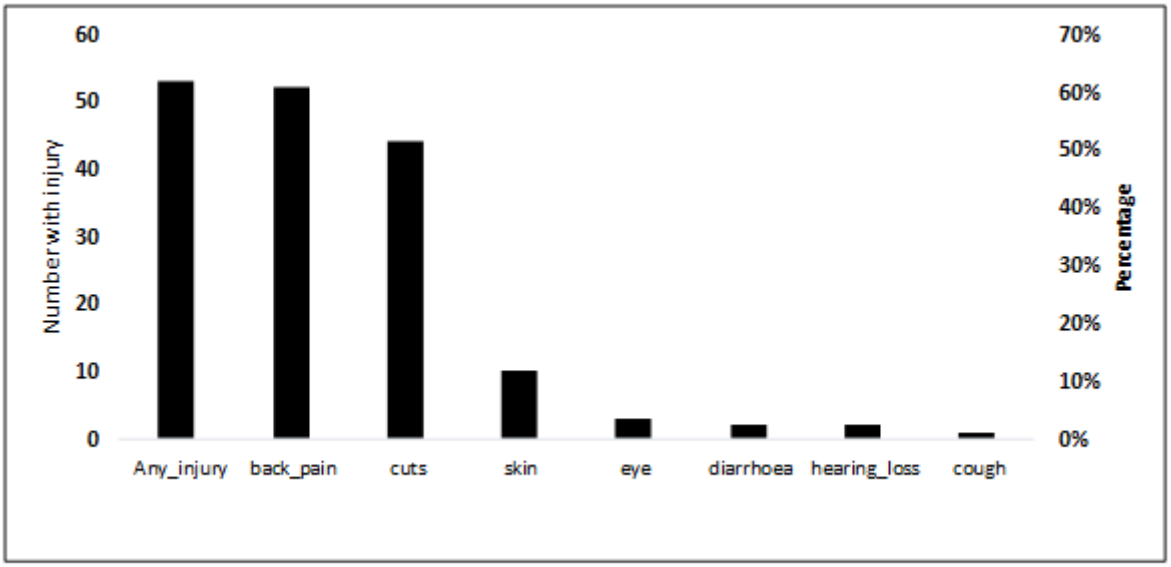

Figure 2. Occupational injuries in thestudy respondents (N=81)

loss, and diarrhoea, were fewer in those using PPE compared with those who were not using PPE (Table 2). However, there was no evidence to suggest that respiratory complaints and cuts were fewer in those using PPE compared to those not using PPE.

Factors associated with occupational injuries in casual waste workers

In the bivariable analysis, the factors that were associated with a lower risk of injury were longer experience in waste work (OR 0.99; 95% CI 0.98–1.00; P=0.019), self-reported PPE use (OR 0.14; 95% CI 0.03–0.64; P=0.011), being aware of the policies and rules (OR 0.13; 95% CI 0.03–0.59; P=0.009), and knowledge of the administrative structures at the waste dumping site (OR 0.08; 95% CI 0.01–to 0.64; P=0.017). On the other hand, the odds of injury were 13-times higher in those who perceived being at risk than those who did not perceive themselves to be at risk (OR 13.32; 95%CI 4.09–43.41; P<0.001). In the final multivariable model (Table 3), PPE use was protective against injuries (OR 0.09; 95% CI 0 .01–0.57; P=0.011) while perceived risk by respondents was associated with greater injury risk OR 34.95; 95% CI 7.00–174.56; P<0.001).

Table 1. Prevalence of injuries by PPE use

Variable	Category	Number (%) using PPE; n=54	Number (%) not using PPE; n=27	Total (%) n=81	$\chi 2$	p-value
Any injury	Yes	27 (51)	26 (49)	53 (100)	17.06	0.005
	No	27 (96)	1 (4)	22(100)		
Skin Injuries	Yes	0 (0)	10 (100)	10(100)	22.82	<0.001
	No	54 (76)	17 (240	71(100)		
Back pain	Yes	27 (52)	25 (48)	52(100)	14.21	<0.001
	No	27 (93)	2 (7)	29(100)		
Diarrhoea	Yes	0 (0)	2 (100)	2(100)	4.10	0.043
	No	54 (68)	25 (32)	79(100)		
Cuts	Yes	28 (64)	16 (36)	44(100)	0.40	0.528
	No	26 (70)	11 (30)	37(100)		
Cough	Yes	0 (0)	1 (100)	1 (100)	2.03	0.115
	No	54 (68)	26 (32)	80 (100)		
Eye injuries	Yes	0 (0)	3 (100)	3(100)	6.23	0.013
	No	54 (69)	24 (31)	78(100)		
Auditory injuries	Yes	0 (0)	2 (100)	2 (100)	4.10	0.043
	No	54 (68)	25 (32)	79 (100)		
Other injuries	Yes	17 (94)	1 (6)	18 (100)	8.04	0.005
	No	37 (59)	26 (41)	63 (100)		

Note: PPE-personal protective equipment

Factors associated with the use of PPE by casual workers in waste management

In the bivariate analysis, the factors associated with PPE use were age (OR 1.13 (1.05 –1.22; P=0.001), long experience in waste work (OR 1.05; 95% CI 1.02–1.08; P=0.001), prior training and high daily income (OR 1.57; 95%CI 1.03–2.38; P=0.036). On the contrary, sorters, compared to pickers, were less likely to use PPE (OR 0.19; 95% CI 0.06–0.62; P=0.006). In the final multivariate model (Table 4), prior training in PPE use (AOR 44.69; 95% CI 6.12–342.02; P=0.002) and older age (AOR 1.16; 95% CI 1.03–1.31; P=0.014) were associated with higher odds of PPE use. On the other hand, site traders who deal in waste products were less likely to use PPE (AOR 0.01; 95% CI 0.00–0.24; P=0.006).

4 Discussion

In this cross-sectional study among casual waste workers in Kampala, one in three waste workers was not using PPE. The burden of occupational injuries was high and highest among those who were not using PPE. The results of our study are consistent with studies in similar settings that have reported occupational injury rates of 30%-50% in waste workers [19, 22, 25].

In the present study, the use of PPE was associated with lower rates of occupational injuries, while perceived risk of occupational injury was associated with greater odds of actual occupational injury. This study has documented that training in PPE use and older age were associated with greater odds of PPE use. While a similar study reported a general lack of PPE in casual workers in Zimbabwe [20], another study reported a lack of consistent use in Tanzania [26]. While there was no significant relationship between socioeconomic covariates and occupational injury in this study, this may reflect a generally homogenous poor population since this study targeted casual workers. In Tanzania, alcohol use was associated with occupational injuries while males had twice as higher odds of injury as women. Therefore, social and behavioural practice barriers to appropriate PPE use should remain a focus for public health interventions.

Although most occupational injuries in this study were acute injuries (e.g., cuts), they have the potential of spreading serious infections. For example, more than half of the workers reported work-related cuts. Other studies have also reported cuts to be the major occupational injury among waste workers [22, 26]. Skin puncture injuries and cuts

Table 2. Factors associated with occupational injury injuries within one year

Variable		Crude OR (95%)	P-value	Adjusted OR (95%)	P-value
Sex	Female	0.59 (0.22, 0.62)	0.306		
	Male	Ref		Ref	
Age		0.95 (0.90,1.01)	0.090	1.00 (0.91, 1.09)	0.933
Duration (months)		0.99 (0.98, 1.00)	0.019	0.98 (0.97,1.00)	0.052
Daily income (USD)		1.04 (0.76, 1.43)	0.794		
payment (USD per hour) [1]		0.31(0.06, 1.68)	0.174		
Education	None	Ref			
	Primary	2.16 (0.52, 9.03)	0.292		
	Secondary	1.14 (0.26, 4.95)	0.858		
Marital status	Single	Ref			
	Married	1.05 (0.35, 3.18)	0.931		
	Separated	0.64 (0.15, 2.77)	0.547		
	Divorced	1.45 (0.14, 5.04)	0.753		
Waste type	Metal	Ref			
	Plastic	2.36 (0.75, 7.42)	0.143		
	Other [2]	1.15 (0.32, 4.16)	0.829		
Job category	Picker				
	Sorter	2.69 (0.54, 3.29)	0.224		
	Trader	0.31 (0.12, 1.74)	0.254		
Prior Training	Yes	0.80 (0.29, 2.18)	0.660		
	No	Ref			
Perceived risk	Yes	13.32 (4.09, 43.41)	<0.001	34.95 (7.00, 174.56)	<0.001
	No	Ref		Ref	
PPE use	Yes	0.14 (0.03, 0.64)	0.011	0.09 (0 .01, 0.57	0.011
	No	Ref		Ref	
Know administration	Yes	0.08 (0.01, 0.64)	0.017	0.31 (0.02, 4.22)	0.382
	No	Ref		Ref	
Know Policies and Rules	Yes	0.13(0.03, 0.59)	0.009	0.34 (0.02, 6.49	0.474
	No				

Note: [1]USD-United states dollars, [2]These included biological waste, for example, food vegetation; the variables without AOR were not considered in the multivariable model because they had a Wald/trend p-value>0.2

Table 3. Predictors of PPE use

Variable		Crude OR (95%)	P-value	Adjusted OR (95%)	P-value
Sex	Female	Ref			
	Male	0.74 (0.29,1.89)	0.529		
Age		1.13 (1.05, 1.22)	0.001	1.16 (1.03, 1.31)	0.014
Duration (months)		1.05 (1.02,1.08)	0.001	1.03 (0.99, 1.06)	0.131
Daily income (USD)		1.57 (1.03, 2.38)	0.036	1.28 (0.56,2.93)	0.557
payment (USD per hour) [1]		1.17 (0.26, 5.21)	0.837		
Education	None	Ref		Ref	
	Primary	1.27(0.34, 4.84)	0.722	1.17 (0.11, 12.46)	0.895
	Secondary	3.67(0.79, 17.00)	0.097	18.93(0.78, 457.52)	0.070
Marital status	Single	Ref			
	Married	1.26(0.45, 3.54)	0.657		
	Separated	2.61(0.47, 14.30)	0.270		
	Divorced	0.39 (0.06, 2.68)	0.335		
Waste type	Metal	Ref			
	Plastic	1.95 (0.64, 5.89)	0.239	0.73 (0.11, 4.72)	0.743
	Other [2]	0.41 (0.12, 1.39	0.152	0.32 (0.04, 2.76)	0.302
Job category	Picker	Ref		Ref	
	Sorter	0.19 (0.06, 0.62)	0.006	0.23 (0.02, 2.42)	0.223
	Trader	0.55 (0.14, 2.20)	0.402	0.01(0.00, 0.24)	0.006
Prior Training	Yes	30.16 (3.81, 238.46)	0.001	44.69 (6.12,342.02)	0.002
	No				

Note: [1]USD-United states dollars, [2]These included biological waste, for example, food and vegetation; the variables without AOR were not considered in the multivariable model because they had a Wald/trend p-value>0.2.

are potential avenues for serious infections, including tetanus, HIV, and hepatitis infections. Additionally, injuries like back pain and hearing loss have the potential to evolve into severe disabling complications. In addition, the fact that musculoskeletal injuries, including back pain, were common suggests that physiotherapy and ergonomics training should be integrated into injury prevention services. Therefore, public interventions should also focus on improving access to health services so that workers receive prompt health care. The driver of the non-use of PPE in this study seems to be the lack of accessibility to PPE. Therefore, the provision of PPE may increase PPE use in informal waste workers. Despite the challenges of enforcing occupational safety in the informal sector, the informal sector is a dominant stakeholder in waste management [7, 8]. Most of the respondents joined the industry because of poverty. Their daily income is just below the poverty level. This may explain why most waste workers were using improvised PPE. Therefore, despite the high rate of occupational injuries, the informal sector should be prioritized for PPE accessibility.

Despite the weaknesses, this study addressed an important occupational health problem amongst casual waste workers in the informal sector. This population is at the highest risk of occupational injuries and should be a focus for occupational health research. In this study, we determined the relationship between specific injuries and PPE use. This study is an important investigation to highlight the efficacy of PPE in protecting major injuries. In addition, previous studies were conducted in predominantly female populations [12, 22]. In the Uganda context and most countries, waste management is dominated by males [27, 28]. The results of this study are therefore generalizable to other LMICs [13] where the waste management sector is dominated by the male gender. This analysis is therefore important for understanding whether PPE provides comprehensive occupational safety in many LMICs.

5 Limitations

This study is not without weakness. First, the sample size was small. Nevertheless, the estimates are robust enough and may not be due to a type 2 error alone. However, this study was not well powered to determine the relationships between injury risk and some covariates. Second, there is potential recall bias since participants were interviewed about their injury experiences over the previous year. However, this period is reasonable and has been used in other studies that have focused on a similar research question [12, 22].

6 Conclusions

Overall, there is a high rate of noncompliance with PPE use by casual workers in the informal waste management sector. The majority of the workers used nonconventional PPEs and experienced high rates of injuries. The commonest injuries were cuts and skin injuries, but there were also significant injuries that are associated with disability and morbidity. The use of PPE could be protective against injuries if accessible and appropriately used by casual workers. To mitigate the high rates of skin puncture injuries and cuts, municipal authorities should supplement PPE with onsite first aid health services. Since the informal sector is dominated by a poor population, public health interventions to increase PPE use and avert occupational injuries must focus on distribution and training workers on PPE use.

Author Contributions: JN originated the idea and collected the data, assisted by BB and DMB. DMB and IA conducted the analysis, and DMB drafted the initial draft, which was then reviewed by all authors. All authors reviewed and approved the final manuscript.

7 Funding:

This research received no external funding.

Institutional Review Board Statement:

Ethical review and approval were waived for this study, due to this study posing minimal risk to participants. Nevertheless, Administrative permission was also sought from the Directorate of Public Health and Environment (DPHE), Kampala Capital City Authority. All study methods and procedures were per the ethical guidelines and regulations of the HDREC and the Declaration of Helsinki.

Informed Consent Statement:

Informed consent was obtained from all subjects involved in the study

Data Availability Statement:

The Uganda Data Protection and Privacy Act, 2019, expressly prohibits the sharing of clinical data without permission from the government. Therefore, the data may not be publicly available. Data are however available from the authors upon reasonable request and with permission from the government data protection office

Acknowledgements:

We acknowledge the study participants and the course convenor for Environmental Health at the Makerere School of Public Health.

We also thank and acknowledge the support of the Kampala City Council Authority, especially the Environment and Public Health Directorate. This work was also supported by the leaders of the waste collector's association.

Conflicts of Interest:

The authors declare no conflict of interest. Data presented herein was collected by a student (JN) in fulfilment of an award for a bachelor's degree from Makerere University.

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