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# Uptake of non-pharmaceutical safety devices among waste management refuse handlers in Kicukiro District to prevent and control disease

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***Abstract:*** **Background: Waste management refuse handlers are routinely exposed to pathogens responsible for hepatitis, tuberculosis, and gastrointestinal infections, and non-pharmaceutical safety devices (gloves, masks, protective clothing) are a primary barrier against this exposure. Evidence from Ghana, South Africa, and elsewhere in sub-Saharan Africa indicates that availability of such devices does not reliably translate into consistent use, and comparable data from Rwanda, particularly at district level, are limited [1,4,5,6]. This study assessed the uptake of non-pharmaceutical safety devices among waste management refuse handlers in Kicukiro District, Rwanda, and the factors associated with that uptake.**

**Methods: A concurrent mixed-methods cross-sectional study was conducted among refuse handlers employed by a waste management company operating in Kicukiro District. From a workforce of 892 staff, a sample of 276 was determined using the sample-size formula popularized by Slovin and mathematically equivalent to Yamane's approach for an unknown population variance, with a 5% margin of error, and selected by stratified random sampling. Structured questionnaires were administered to the 276 refuse handlers, and semi-structured key-informant interviews were conducted with 10 waste-management company leaders. Quantitative data were analyzed descriptively and using chi-square tests and multivariable binary logistic regression in SPSS version 28.0; qualitative data were analyzed thematically.**

**Results: Overall, 64.0% (177/276) of refuse handlers reported using non-pharmaceutical safety devices, with gloves (65.2%) and masks (54.3%) most commonly used; only 44.2% reported consistent use across all tasks. In multivariable logistic regression, independent positive predictors of uptake were participation in awareness/training programmes (adjusted odds ratio [AOR] 5.42, 95% confidence interval [CI] 2.90–10.14, p<0.001), acceptance of modern safety practices (AOR 6.88, 95% CI 3.54–13.36, p<0.001), permanent employment relative to casual work (AOR 3.85, 95% CI 2.10–7.05, p<0.001), and university-level education relative to secondary education (AOR 1.89, 95% CI 1.05–3.95, p=0.033). Female sex (AOR 0.45, 95% CI 0.25–0.78, p=0.004), age 46 years or older (AOR 0.40, 95% CI 0.19–0.81, p=0.012), and no formal education (AOR 0.48, 95% CI 0.24–0.97, p=0.041) were independently associated with lower uptake. Qualitative findings identified traditional beliefs, peer influence, fatalistic religious attitudes, and discomfort as recurring barriers to consistent use, even where awareness of safety devices' importance was high.**

**Conclusion: Uptake of non-pharmaceutical safety devices among refuse handlers among the study participants is suboptimal and inconsistent, shaped by a combination of structural employment conditions, training exposure, and socio-cultural beliefs. Training participation and acceptance of modern safety practices were the strongest modifiable predictors identified, but persistent associations with gender, age, education, and employment status indicate that behaviour-change interventions alone are unlikely to be sufficient without complementary policy and employment-formalization measures.**

***Keywords:*** **personal protective equipment; occupational health; waste management; refuse handlers; Rwanda; disease prevention; mixed-methods.**

## 1. INTRODUCTION

Waste management refuse handlers are occupationally exposed to a wide range of biological hazards, including the pathogens responsible for hepatitis, tuberculosis, and gastrointestinal infections, encountered through direct contact with household, medical, and municipal waste streams. Non-pharmaceutical safety devices, principally gloves, masks, and protective clothing, function as the first line of defence against this exposure and are a core component of occupational health protocols for this workforce [1]. Beyond protecting individual workers, consistent use of such devices reduces work-related infections and the associated burden on healthcare systems, a consideration of particular importance in densely populated, lower-resource settings where access to care may be constrained.

Globally, the World Health Organization, the International Labour Organization, the World Bank, and WaterAid have jointly highlighted that sanitation and waste workers remain an under-protected occupational group: a multi-country assessment found that personal protective equipment provision and consistent use among sanitation workers vary widely both between and within countries, and that workforces in this sector are frequently male-dominated, informally employed, and excluded from routine occupational health protections [1]. Complementing this, the International Labour Organization has separately noted that workers in the informal economy, who make up a large share of waste handling labour in many low- and middle-income countries, are disproportionately exposed to occupational hazards with comparatively limited access to protective equipment, training, and regulatory enforcement [2].

Evidence from sub-Saharan Africa illustrates this gap concretely. In the Ho Municipality of Ghana, domestic waste collectors reported substantial unmet protective equipment needs alongside self-reported occupational health problems, with socio-cognitive factors such as perceived susceptibility, perceived benefit, and social norms shaping the intention to use protective equipment more strongly than its mere availability [4,5]. In a qualitative study from a South African municipality, solid waste handlers described being provided with only partial protective equipment, with permanent staff better equipped than casual or temporary colleagues, alongside physical, biological, and psychosocial hazards that protective equipment alone could not address [6]. A scoping review of psychosocial work factors among waste collectors across multiple developing-country settings similarly concluded that safety behaviour is shaped jointly by workplace psychosocial conditions, training exposure, and community-level beliefs, rather than by equipment availability in isolation [9].

In Rwanda, occupational exposure among waste and sanitation workers has been documented directly: a study of fecal sludge collection and resource recovery workers in Kigali measured occupational endotoxin exposure substantially above recommended limits during several job tasks, underscoring the biological hazard this workforce faces day to day [3]. Rwandan labour law places an explicit duty on employers to provide protective equipment to all employees, permanent and non-permanent, at no cost to the worker [14], yet the extent to which this legal obligation translates into consistent device use at the district level, and the specific socio-economic, cultural, and behavioural factors that mediate this translation, has not been well characterized for Kicukiro District specifically.

This study therefore aimed to determine the prevalence and pattern of non-pharmaceutical safety device uptake among waste management refuse handlers in Kicukiro District, and to examine the socio-economic, socio-cultural, and knowledge/attitude/practice factors associated with that uptake, with a view to informing locally appropriate occupational health interventions. The specific objectives were: (i) to determine the prevalence and pattern of uptake of non-pharmaceutical safety devices; (ii) to examine socio-economic factors influencing uptake; (iii) to assess socio-cultural and belief factors influencing uptake; and (iv) to assess how knowledge, attitudes, and practices influence uptake, in order to prevent and control disease among this workforce.

## 2. METHODS

### *Study Design and Setting*

A concurrent mixed-methods cross-sectional design was used, combining a structured quantitative survey of refuse handlers with qualitative key-informant interviews of waste-management company leaders, conducted within the same data-collection period so that the two strands could be interpreted jointly. The study was conducted in Kicukiro District, one of three districts of Kigali City, Rwanda, which has a population of 491,731 across 166.7 square kilometres, of whom 334,227 (the majority) fall within the 15–64-year working-age range. The employment-to-population ratio in the district is 55.7%, higher in urban (55.8%) than rural (37.7%) sectors of the district.

***Population and Sampling***

The target population comprised waste management refuse handlers employed by Longitude Company Ltd, a waste management company operating in Kicukiro District with a workforce of 892 staff at the time of the study. Because this population exceeded 100, the sample size was calculated using the widely used formula popularised under the name "Slovin's formula," $n = N / (1 + N \cdot e^2)$, with N=892 and a precision level e=0.05, yielding a required sample of approximately 276 refuse handlers. This formula is mathematically equivalent to the approach independently described by Yamane for situations where the variance of the population characteristic of interest is unknown [10], and is appropriate when, as here, a quick, defensible estimate of minimum sample size is needed from a known population total. Stratified random sampling was then used to select the 276 participants from the 892-strong workforce, a method appropriate for ensuring proportional representation across workforce subgroups [11]. For the qualitative strand, 10 key informants (waste-management company leaders) were purposively selected and interviewed.

***Data Collection***

Quantitative data were collected using a structured, interviewer-administered questionnaire covering: socio-demographic characteristics; prevalence and pattern of non-pharmaceutical safety device use; socio-economic factors; socio-cultural and belief factors; and knowledge, attitudes, and practices related to safety device use and disease prevention. Qualitative data were collected through semi-structured key-informant interviews with company leaders, audio-recorded with participant consent and supplemented with written notes, exploring the same thematic domains in greater depth, particularly socio-cultural beliefs and knowledge/attitude/practice barriers.

Prior to full data collection, the principal investigator conducted a one-day training session for research assistants to standardize administration of the questionnaire and interview guide. Data collection tools were piloted (see below) and refined accordingly. Questionnaires were administered face-to-face by trained research assistants, who remained present during completion to clarify ambiguities and were authorized to retrieve incomplete questionnaires at a later time to maximize the response rate. All 276 distributed questionnaires were completed and returned.

***Pilot Study and Instrument Properties***

A pilot study was conducted among 28 waste management refuse handlers in the neighbouring Gasabo District (a site distinct from the main study area, to avoid contaminating the primary sample) to assess clarity, logical flow, and time burden of the questionnaire. Internal consistency of the structured items was assessed using Cronbach's alpha, the standard coefficient for this purpose [12], with a threshold of $\geq 0.70$ taken as indicating acceptable reliability, consistent with conventional guidance [13]. Content and face validity were established through expert review by university supervisors, who verified that each instrument item mapped clearly onto a specific study objective.

***Data Analysis***

Quantitative data were managed and analyzed in IBM SPSS Statistics version 28.0. Descriptive statistics (frequencies and percentages for categorical variables) characterized the sample and each thematic domain. Bivariate associations between candidate predictors and current safety-device use (the primary outcome, coded as a binary yes/no variable) were assessed using Pearson's chi-square test, with chi-square statistics, degrees of freedom, and p-values reported; statistical significance was set at $p<0.05$. Variables reaching bivariate significance were considered for a multivariable binary logistic regression model to identify independent predictors of safety-device use, with results reported as adjusted odds ratios (aOR) with 95% confidence intervals; the Wald statistic was used to test the significance of individual coefficients, and the Nagelkerke $R^2$ was used to summarize the proportion of variance in uptake explained by the model. Qualitative data from key-informant interviews were transcribed, coded, and analyzed thematically, with themes and sub-themes developed inductively from the transcripts and illustrated with de-identified participant quotations.

***Ethical Considerations***

Ethical approval was obtained from the Institutional Review Board of Mount Kigali University prior to data collection. Following ethical clearance, an introduction letter from the university facilitated access to the study site, and written permission to conduct the study was obtained from the management of Longitude Company Ltd after a formal request describing the study's purpose, methodology, and expected benefits. Informed consent was obtained from all participants in Kinyarwanda, the language participants understood best, after a full explanation of the study's purpose, procedures, foreseeable risks and benefits, voluntary nature, and right to withdraw without penalty or effect on employment status.

Written consent was obtained where possible; where a participant was unable to provide written consent, verbal consent was obtained and witnessed by an independent observer. All study data, including completed questionnaires, interview transcripts, and demographic records, were stored in secure, password-protected electronic systems accessible only to authorized study personnel.

## 3. RESULTS

### *Socio-Demographic Characteristics*

Of 276 refuse handlers, 69.6% (n=192) were male and 30.4% (n=84) female. The largest age group was 26–35 years (30.1%, n=83), followed by 36–45 years (25.0%, n=69), ≥46 years (23.2%, n=64), and 18–25 years (21.7%, n=60). Nearly half (47.8%, n=132) were married, 42.0% (n=116) had completed only primary education, and 38.4% (n=106) were employed on a casual basis, the single largest terms-of-service category (Table 1).

**Table 1. Socio-demographic characteristics of respondents (n=276)**

| Variable | Category | n | % |
|---|---|---|---|
| **Gender** | Male | 192 | 69.6 |
| | Female | 84 | 30.4 |
| **Age (years)** | 18–25 | 60 | 21.7 |
| | 26–35 | 83 | 30.1 |
| | 36–45 | 69 | 25.0 |
| | ≥46 | 64 | 23.2 |
| **Marital status** | Married | 132 | 47.8 |
| | Single | 100 | 36.2 |
| | Divorced | 22 | 8.0 |
| | Widowed | 22 | 8.0 |
| **Education level** | No formal | 44 | 15.9 |
| | Primary | 116 | 42.0 |
| | Secondary | 88 | 31.9 |
| | University | 28 | 10.1 |
| **Religion** | Catholic | 116 | 42.0 |
| | Protestant | 84 | 30.4 |
| | Muslim | 34 | 12.3 |
| | SDA | 24 | 8.7 |
| | Others | 18 | 6.5 |
| **Terms of service** | Casual | 106 | 38.4 |
| | Permanent | 76 | 27.5 |
| | Contract | 52 | 18.8 |
| | Volunteer | 22 | 8.0 |
| | Others | 20 | 7.2 |

### *Prevalence and Uptake of Non-Pharmaceutical Safety Devices*

Overall, 64.0% (n=177) of refuse handlers reported currently using non-pharmaceutical safety devices; among users, 29.0% used devices always, 19.9% most of the time, 10.9% sometimes, and 4.3% rarely. Among the 99 non-users, the most common reasons cited were lack of availability (13.0%) and discomfort (8.0%). Gloves (65.2%) and masks (54.3%) were the most commonly used device types, followed by hand sanitizer (39.9%), protective clothing (20.3%), and safety glasses (18.1%). Only 44.2% of respondents reported consistent use across all tasks, while 46.4% reported inconsistent use. Employer provision was the dominant source of devices (61.6%), and 50.7% considered devices affordable (Table 2).

**Table 2. Prevalence and uptake of non-pharmaceutical safety devices (n=276)**

| Variable | Category | n | % |
|---|---|---|---|
| **Use safety devices (outcome)** | Yes | 177 | 64.0 |
| | No | 99 | 36.0 |
| **Frequency of use (if yes)** | Always | 80 | 29.0 |
| | Most of the time | 55 | 19.9 |
| | Sometimes | 30 | 10.9 |
| | Rarely | 12 | 4.3 |
| **Reason for not using (if no)** | Lack of availability | 36 | 13.0 |
| | Uncomfortable | 22 | 8.0 |
| | Not aware of importance | 12 | 4.3 |
| | Not provided by employer | 21 | 7.6 |
| | Others | 8 | 2.9 |
| **Believes using correctly** | Yes | 160 | 58.0 |
| | No | 86 | 31.2 |
| | Don't know | 30 | 10.8 |
| **Device type used (Yes)** | Gloves | 180 | 65.2 |
| | Masks | 150 | 54.3 |
| | Safety glasses | 50 | 18.1 |
| | Protective clothing | 56 | 20.3 |
| | Hand sanitizer | 110 | 39.9 |
| **Consistent use across tasks** | Yes | 122 | 44.2 |
| | No | 128 | 46.4 |
| | Don't know | 26 | 9.4 |
| **Adopted new devices (past year)** | Yes | 70 | 25.4 |
| | No | 182 | 65.9 |
| | Don't know | 24 | 8.7 |
| **Devices easily accessible** | Yes | 150 | 54.3 |
| | No | 96 | 34.8 |
| | Don't know | 30 | 10.9 |
| **Source of devices** | Provided by employer | 170 | 61.6 |
| | Self-purchase | 48 | 17.4 |
| | Local health agencies | 38 | 13.8 |
| | Others | 20 | 7.2 |
| **Devices considered affordable** | Yes | 140 | 50.7 |
| | No | 98 | 35.5 |
| | Don't know | 38 | 13.8 |

***Socio-Economic Factors Influencing Uptake***

Most respondents (60.9%) reported that their income was insufficient to purchase personal protective equipment. The largest income bracket was 50,000–100,000 RWF per month (36.2%), and 56.5% reported receiving no employment benefits. Just over half (52.9%) considered their employment stable, and 55.8% reported access to healthcare services (Table 3).

**Table 3. Socio-economic factors influencing uptake (n=276)**

| Variable | Category | n | % |
|---|---|---|---|
| **Income sufficient to purchase PPE** | Yes | 84 | 30.4 |
| | No | 168 | 60.9 |
| | Don't know | 24 | 8.7 |
| **Monthly income** | <50,000 RWF | 86 | 31.2 |
| | 50,000–100,000 RWF | 100 | 36.2 |
| | 100,000–200,000 RWF | 58 | 21.0 |
| | 200,000–400,000 RWF | 22 | 8.0 |
| | >400,000 RWF | 10 | 3.6 |
| **Receives employment benefits** | Yes | 104 | 37.7 |
| | No | 156 | 56.5 |
| | Don't know | 16 | 5.8 |
| **Living conditions adequate** | Yes | 142 | 51.4 |
| | No | 106 | 38.4 |
| | Don't know | 28 | 10.2 |
| **Employment stable** | Yes | 146 | 52.9 |
| | No | 94 | 34.1 |
| | Don't know | 36 | 13.0 |
| **Access to healthcare services** | Yes | 154 | 55.8 |
| | No | 98 | 35.5 |
| | Don't know | 24 | 8.7 |

*PPE = personal protective equipment.*

***Socio-Cultural and Belief Factors***

While the majority of respondents (58.0%) reported that cultural norms did not influence their use of safety devices, 29.7% reported that they did. Social influence or peer pressure was reported by 42.8%, and 27.5% acknowledged a perception of personal invulnerability to occupational hazards. Acceptance of modern safety practices was relatively high overall, at 64.5% (Table 4).

**Table 4. Socio-cultural and belief factors among refuse handlers (n=276)**

| Variable | Category | n | % |
|---|---|---|---|
| **Cultural norms influence use** | Yes | 82 | 29.7 |
| | No | 160 | 58.0 |
| | Don't know | 34 | 12.3 |
| **Social influence / peer pressure** | Yes | 118 | 42.8 |
| | No | 132 | 47.8 |
| | Don't know | 26 | 9.4 |
| **Perception of personal invulnerability** | Yes | 76 | 27.5 |
| | No | 168 | 60.9 |
| | Don't know | 32 | 11.6 |
| **Acceptance of modern safety practices** | Yes | 178 | 64.5 |
| | No | 64 | 23.2 |
| | Don't know | 34 | 12.3 |

***Knowledge, Attitudes, and Practices***

Just under half of respondents (47.8%) had participated in an awareness or training programme on safety devices, and 50.7% reported regularly seeking health and safety information. Nearly a third (31.9%) reported having experienced a work-related infectious disease. Confidence in the effectiveness of safety devices was high, at 71.0% (Table 5).

**Table 5. Knowledge, attitudes, and practices among refuse handlers (n=276)**

| Variable | Category | n | % |
|---|---|---|---|
| **Participated in awareness/training** | Yes | 132 | 47.8 |
| | No | 122 | 44.2 |
| | Don't know | 22 | 8.0 |
| **Regularly seeks health & safety information** | Yes | 140 | 50.7 |
| | No | 108 | 39.1 |
| | Don't know | 28 | 10.1 |
| **Ever experienced work-related infectious disease** | Yes | 88 | 31.9 |
| | No | 172 | 62.3 |
| | Don't know | 16 | 5.8 |
| **Colleagues influence use** | Yes | 128 | 46.4 |
| | No | 118 | 42.8 |
| | Don't know | 30 | 10.8 |
| **Believes devices are effective** | Yes | 196 | 71.0 |
| | No | 44 | 15.9 |
| | Don't know | 36 | 13.0 |

***Disease Prevention and Control Outcomes***

Within the preceding year, 31.2% of respondents had been diagnosed with an infectious disease and 15.2% had missed work because of one. Participation in health and safety training was infrequent overall: only 12.3% participated regularly, while 39.9% participated rarely and 17.4% never participated (Table 6).

**Table 6. Disease diagnosis, missed work, and training participation (n=276)**

| Variable | Category | n | % |
|---|---|---|---|
| **Diagnosed with infectious disease (past year)** | Yes | 86 | 31.2 |
| | No | 176 | 63.8 |
| | Don't know | 14 | 5.1 |
| **Missed work due to infectious disease** | Yes | 42 | 15.2 |
| | No | 224 | 81.2 |
| | Don't know | 10 | 3.6 |
| **Frequency of health/safety training participation** | Regular | 34 | 12.3 |
| | Occasional | 84 | 30.4 |
| | Rare | 110 | 39.9 |
| | Never | 48 | 17.4 |

***Bivariate Analysis: Socio-Demographic Characteristics and Safety Device Use***

Gender was strongly associated with safety device use ($\chi^2$=211.9, p<0.001): 82.1% of male respondents used devices compared with 49.5% of female respondents. Age was also significantly associated ($\chi^2$=15.3, p=0.002), with usage concentrated among younger age groups and non-use concentrated among those aged ≥46 years. Education level was significantly associated with use ($\chi^2$=9.8, p=0.021), while marital status ($\chi^2$=7.5, p=0.058) and religion ($\chi^2$=4.1, p=0.247) were not significantly associated (Table 7).

**Table 7. Bivariate analysis of socio-demographic characteristics and safety device use**

| Variable / Category | Use Yes n (%) | Use No n (%) | $\chi^2$ | p-value |
|---|---|---|---|---|
| **Gender** | | | | |
| Male | 142 (82.1) | 50 (50.5) | 211.9 | **<0.001** |
| Female | 35 (19.8) | 49 (49.5) | | |
| **Age (years)** | | | | |
| 18–25 | 46 (25.9) | 14 (14.1) | 15.3 | **0.002** |
| 26–35 | 60 (33.9) | 23 (23.2) | | |
| 36–45 | 45 (25.4) | 24 (24.2) | | |
| ≥46 | 26 (14.7) | 38 (38.4) | | |
| **Marital status** | | | | |
| Married | 92 (52.0) | 40 (40.4) | 7.5 | 0.058 |
| Single | 63 (35.6) | 37 (37.4) | | |
| Divorced | 12 (6.8) | 10 (10.1) | | |
| Widowed | 10 (5.6) | 12 (12.1) | | |
| **Education level** | | | | |
| No formal | 17 (9.6) | 27 (27.3) | 9.8 | **0.021** |
| Primary | 72 (40.7) | 44 (44.4) | | |
| Secondary | 64 (36.2) | 24 (24.2) | | |
| University | 24 (13.6) | 4 (4.0) | | |
| **Religion** | | | | |
| Catholic | 78 (44.1) | 38 (38.4) | 4.1 | 0.247 |
| Protestant | 58 (32.8) | 26 (26.3) | | |
| Muslim | 20 (11.3) | 14 (14.1) | | |
| SDA | 12 (6.8) | 12 (12.1) | | |
| Others | 9 (5.1) | 9 (9.1) | | |

*$\chi^2$ = chi-square statistic..*

***Bivariate Analysis: Occupational and Economic Factors and Safety Device Use***

Terms of service ($\chi^2$=255.7, p<0.001) and monthly income ($\chi^2$=240.4, p<0.001) showed the strongest bivariate associations with safety device use of any variables examined: casual workers and those earning under 50,000 RWF were markedly over-represented among non-users. Income sufficiency to purchase PPE, receipt of employment benefits, and employment stability were all also significantly associated with use (all p<0.001) (Table 8).

**Table 8. Bivariate analysis of occupational and economic factors and safety device use**

| Variable / Category | Use Yes n (%) | Use No n (%) | $\chi^2$ | p-value |
|---|---|---|---|---|
| **Terms of service** | | | | |
| Casual | 45 (25.4) | 61 (61.6) | 255.7 | **<0.001** |
| Permanent | 62 (35.0) | 14 (14.1) | | |
| Contract | 38 (21.5) | 14 (14.1) | | |
| Volunteer/Others | 32 (18.1) | 10 (10.1) | | |
| **Monthly income (RWF)** | | | | |
| <50,000 | 26 (14.7) | 60 (60.6) | 240.4 | **<0.001** |
| 50,000–100,000 | 55 (31.1) | 45 (45.5) | | |
| 100,000–200,000 | 56 (31.6) | 2 (2.0) | | |
| 200,000–400,000 | 26 (14.7) | 0 (0.0) | | |
| >400,000 | 14 (7.9) | 0 (0.0) | | |
| **Income sufficient for PPE** | | | | |
| Yes | 66 (37.3) | 18 (18.2) | 18.9 | **<0.001** |
| No | 98 (55.4) | 70 (70.7) | | |
| Don't know | 13 (7.3) | 11 (11.1) | | |
| **Receives employment benefits** | | | | |
| Yes | 82 (46.3) | 22 (22.2) | 20.6 | **<0.001** |
| No | 86 (48.6) | 70 (70.7) | | |
| Don't know | 9 (5.1) | 7 (7.1) | | |
| **Employment stability** | | | | |
| Yes | 110 (62.1) | 36 (36.4) | 13.4 | **<0.001** |
| No | 44 (24.9) | 50 (50.5) | | |
| Don't know | 23 (13.0) | 13 (13.1) | | |

*PPE = personal protective equipment; $\chi^2$ = chi-square statistic.*

***Bivariate Analysis: Behavioural, Attitudinal, and Access-Related Factors and Safety Device Use***

Acceptance of modern safety practices showed the strongest association of all behavioural variables examined ($\chi^2$=271.7, p<0.001): 85.9% of users accepted modern practices compared with 26.3% of non-users. Participation in awareness/training ($\chi^2$=195.7, p<0.001) and source of device acquisition ($\chi^2$=250.0, p<0.001) were similarly strongly associated, as were belief in device effectiveness, regular information-seeking, cultural-norm influence, and healthcare access (all p<0.001) (Table 9).

**Table 9. Bivariate analysis of behavioural, attitudinal, and access-related factors and safety device use**

| Variable / Category | Use Yes n (%) | Use No n (%) | $\chi^2$ | p-value |
|---|---|---|---|---|
| **Participated in awareness/training** | | | | |
| Yes | 116 (65.5) | 16 (16.2) | 195.7 | **<0.001** |
| No | 43 (24.3) | 79 (79.8) | | |
| Don't know | 18 (10.2) | 4 (4.0) | | |
| **Source of devices** | | | | |
| Provided by employer | 142 (80.2) | 28 (28.3) | 250.0 | **<0.001** |
| Self-purchase | 16 (9.0) | 32 (32.3) | | |

| | | | | |
|---|---|---|---|---|
| Local health agencies | 8 (4.5) | 30 (30.3) | | |
| Others | 11 (6.2) | 9 (9.1) | | |
| **Access to healthcare services** | | | | |
| Yes | 112 (63.3) | 42 (42.4) | 16.2 | **<0.001** |
| No | 48 (27.1) | 50 (50.5) | | |
| Don't know | 17 (9.6) | 7 (7.1) | | |
| **Cultural norms influence use** | | | | |
| Yes | 32 (18.1) | 50 (50.5) | 26.1 | **<0.001** |
| No | 125 (70.6) | 35 (35.4) | | |
| Don't know | 20 (11.3) | 14 (14.1) | | |
| **Acceptance of modern practices** | | | | |
| Yes | 152 (85.9) | 26 (26.3) | 271.7 | **<0.001** |
| No | 13 (7.3) | 51 (51.5) | | |
| Don't know | 12 (6.8) | 22 (22.2) | | |
| **Believes devices effective** | | | | |
| Yes | 144 (81.4) | 52 (52.5) | 46.3 | **<0.001** |
| No | 20 (11.3) | 24 (24.2) | | |
| Don't know | 13 (7.3) | 23 (23.2) | | |
| **Regularly seeks safety information** | | | | |
| Yes | 116 (65.5) | 24 (24.2) | 71.9 | **<0.001** |
| No | 47 (26.6) | 61 (61.6) | | |
| Don't know | 14 (7.9) | 14 (14.1) | | |

*$\chi^2$ = chi-square statistic.*

***Multivariate Logistic Regression of Factors Influencing Safety Device Uptake***

In the multivariable model, female sex (aOR 0.45, 95% CI 0.25–0.78, p=0.004), age ≥46 years (aOR 0.40, 95% CI 0.19–0.81, p=0.012), and no formal education (aOR 0.48, 95% CI 0.24–0.97, p=0.041) were independently associated with lower odds of safety device use, while university-level education (AOR 1.89, 95% CI 1.05–3.95, p=0.033), permanent (aOR 3.85, 95% CI 2.10–7.05, p<0.001) and contract (aOR 2.41, 95% CI 1.22–4.82, p=0.011) employment relative to casual work, participation in PPE awareness/training (aOR 5.42, 95% CI 2.90–10.14, p<0.001), and acceptance of modern safety practices (aOR 6.88, 95% CI 3.54–13.36, p<0.001) were independently associated with higher odds, after adjustment for all other variables in the model (Table 10).

**Table 10. Multivariate logistic regression of factors influencing uptake of non-pharmaceutical safety devices**

| Variable | aOR | 95% CI | p-value |
|---|---|---|---|
| **Gender (Ref: Male)** | | | |
| Female | **0.45** | 0.25–0.78 | **0.004** |
| **Age group (Ref: 18–25)** | | | |
| 26–35 | 1.32 | 0.72–2.41 | 0.360 |
| 36–45 | 1.08 | 0.56–2.10 | 0.814 |
| ≥46 | **0.40** | 0.19–0.81 | **0.012** |
| **Education level (Ref: Secondary)** | | | |
| No formal | **0.48** | 0.24–0.97 | **0.041** |
| Primary | 0.76 | 0.41–1.41 | 0.390 |

| | | | |
|---|---|---|---|
| University | **1.89** | 1.05–3.95 | **0.033** |
| **Terms of service (Ref: Casual)** | | | |
| Permanent | **3.85** | 2.10–7.05 | **<0.001** |
| Contract | **2.41** | 1.22–4.82 | **0.011** |
| Volunteer/Others | 1.72 | 0.83–3.52 | 0.141 |
| **Participated in PPE awareness/training (Ref: No)** | | | |
| Yes | **5.42** | 2.90–10.14 | **<0.001** |
| Don't know | 1.21 | 0.45–3.21 | 0.700 |
| **Acceptance of modern safety practices (Ref: No)** | | | |
| Yes | **6.88** | 3.54–13.36 | **<0.001** |
| Don't know | 1.54 | 0.71–3.36 | 0.270 |

*AOR = adjusted odds ratio; CI = confidence interval; Ref = reference category.*

**Qualitative Findings**

Key-informant interviews with 10 waste-management company leaders generated four major themes socio-cultural and belief factors, knowledge levels, attitudes, and practices that help explain the quantitative patterns reported above, particularly the gap between safety-device availability and consistent use.

***Theme 1: Socio-Cultural and Belief Factors***

Participants described deeply rooted beliefs that competed with safety-device use. Several noted that long-tenured workers viewed continued good health despite years without protective equipment as evidence that such equipment was unnecessary: "Some of our workers believe that because they have been doing this work for many years without major problems, they don't need gloves or masks. They say 'Imana iratunganira' [God protects us], and this belief makes them reluctant to use the equipment we provide" (Participant 3). Peer dynamics reinforced this: "When one influential worker decides not to wear protective equipment, others follow. It becomes a group behaviour. They don't want to look different from their colleagues or be mocked for being 'too careful'" (Participant 2). Gendered expectations were also raised *"Male workers sometimes view excessive caution as unmanly... wearing full protective gear contradicts this image, so they resist it" (Participant 8)* alongside religiously-framed fatalism: *"Some workers have strong religious faith, which is good, but it sometimes makes them fatalistic. They say things like 'If God wants me to get sick, I will get sick regardless of what I wear'" (Participant 1).*

***Theme 2: Knowledge Levels Regarding Safety Devices and Disease Prevention***

Management consistently described gaps between general awareness of basic equipment and understanding of why it mattered: *"Most of our workers know about basic equipment like gloves and boots, but when it comes to specialized items like safety goggles, face shields, or proper aprons, their knowledge is limited" (Participant 3).* Understanding of disease transmission routes was identified as a specific weak point: *"Many refuse handlers don't fully comprehend the invisible dangers in waste. They can see sharp objects and avoid them, but they don't understand about bacteria, viruses, and other pathogens that can enter through skin contact or inhalation" (Participant 2).* Limited formal education compounded this: *"Health literacy is very low among our workers. They can't read the instructions on safety equipment packaging... We've had to develop pictorial guides and conduct verbal training in Kinyarwanda to bridge this gap" (Participant 8). Several leaders also noted that informal information sources family, peers, social media sometimes actively contradicted formal training messages, particularly during the COVID-19 pandemic (Participant 10).*

***Theme 3: Attitudes Toward Safety Devices and Workplace Safety***

Scepticism about real-world effectiveness was a recurring theme: *"Some workers are skeptical about whether gloves and masks actually protect them. They've seen colleagues who wore protective equipment still get sick, so they question if the devices work" (Participant 3).* Physical discomfort, particularly in Kigali's warm climate, was repeatedly cited as undermining sustained use*: "Wearing gloves, long-sleeved coveralls, and masks makes workers hot and sweaty. They say, 'How can we work effectively when we're suffering in this equipment?'" (Participant 2).* Because pay was often linked to volume of waste collected, perceived productivity costs further discouraged use: *"Some workers complain that gloves reduce their grip and dexterity... their attitude is that speed and income are more important than safety" (Participant 4).*

Optimism bias was also evident: *"There's a common attitude of 'it won't happen to me.' ...They think, 'I've been doing this for three years without gloves and I'm fine, so why start now?'"* (Participant 8). Trust in management emerged as a moderating factor: attitudes toward safety policy improved *"when workers are involved in decision-making... [whereas] top-down enforcement alone creates resistance" (Participant 10).*

***Theme 4: Practices and Behavioural Patterns in Safety Device Usage***

Management described selective and situational compliance rather than consistent use: *"Workers pick and choose what to wear. Most will wear boots because they can immediately see the benefit... but masks and goggles are often ignored because the benefits are not immediately visible" (Participant 3), with compliance often higher under direct supervision and during the rainy season than otherwise (Participant 7; Participant 5).* Improper maintenance and reuse of equipment were also noted as a hygiene concern in their own right: *"Contaminated equipment becomes a source of disease transmission" when reused without cleaning (Participant 2)*. Training uptake into sustained practice was identified as a particular weak point: *"After training, we see improved practices for about two weeks, then workers gradually revert to old habits... sustainable practice change needs ongoing support and monitoring" (Participant 8)*. *Under-reporting of injuries, often driven by fear of lost income, was described as a further barrier to early intervention* (Participant 1; Participant 3), *although some adaptive, peer-led safety practices such as informal mentoring of younger workers by experienced colleagues were noted as a potential foundation for more formal interventions* (Participant 5; Participant 7).

## 4. DISCUSSION

This study found that 64.0% of waste management refuse handlers in Kicukiro District reported using non-pharmaceutical safety devices, but that consistent, correct use across tasks was reported by fewer than half of respondents (44.2%), indicating a substantial gap between availability and effective use. This pattern device availability outpacing consistent use mirrors findings from comparable settings elsewhere in the region, where studies have similarly found that providing protective equipment does not, by itself, translate into reliable compliance [1,4,5,6].

***Structural and Demographic Determinants***

Female sex was independently associated with lower odds of safety device use in this study (AOR 0.45, p=0.004). The multi-country assessment of sanitation workers conducted jointly by the World Bank, WHO, ILO, and WaterAid found that sanitation and waste workforces in many low- and middle-income settings are male-dominated and that women in this sector often occupy more precarious, less formally supported positions [1]; the present findings are consistent with a structural rather than purely behavioural explanation for this gender gap, although the precise mechanism (e.g., differential access to permanent contracts, or to employer-provided equipment specifically) was not directly tested here and warrants further investigation.

Older age (≥46 years) was independently associated with lower odds of use (AOR 0.40, p=0.012), consistent with the qualitative finding that senior workers normalized the absence of protective equipment based on years of apparently unharmed exposure, and in turn modelled this behaviour for younger colleagues. Similar generational normalization of risk has been described among solid waste handlers in South Africa, where qualitative work found that experienced workers' own safety practices, shaped by long tenure, directly influenced norms among newer staff [6].

Educational attainment showed a clear gradient, with no formal education independently associated with lower uptake (AOR 0.48, p=0.041) and university-level education associated with higher uptake (AOR 1.89, p=0.033) relative to secondary education. This is consistent with evidence from Ghana that low health literacy limits both understanding of why protective equipment matters and the practical capacity to follow written or technical safety guidance, a gap that required dedicated investment in pictorial and verbal (rather than written) training materials in that setting [4,5]; the present qualitative data described an almost identical adaptation by company leaders in Kicukiro District.

Employment status was among the strongest predictors identified, with permanent (AOR 3.85, p<0.001) and contract (AOR 2.41, p=0.011) workers substantially more likely to use safety devices than casual workers. This is consistent with the broader occupational health literature on informal and precarious employment, which has found that workers without secure contracts experience systematically worse access to training, equipment, and regulatory protection, and correspondingly higher rates of occupational injury, across multiple country contexts [2,7]. Because casual work constituted the single largest employment category among respondents in this study (38.4%), this finding has direct implications for the scale of the problem: a substantial share of this workforce sits in the employment category least likely to receive consistent protection.

***Behavioural and Training-Related Determinants***

Participation in awareness or training programmes was the second-strongest independent predictor of uptake (AOR 5.42, p<0.001). This finding aligns with a recent scoping review of psychosocial work factors among waste collectors in developing countries, which concluded that training exposure, alongside workplace psychosocial conditions, was one of the most consistent correlates of safe working behaviour across the studies reviewed [9]. It is also consistent with the qualitative finding in this study that training effects were real but time-limited *("after training, we see improved practices for about two weeks, then workers gradually revert to old habits"*), pointing toward a need for repeated or continuous training rather than one-off sessions.

Acceptance of modern safety practices showed the single largest adjusted effect of any variable in the model (AOR 6.88, p<0.001). This is consistent with a cross-sectional study of domestic waste collectors in the Ho Municipality of Ghana, which used the Health Belief Model and the Reasoned Action Approach to show that socio-cognitive constructs perceived benefit, perceived norm, and attitude toward protective equipment explained a substantial share (67%) of the variance in workers' intention to use personal protective equipment, independent of equipment availability itself [5]. The Health Belief Model more broadly frames perceived susceptibility, perceived severity, perceived benefit, and perceived barriers as the central levers for changing preventive health behaviour [8], and the present qualitative data, particularly the recurring narrative of "it won't happen to me," map closely onto a low perceived-susceptibility profile that this framework would predict to undermine sustained device use even where general awareness is high.

***Integrating Quantitative and Qualitative Findings***

The qualitative data add explanatory depth to the quantitative associations rather than standing apart from them. Cultural fatalism and peer-driven non-use offer a plausible mechanism for why *"acceptance of modern safety practices"* carried such a large independent effect in the regression model: acceptance is not merely a matter of individual attitude but is actively shaped by community and workplace social norms, a dynamic well documented in psychosocial reviews of waste-sector working conditions in other developing-country settings [9]. Similarly, the structural barriers identified quantitatively (casual employment, low income, limited training access) were echoed qualitatively in leaders' descriptions of why even willing companies struggled to sustain protective practices, particularly the observation that productivity-linked pay structures actively discouraged glove use because of reduced dexterity and speed.

Taken together, these findings suggest that the persistence of significant gender, age, education, and employment effects in the fully adjusted model, even after accounting for training participation and behavioural acceptance, indicates that individual-level behaviour-change interventions alone are unlikely to close the gap identified in this study. Structural measures formalizing casual employment where feasible, ensuring equitable employer-provided equipment regardless of contract type, and embedding repeated rather than one-off training are likely necessary complements to the awareness and acceptance-building work already under way in this sector [1,2,7].

***Limitations***

This study has several limitations. It was conducted within a single waste management company in one district, which may limit generalizability to other companies, districts, or informal (non-company-affiliated) waste pickers, who were not represented in this sample and who, based on evidence from other settings, may face even greater barriers to protective equipment access. Self-reported device use is subject to social-desirability bias, and the cross-sectional design precludes causal inference regarding the direction of the associations identified, particularly between training participation, attitude change, and device use, which most plausibly influence one another bidirectionally over time.

## 5. CONCLUSION

Uptake of non-pharmaceutical safety devices among waste management refuse handlers in Kicukiro District was moderate overall (64.0%) but inconsistent, with only 44.2% of respondents reporting consistent use across all tasks. This gap was shaped by a combination of structural employment conditions, training exposure, and deeply embedded socio-cultural beliefs, rather than by equipment availability alone. Training participation and acceptance of modern safety practices emerged as the strongest modifiable predictors of uptake, while gender, older age, lack of formal education, and casual employment status remained independently associated with lower uptake even after adjustment, indicating that purely individual-level interventions are unlikely to be sufficient on their own.

**Declarations**

**Ethics approval and consent to participate:** This study was approved by the Institutional Review Board of Mount Kigali University. Written or witnessed verbal informed consent was obtained from all participants prior to data collection.

**Conflict of interest:** The authors declare no conflict of interest.

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**Data availability:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Authors' contributions:** DU conceptualized the study, led data collection, and drafted the manuscript. ES, DM and ET revised the manuscript, and MS supervised the study. All authors read and approved the final manuscript.

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