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Types and distribution of occupational injuries among solid waste collectors in Nairobi city county, Kenya

Kanario Jane[1], Osero Justus[2], Warutere Peterson[3], Migiro Victor[4]
[1-4] School of Public Health and Applied Human Sciences, Kenyatta University, Kenya

Abstract
Background: Solid waste collectors are persons who pick up garbage to deposit at transfer stations or recyclable materials to deposit at existing recycling sites. In developing countries such as Kenya, solid waste handling is done manually which exposes the solid waste collectors to occupational injuries. This study therefore, assessed the types and distribution of occupational injuries among solid waste collectors in Nairobi City County.
Method: The study employed the use of cross sectional study design and the sample for the study constituted 328 solid waste collectors who were clustered into private companies, community based organizations (CBOs) and Nairobi City County environment department employee solid waste collectors. Systematic random sampling was used to select the study subjects. Data for the study was collected using structured interview schedule by the trained research assistants.
Results: The findings show that 88.1% of the solid waste collectors experienced at least one type of occupational injury. The SWCs suffered strain or sprain; puncture; contusion; laceration and fracture injuries with the most prevalent injury being puncture 264(80.5%) and the least prevalent being fracture injury 28(8.5%). There was a negative association between puncture injury and sex (OR=0.458; S.E=0.454; p=0.048); and level of education (OR=0.016; S.E=0.293; p=0.017); and positive association between puncture injury and monthly income (OR=1.188; S.E=0.176; P=0.001. There is a negative association between contusion injury and the level of education (OR=0.877; S.E=0.257; P=0.014); and a positive association between contusion injury and monthly income (OR=1.881; S.E=0.149; P=0.000). There is a negative association between fracture injury and marital status (OR=0.386; S.E=0.410; P=0.020).
Conclusion: The proportion of occupational injuries among SWCs was very high. SWCs who were less educated suffered higher proportion of puncture and contusion injuries. The married had a higher proportion of fracture injury, SWCs who earned higher income suffered more puncture and contusion injuries and female SWCs suffered higher proportion of puncture injury than the male.

Keywords: ergonomics, injuries, occupational health, safety, solid waste, waste collectors

Introduction

Increased generation of solid waste has become a problem in large urban centers, leading to increased demand for public solid waste collection services. This means that, the waste collector is an important actor, and his body is turned into a tool used to carry solid waste [2]. Waste" is a relative term and it is subjected to individual perception of any particular material or product [3, 4]. Solid waste collectors play an important role in maintaining health and hygiene in cities or communities. However, their job exposes them to various occupational injuries with little or no attention paid to their health status [5]. Solid waste collectors are at risk for a variety of occupational diseases as a result of daily exposure to work related hazards [6]. In many developing countries, solid waste is collected manually [7], and collection of household waste, industrial waste and mixed waste is also a job which requires repeated heavy physical activity [8, 9].

Safety procedures in the workplace should be employed by ensuring the use of adequate personal protective equipment among solid waste collectors to protect the workers against occupational injuries [10]. Health impact and morbidity data about occupational exposure to solid waste among solid waste collectors is scarce [11].

Occupational injuries are an important public health problem In both developed and developing countries, with substantial economic burden in productivity, low wages and compensation cost. The injuries also contribute to absenteeism, increased work restriction, transfer to other jobs, or disability more than any other group of diseases with a considerable economic toll to individuals and organisations [8]. Solid waste collectors in low income countries are most likely to be of low socio-economic status with their medical problems compounded further by various socio-economic factors such as poverty, poor diet, lack of education and poor housing conditions [12].

Like in many cities in the developing countries, solid waste collection in Nairobi City is done manually which exposes the solid waste collectors to many injuries and illnesses [13]. This study therefore, aimed to assess the types and distribution of occupational injuries and associated factors among solid waste collectors in Nairobi City County. This was meant to also provide an overview of the occupational safety and health of solid waste collectors. This study therefore provides a description of the health impact of solid waste collection in Nairobi City County, Kenya and to consequently call for corrective measures, occupational safety and health hazard evaluation and monitoring programs.

Methods

Nairobi City County occupies approximately 696 sq. Km and a population of 4,556,381 (2019 national census) and subdivided into 17 sub counties. Nairobi City County is located on geographic coordinates of 1°16'S latitude and 36°48'E longitude. Nairobi being a cosmopolitan environment is occupied by Kenyans from all walks of life and also the international community. The study was carried out in five of the seventeen administrative sub-counties in Nairobi County i.e. Kasarani, Dagoretti North, Langata, Embakasi central and Starehe sub-counties.

Study design

The study employed the use of descriptive cross-sectional study design and involved quantitative data collection methods and was conducted upon eligible solid waste collectors working at the Nairobi City County, Kenya.

Study population

The study targeted solid waste collector in Nairobi City County. The total number of eligible solid waste collectors in Nairobi City County at the time of the study was 2246 spread across registered private companies, community based organizations (CBOs) and the Nairobi County environment department employees.

The registered private companies had a total of 726 eligible solid waste collectors. The County had a total 288 eligible SWC employed by environment department. The total number of eligible solid waste collectors employed by registered CBOs in Nairobi County at the time of the study was 1232.

Sampling technique

Nairobi City County was purposively sampled because it is the largest city in Kenya with huge amount of solid waste generated daily hence as the highest number of Solid Waste Collectors. Simple random sampling was used to sample five sub-counties from seventeen sub-counties. Finally systematic random sampling was used to select a total of 328 study subjects from the private companies, CBOs and from Nairobi city county environment department employees.

Inclusion criteria

Solid waste collectors on permanent or temporary employment and having been employed for at least six months prior to the study were eligible hence included in the study.

Data collection instrument and technique

Interviewer scheduled tool was used for data collection whereby solid waste collectors were interviewed and examined at their respective sub-counties.

Ethical consideration

Approval was obtained from Kenyatta University graduate school. Ethical clearance was also obtained from Kenyatta University Ethical Review Committee. The research permit to carry out the study was obtained from the National Council of Science, Technology and Innovation (NACOSTI) of Kenya. Informed consent was obtained from all the study participants after a brief introduction of the intent of the study

Data analysis Data

After data collection the completed interview schedules were cleaned and then coded, then the data was entered in the statistical computer package for social scientists (SPSS version 21.0) software for data analysis. Analyzed data was summarized using frequencies, means and standard deviations. Chi-square test and Fisher's exact test were used to test for level of significance to establish relationships between categorical variables and the study outcomes (use of personal protective equipment, work environment versus the injuries and related health problems incurred). In all cases $p<0.05$ was used as a cut off for statistical significance. The analyzed data was presented and interpreted in tables, graphs and pie charts. Logistic regression analysis was done to determine the true predictors of occupational injuries.

Results

Socio-demographic characteristics are presented in Table 4.1. Majority of the solid waste collectors (91.8%) were males. Majority of the respondents (55.8%) were aged above 30 years old. The ages of respondents ranged from 18 to 57 years, with the mean age being 34.63 years.

The study established that, majority of the respondents had at most primary school level of education (72.3%); had work experience of at most 3 years (57.6%). The study also shows that (67.1%) of the respondents were slum dwellers and only (32.9%) were non-slum dwellers. Majority of the respondents (43.0%) earned Kshs 0-10000 with the least (22.6%) earning above Kshs. 20000 (Table 4.1).

Table 1: Socio-demographic characteristics

Characteristic	Solid waste collectors organization type			
	Private Company (n=106)	Nairobi County Environment Department (n=42)	Community Based Organization (CBO) (n=180)	Total (n=328) (n=100%)
Sex				
Male	102	26	173	301(91.8)
Female	4	16	7	27(8.2)
Age				
≤30	56	0	89	145(44.24)
>30	50	42	91	183(55.8)
Marital Status				
Married	59	30	112	201(61.3)
Single	47	12	68	127(38.7)
Highest Level of Education				
≤ Primary level	68	35	134	237(72.3)
≥ Secondary level	38	7	46	91(27.7)
Income				
Kshs. 0-10000	58	10	73	141(43.0)

Kshs 10001-20000	33	6	74	113(34.5)
Kshs >20000	15	26	33	74(22.6)
Residence				
Slum	76	16	128	220(67.1)
Non-slum	30	26	52	108(32.9)
Years of experience				
≤3	51	10	128	189(57.6)
>3	55	32	52	139(42.4)
Weekly work hours				
≤30	26	10	34	70(21.3)
>30	80	32	146	258(78.7)

The mean monthly income of the respondents was Kshs 16769.51 with the minimum income earned being Kshs 3000 and maximum being Kshs 50000 respectively (Table 4.2). Majority of the respondents (78.7%) worked for more than 30 hours per week with only (21.3%) working for at most 30 hours per week (Table 4.1). The mean weekly work hours was 50.90 hours with the minimum work hours being 10 hours and the maximum work hours being 90 hours (Table 4.2).

The study further found out that 201(61.3%) were married with the rest 127(38.7%) being single (never married or separated or widowed) (Table 4.1). The mean duration of employment as a SWC was 6.95 years with the minimum being 1 year and maximum being 31 years (Table 4.2).

Table 2: Descriptive statistics for continuous variables

Descriptive Statistics									
Variables	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
						Statistic	**Std. Error**	**Statistic**	**Std. Error**
Respondents' age	328	18	57	34.63	9.405	.544	.135	-.719	.268
Respondents' monthly income (KES)	328	3000.00	50000.00	16769..51	11498.64	1.696	.135	1.941	.268
Respondents' duration of employment (years)	328	1	31	7.29	8.473	1.679	.135	1.504	.268
Respondents' weekly work hours	328	10	90	48.43	20.199	-.279	.135	-.806	.268
Valid N (Listwise)	328								

The magnitude of occupational injuries among solid waste collectors within six months prior to the study

The study shows that (88.1%) of the sampled solid waste collectors had suffered at least a type of injury within six months prior to the study (Figure 4.1).

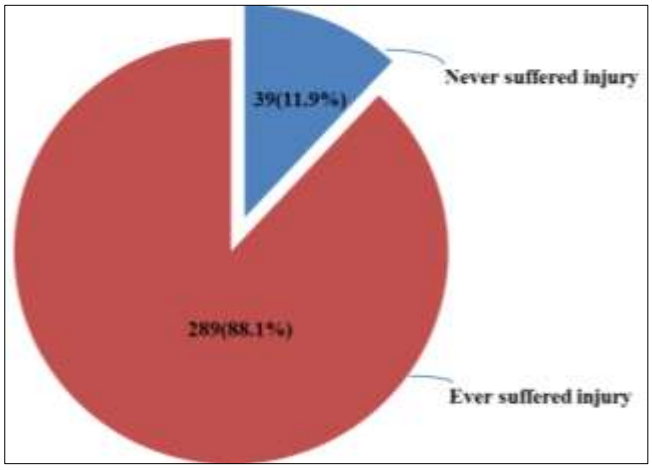

Fig 1: Proportion of SWCs who suffered occupational injuries six months prior to the study

Types of occupational injuries suffered by solid waste collectors within six months prior to the study

The various types and magnitude of occupational injuries suffered by SWC were as follows: fracture injury (8.5%); sprain or strain injury (31.1%); contusion injury (56.1%); laceration injury (75%); and puncture injury (78.4%) respectively. It was evident that puncture injuries were the most prevalent and fracture injuries the least prevalent among the solid waste collectors (Figure 4.2).

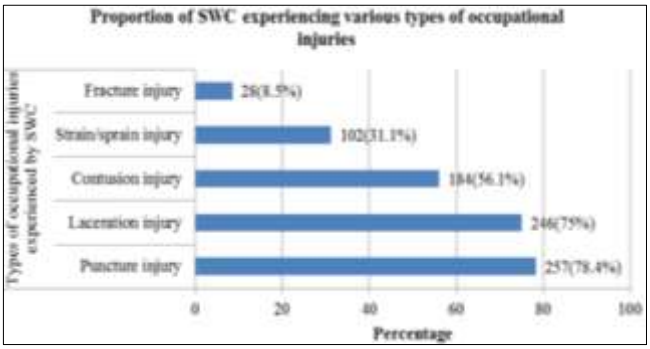

Fig 2: Types and magnitude of occupational injuries suffered by SWC six months prior to the study

Distribution of occupational injuries based on socio-demographic characteristics

Distribution of strain or sprain injuries within six months prior to the study

The study indicates that most of the solid waste collectors aged >30 years experienced a higher proportion of strain or sprain injury (31.7%) than those aged ≤30 years (30.3%); female SWCs experienced higher proportion of strain or sprain injury (37%) than the male SWCs (30.6%); SWCs who had single marital status experienced a higher proportion of strain or sprain injury (34.6%) than the married (28.9%); SWCs who were non-slum dwellers experienced a higher proportion of strain or sprain injury (35.2%) than the slum dwellers (29.1 %). Solid waste collectors who had attained at most primary level of education experienced a higher proportion of strain or sprain injury (31.6%) than those who had attained at least secondary level of education (29.7%); and SWCs who earned Kshs 10001-20000 experienced the highest proportion of strain or sprain injury (34.5%) with

those earning Kshs > 20000 experiencing the least proportion of strain or sprain injury (24.3%) (Table 4.3).

Table 3: Distribution of strain or sprain injury based on socio-demographic characteristics

Socio-demographic characteristics		Status of strain or sprain injury		χ2-value
		Present n (%)	Absent n (%)	
Age (years)	≤30 years	44(30.3%)	101(69.7%)	χ2=0.069; df=1; p=0.793
	>30 years	58(31.7%)	125(68.3%)	
Sex	Male	92(30.6%)	209(69.4%)	χ2=0.484; df=1; p=0.486
	Female	10(37%)	17(63%)	
Marital status	Married	58(28.9%)	143(71.1%)	χ2=1.218; df=1; p=0.270
	Single	44(34.6%)	83(65.4%)	
Place of residence	Slum	64(29.1%)	156(70.9%)	χ2=1.222; df=1; p=0.262
	Non-slum	38(35.2%)	70(64.8%)	
Level of education	At most primary	75(31.6%)	162(68.4%)	χ2=0.120; df=1; p=0.729
	At least secondary	27(29.7%)	64(70.3%)	
Monthly income (KES)	0-10000	45(31.9%)	96(68.1%)	χ2=2.244; df=2; p=0.326
	10001-20000	39(34.5%)	74(65.5%)	
	≥20000	18(24.3%)	56(75.7%)	

Distribution of puncture injury within six months prior to the study

A total of (78.4%) solid waste collectors experienced puncture injury, with those aged ≤30 years experiencing a higher proportion of puncture injury (82.8%) than those aged >30 years (74.9%); male SWCs had a higher proportion of puncture injury (79.7%) than their female counterparts (63%); SWCs who were married had a proportionately higher puncture injury (80.1%) than the single (37.4%). Slum dwellers experienced a higher proportion of puncture injury (80.5%) than non-slum dwellers (74.1%); SWCs who had attained at most primary level of education experienced proportionately higher puncture injury (81.9%) than those with at least secondary level of education (69.2%); both SWCs who earned Kshs 0-10000 had the highest proportion of puncture injury (84.4%), whereas those who earned Kshs >20000 had the least proportion of occupational injuries (67.1%) (Table 4.4).

Table 4: Distribution of puncture injury based on socio-demographic characteristics

Socio-demographic characteristics		Status of puncture injury		χ2-value
		Present n (%)	Absent n (%)	
Age (years)	≤30 years	120(82.8%)	25(17.2%)	χ2=2.973; df=1; p=0.085
	>30 years	137(74.9%)	46(25.1%)	
Sex	Male	240(79.7%)	61(20.3%)	χ2=4.109; df=1; p=0.043
	Female	17(63%)	10(37%)	
Marital status	Married	161(80.1%)	40(19.9%)	χ2=0.933; df=1; p=0.332
	Single	96(37.4%)	31(24.4%)	
Place of residence	Slum	177(80.5%)	43(19.5%)	χ2=1.738; df=1; p=0.187
	Non-slum	80(74.1%)	28(25.9%)	
Level of education	At most primary	194(81.9%)	43(18.1%)	χ2=6.180; df=1; p=0.013
	At least secondary	63(69.2%)	28(30.8%)	
Monthly income (Kshs)	0-10000	119(84.4%)	22(15.6%)	χ2=15.099; df=2; p=0.001
	10001-20000	92(81.4%)	21(16.6%)	
	≥20000	46(62.2%)	28(37.8%)	

Distribution of contusion injury within six months prior to the study

Solid waste collectors aged ≤30 years suffered more from contusion injury (62.1%) than those aged >30 years (51.4%); male SWCs had higher proportion of contusion injury (56.8%) than the female SWCs (48.1%); SWCs with single marital status had a proportionately higher contusion injury (57.5%) than the married (55.2%). Slum dwellers suffered more from contusion injury (57.3%) than non-slum dwellers (53.7%); SWCs who had attained at most primary level of education experienced higher proportion of contusion injury (60.3%) than those with at least secondary level of education (45.1%); and SWCs who earned Kshs 0-10000 had the highest proportion of contusion injury (66%), with those who earned Kshs >20000 experiencing the least proportion of contusion injuries (33.8%) (Table 4.5).

Table 5: Distribution of contusion injury based on socio-demographic characteristics

Socio-demographic characteristics		Status of contusion injury		χ2-value
		Present n (%)	Absent n (%)	
Age(years)	≤30 years	90(62.1%)	55(37.9%)	χ2=3.763; df=1; p=0.052
	>30 years	94(51.4%)	89(48.6%)	
Sex	Male	171(56.8%)	130(43.2%)	χ2=0.755; df=1; p=0.385
	Female	13(48.1%)	14(51.9%)	
Marital status	Married	111(55.2%)	90(44.8%)	χ2=0.161; df1; p=0.688
	Single	73(57.5%)	54(42.5%)	
Place of residence	Slum	126(57.3%)	94(42.7%)	χ2=0.375; df=1; p=0.540

	Non-slum	58(53.7%)	50(46.3%)	
Level of education	At most primary	143(60.3%)	94(39.7%)	$\chi2$=6.236; df=1; p=0.013
	At least secondary	41(45.1%)	50(54.9%)	
Monthly income (Kshs)	0-10000	93(66%)	48(34%)	$\chi2$=20.771; df=2; p=0.001
	10001-20000	66(58.4%)	47(41.6%)	
	≥20000	25(33.8%)	49(66.2%)	

Distribution of laceration injury within six months prior to the study

The study revealed that solid waste collectors aged ≤30 years suffered a higher proportion of laceration injury (77.9%) than those aged >30 years (72.7%); male SWCs had a higher proportion of laceration injury (76.1%) than the female respondents (63%); SWCs who were married had a proportionately higher laceration injury (75.1%) than the single (74.8%). Slum dwellers experienced a higher proportion of laceration injury (78.2%) than non-slums dwellers (68.5%); SWCs with at least secondary level of education experienced a proportionately higher laceration injury (75.8%) than those with at most primary level of education (74.7%); and SWCs who earned Kshs 0-10000 had the highest proportion of laceration injury (82.3%), with those who earned Kshs >20000 having the least proportion of laceration injury (67.6%) (Table 4.6).

Table 6: Distribution of laceration injury based on socio-demographic characteristics

Socio-demographic characteristics		Status of laceration injury		$\chi2$-value
		Present n (%)	Absent n (%)	
Age	≤30 years	113(77.9%)	32(22.1%)	$\chi2$=1.191; df=1; p=0.275
	>30 years	133(72.7%)	50(27.3%)	
Sex	Male	229(76.1%)	72(23.9%)	$\chi2$=2.274; df=1; p=0.132
	Female	17(63%)	10(37%)	
Marital status	Married	151(75.1%)	50(24.9%)	$\chi2$=0.004; df=1; p=0.948
	Single	95(74.8%)	32(25.2%)	
Place of residence	Slum	172(78.2%)	48(21.8%)	$\chi2$=3.608; df=1; p=0.058
	Single	74(68.5%)	34(31.5%)	
Level of education	At most primary	177(74.7%)	60(25.3%)	$\chi2$=0.046; df=1; p=0.831
	At least secondary	69(75.8%)	22(24.2%)	
Monthly income (Kshs)	0-10000	116(84.4%)	22(15.6%)	$\chi2$=7.219; df=2; p=0.027
	10001-20000	880(70.8%)	33(29.2%)	
	≥20000	50(67.6%)	24(32.4%)	

Distribution of fracture injury within six months prior to the study

Solid waste collectors aged >30 years suffered a higher proportion of fracture injury (8.7%) than those aged ≤30 (8.3%); male SWCs had higher proportion of fracture injury (9%) than the female SWCs (3.7%); SWCs with single marital status had a proportionately higher fracture injury (13.4%) than the married (5.5%). Non-slum dwellers suffered a higher proportion of fracture injury (11.1%) than the slum dwellers (7.3%); SWCs with at most primary level of education suffered a higher proportion of fracture injury (9.3%) than those with at least secondary level of education (6.6%); and SWCs who earned Kshs 10001-20000 had the highest proportion of fracture injury (11.5%), with those who earned Kshs >20000 experiencing the least proportion of fracture injury (4.1%) (Table 4.7).

Table 7: Distribution of fracture injury based on socio-demographic characteristics

Socio-demographic characteristics		Status of fracture injury		$\chi2$-value/Fishers exact
		Present n (%)	Absent n (%)	
Age (years)	≤30 years	12(8.3%)	133(91.7%)	$\chi2$=0.023; df=1; p=0.880
	>30 years	16(8.7%)	167(91.3%)	
Sex	Male	27(9%)	274(91%)	Fishers exact p=0.429
	Female	1(3.7%)	26(91.3%)	
Marital status	Married	11(5.5%)	190(94.5%)	$\chi2$=6.242; df=1; p=0.012
	Single	17(13.4%)	110(86.6%)	
Place of residence	Slum	16(7.3%)	204(92.7%)	$\chi2$=1.367; df=1; p=0.242
	Non-slum	12(11.1%)	96(88.9%)	
Level of education	At most primary	22(9.3%)	215(90.7%)	$\chi2$=0.609; df=1; p=0.435
	At least secondary	6(6.6%)	85(93.4%)	
Monthly income (Kshs)	0-10000	12(8.5%)	129(91.5%)	Fishers exact=3.129; p=0.190
	10001-20000	13(11.9%)	100(88.5%)	
	≥20000	3(4.1%)	71(95.9%)	

Logistic regression modelling

A binary logistic regression modelling was done to identify the predictor variables that were independently associated with the various types of occupational injuries (outcome variables).

The regression model shows that with regard to the distribution of puncture injury among socio-demographic characteristics there was association between puncture injury and sex (OR=2.458; S.E=0.454; p=0.048); level of education (OR=2.016; S.E=0.293; p=0.017); puncture injury and monthly income (OR=1.188; S.E=0.176; P=0.001) (Table 4.8). These results are in agreement with the bivariate Chi-square test as shown in Table 4.4.

With regard to the distribution of contusion injuries among socio-demographic characteristics, the regression model shows an association between contusion injury and the level of education (OR=1.877; S.E=0.257; P=0.014); contusion injury and monthly income (OR=1.881; S.E=0.149; P=0.000) (Table 4.8) The results agree with the results of bivariate Chi-square test as shown in Table 4.3. Bivariate test findings (Table 4.5) agree with the regression model that there is an association between fracture injury and the following predictor variable: marital status (OR=0.386; S.E=0.410; P=0.020). Regression model shows that there was no association between fracture injury and monthly income (OR=1.123; S.E=0.264; P=0.661) (Table 4.8) which is contrary to bivariate test findings (Table 4.7).

Table 10: Regression model for distribution of occupational injuries among socio-demographic factors

Variables in the Equation									
Variable		**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)/ Odds Ratio**	**95% C.I. for EXP(B)**	
								Lower	**Upper**
Logistic regression model for distribution of occupational injuries based on socio-demographic characteristics									
Puncture injury	Sex	-.900	.454	3.918	1	.048	.458	.009	1.991
	Education level	-.701	.293	5.720	1	.017	.016	.135	1.581
	Monthly Income	.598	.176	11.557	1	.001	1.818	1.288	2.566
Contusion injury	Education level	-.630	.257	6.025	1	.014	.877	.135	1.103
	Monthly Income	.632	.149	17.899	1	.000	1.881	1.404	2.520
Fracture injury	Marital status	-.953	.410	5.393	1	.020	.386	.173	.862
	Monthly income	.116	.264	.193	1	.661	1.123	.669	1.885

Discussion

The results of the study indicated that solid waste collectors suffered high percentage of occupational injuries 88.1%. SWCs who were less educated suffered higher proportion of puncture and contusion injuries. The married had a higher proportion of fracture injury, SWCs who earned higher income suffered more puncture and contusion injuries and female SWCs suffered higher proportion of puncture injury than the male.

Conclusion

Solid waste collectors experience different types of preventable injuries inherent in their jobs due to their work practice

Solid waste collectors suffered the following occupational injuries; puncture injury was the most prevalent 78.4%; laceration 75%; contusion 56.1%; strain and sprain 31.1%; and fracture 8.5% respectively.

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