Occupational Injuries and Associated Factors Among Municipal Solid Waste Collectors in Harar Town, Eastern Ethiopia: A Cross Sectional Study

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ABSTRACT

BACKGROUND: Municipal solid waste collection is one of the most dangerous jobs in the world since it exposes the workers involved to occupational hazards and predisposes them to certain occupation-related morbidities. Occupational injuries among municipal solid waste collectors have not been adequately addressed or reported in developing countries, including Ethiopia. Therefore, this study aimed to determine the prevalence of occupational injuries and associated factors among municipal solid waste collectors in Harar Town, Ethiopia.

METHODS: A cross-sectional study was conducted in Harar town, Eastern Ethiopia from May 25, 2021 to June 25, 2021. Three hundred eighty-nine (389) municipal solid waste collectors were selected using a simple random sampling method. A self-administered structured questionnaire and an observational checklist were used to collect the data. The collected data was analyzed using SPSS version 20. Bivariate and multivariable logistic regression were used to determine the association between independent variables and the outcome variable. A P-value of $<.05$ was considered as a cut-off point for statistical significance.

RESULTS: The current study found that about 60.4% of municipal solid waste collectors were exposed to occupational injuries. Furthermore, the study found a statistically significant association between the prevalence of occupational injuries and having a primary education [AOR = 0.10, 95% CI (0.03-0.38)], a secondary education [AOR = 0.04, 95% CI (0.03-0.45)], work experience [AOR = 5.975, (95% CI (2.01-17.75)], the use of personal protective equipment [AOR = 0.09, (95% CI: 0.02-0.46)], and training [AOR = 0.10, 95% CI (0.03-0.30)].

CONCLUSIONS: The current study found that more than three-fifth of municipal solid waste collectors were exposed to occupational injury. Furthermore, the current study found that there was an statistical relationship between the prevalence of occupational injuries and having a primary education, a secondary education, work experience, the use of personal protective equipment, and training. Before and after hiring solid waste collectors, employers should provide personal protective equipment and tailored training on safety measures.

KEYWORDS: Occupational injuries, occupational hazards, solid waste collectors, Ethiopia

Introduction

Currently, occupational-related injuries and illnesses are a global public health concern. Although waste collection has been contributing greatly to human health by reducing the risk of several infectious diseases, solid waste collectors are at high risk of fatal and non-fatal injuries.[1]

Working conditions for the majority of the 3 billion workers worldwide do not meet the minimum standards and guidelines set by the World Health Organization and the International Labour Organization (ILO) for occupational health and safety.[2-5] According to the most recent ILO global estimates of occupational accidents and work-related illnesses in 2017, there were an estimated 2.78 million fatalities in 2017, compared to an estimated 2.33 million in 2011.[2-5]

For fatal occupational accidents, there were 380 500 deaths, an increase of 8% in 2014 compared to 2010. Fatal work-related diseases have been a concern since 1998 and are at least 5 times higher than fatalities due to occupational accidents.[2-5]

In 2015, there were 2.4 million deaths due to fatal work-related diseases, an increase of 0.4 million compared to 2011. In Africa, there was the highest fatality rate, which accounted for 16.6 per 100 000 people in the Labour force. However, 374 million people are injured each year, resulting in more than 4 days missed from work, and occupational accidents cost 4% of global gross domestic product (GDP), including lost workdays, production interruption, retraining, and medical expenses.[2-5]

This problem is high in developing countries,[6] where about 80% of workers are employed in unsafe work environments and only 5% to 15% have access to occupational health services.[7] Because waste management procedures in developing countries majorly involve manual handling of the waste.[8] In sub-Saharan Africa, 54 000 workers die, and 42 million work-related accidents each year.[9] However, the problems might be higher than this report as the result of low levels of reporting injuries in most of the developing countries.[4,10,11] Solid waste collectors face occupational health and safety risks around the world due

to the materials they handle, the wastes they collect, and the equipment they utilize.[12] Joint and spinal injuries, fractures, puncture wounds, and damage to the eyes and ears are just a few of the injuries that can occur. Slides from unstable disposal piles, cave-ins of disposal site surfaces, fires, explosions, being caught in processing machinery, and being run over by mobile equipment are only some of the accidents that can happen. Collection, recycling, processing, and disposal technologies are all considered in relation to solid waste management.[12] For example, in Brazil's Social Security data registered a total of 2 152 524 accidents nationwide for all classes of workers in the period between 2011 and 2013. For workers collecting, treating, or disposing of domestic and/or dangerous waste, 27 460 accidents were registered nationwide in the same period, representing less than 1% of the total. Only in 2013, with 7056 registered cases, accidents registered by workers collecting non-dangerous waste were the 14th most frequent type in that year compared with all other registered activities.[13]

In Ethiopia, municipal solid waste workers collect waste door to door and from commercial areas that needs to be shoveled by hand, picked up by hand or emptied from sacks in which the workers have direct contact with solid waste, and exposed to strenuous working conditions.[14,15] The above facts indicate that workers have direct contact with solid waste, and are also exposed to strenuous working conditions. These workers have used less personnel protective equipment, and most municipal solid wastes are not safely contained in liftable load sizes. Besides these problems, there is inadequate evidence on the prevalence of occupational-related injuries and determinant factors among municipal solid waste collectors (MSWC).[16] Occupational related studies are not adequate given that the possible exposure of workers to various work related hazards might exist.[14] This indicates that there is a strong need to generate evidence on the occupational injuries of solid waste collectors to know the extent of the problems in Harar town.

This study was aimed to determine the prevalence of occupational injuries and associated factors among municipal solid waste collectors. The finding of the current study can be used by the concerned organizations, including policy makers, and health program planners to take an appropriate measure to minimize the severity of occupational injuries and associated risk factors. It can also vital for designing mechanisms to resolve the gap for concerned stakeholders.
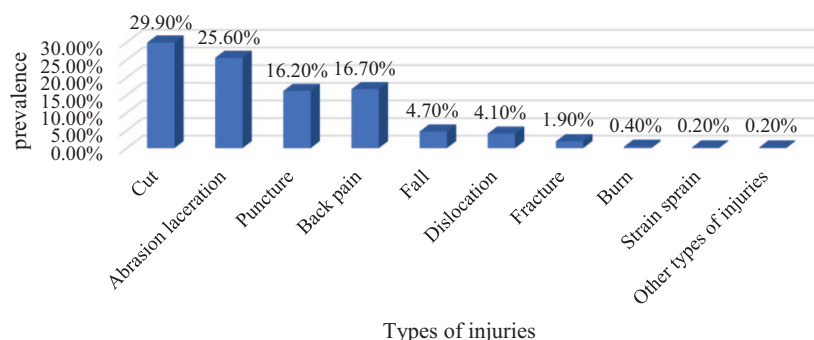
Materials and Methods

Study area, period, and design

The study was conducted in Harar town from May 25, 2021 to June 25, 2021. Harar town found at about 525 km from the capital city of Ethiopia, Addis Ababa. Harar town are located at a latitude and longitude of 9°19′N and 42°7′E, respectively. Based on 2015/2016, projected census by the Central Statistics Agency of Ethiopia, Harar has a total population of 255 690: 121 133 males and 134 557 females. Harari Regional State is divided into 6 urban and 3 rural administrative woredas.

Source and study population

All solid waste collectors found in Harar town were the source population while the selected solid waste collectors in all woreda of Harar town were the study population. Municipal solid waste collectors engaged in each element of the solid waste collection system in 6 woredas of Harar town included in the current study. Solid waste collectors seriously ill other than occupational injuries, on maternity and annual leave were excluded from the study. In Ethiopia, solid waste workers collect the waste door to door and from commercial areas that needs to be shoveled by hand, picked up by hand or emptied from sacks in which the workers have direct contact with solid waste.[14,15]

Sample size determination

Sample size was calculated based on the pervious reported prevalence (63.9%) in Ethiopia[13] with a 95% confidence interval of, z=1.96 and 0.05 margin of error (d)=, q=0.361. Furthermore, 10% non-response rate was also considered. Finally, 389 sample was obtained using the equation bellow.[17]

$$n = Z^2 \frac{q^* p}{d^2}$$

Sampling technique and procedures

A sample size of 389 solid waste collectors was selected in the 6 Woredas. Finally, the respondents who were included in the study from each woreda were identified by using a simple random sampling method and random number generator software based on the sampling frame obtained from the Harar town municipality workers' registration book (N=570) (Supplemental File: Figure 1).

Figure 1. Types of occupational injuries of municipal solid waste collectors of Harar town, Eastern Ethiopia.

Data collection method and procedures

Questionnaire was prepared by reviewing previously conducted studies and international organization such as International Labour Organization (ILO).[10,14,15,18-23] It was designed to collect information about the prevalence of occupational injuries, socio demographic, behavioral, and other work-related factors. The questionnaire was first prepared in English and translated in to local language (Amharic and Afan Oromo), the local language of study participants. The questionnaire was pre-tested on solid waste collectors in the Dire Dawa town who are not included for the study before the start of actual data collection on 5% of sample size. The training was given for the data collectors on data collection tools, and ethics. Data were collected by face-to-face interviews using structured and observational checklist.

Study variables

Dependent variable
- Prevalence of occupational injuries

Independent variables
- Socio-demographic variables: Age of the worker, sex, educational status, marital status, and monthly income
- Working environment related variables: Daily working hours, work experience, occupational health and safety training, job category or work duty, and availability of PPE
- Behavioral related variables: utilization of personal protective equipment, alcohol consumption, cigarette smoking, and sleeping pattern

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Data quality control

The questionnaire and observational checklist were pre-tested in Dire Dawa town, outside the study area, to check the relevance, applicability, and clarity of the data collection tools. The data collectors were trained on the data collection tools, the ways of data collection and ethics. The collected data was then checked for their completeness daily. The data entry was done 2 times to reduce the error.

Data processing and analysis

Data was entered using EPI INFO version 7.2.4 statistical software and analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Descriptive statistics were used to estimate the percentages, means, and standard deviations. Bivariate and multivariate regression analyses were used to determine the association between dependent and independent variables. A multi-collinearity test was used to assess the correlation between some independent variables. Finally, P-value $< .05$ was considered as a cutoff point for statistical significance.

Results

Socio–demographic Characteristics

Of 389 solid waste collectors, 381 were interviewed, with a response rate of 98%. Among the interviewed, 223 (58.5%) were females. The median age of respondents was $38 \pm$ interquartile range (IRQ) of 12 years. Two hundred forty-three (63.8%) were married, and 214 (56.2%) were illiterate (Table 1).

Behavioral and work-related characteristics of respondents

Two hundred fifty-five (66.9%) of the study participants were working more than 5 days per week. Among respondents, 204 (53.5%) respondents had personal protective equipment (PPE), of which 185 (90.7%) were using PPE. Furthermore, 93 (24.4%), 203 (53.3%), and 82 (21.5%) of the participants had a history of alcohol consumption, chewing khat, and smoking cigarettes, respectively (Table 2).

Prevalence of occupational injuries among respondents

Of 381 solid waste collectors, 230 (60.4%) were exposed to occupational related injuries in the last 12 months, of which 184 (80%) sustained injuries more than once and 109 (28.6%) were exposed in the last 1 month.

The most common body parts exposed to injury were the hand, leg, and back, which accounted for 237 (56.8%), 85 (20.4%), and 83 (19.9%), respectively. Furthermore, 175 (76.1%) participants were exposed to injuries in the last 12 months (Table 3).

The most prevalent types of occupational injuries among solid waste collectors were cut 140 (29.9%), abrasion/laceration 120 (25.6%), and back pain 78 (16.7%) (Figure 1).

The research shows that this group of workers were severely injured while collecting waste, 173 (38.8%). Transferring waste from the household's receptacles as well as picking openly discarded waste from the ground are examples of these activities. Following that, there were 121 (27.1%) lifting rubbish, 120 (26.7%) loading tracks, and 16 (3.6%) unloading tracks. Other tasks include loading the sacks or carts and sweeping the container's area at the curb (Figure 2).

Factors associated with occupational injuries

The current study found that workers who completed primary education had an 89.8% lower risk of occupational injury [AOR = 0.102 (95% CI: 0.028-0.375)]. Furthermore, when compared to the illiterate, workers with a secondary or higher education had a 96% lower risk of injury [AOR = 0.04 (95% CI: 0.030-0.452)]. Solid waste collectors who received health and safety training had a 90% lower chance of being injured than those who did not [AOR = 0.10 (95% CI: 0.026-0.303)]. Furthermore, the use of on-the-job helped to prevent occupational injuries among solid waste collectors. When compared to their counterparts, PPE users had a 91.1% lower risk of harm [AOR = 0.089, 95% CI (0.017-0.457)] (Table 4).

Table 1. Socio-demographic characteristics of municipal solid waste collectors in Harar town, Eastern Ethiopia, from May 25 to June 25, 2021 (n = 381).

VARIABLES	CATEGORY	FREQUENCY	PERCENTAGE
Sex	Female	223	58.5
	Male	128	41.5
Age (y)	⩽20	18	4.7
	21-30	92	24.1
	31-40	141	37.0
	41-50	130	34.1
Marital status	Married	243	63.8
	Single	76	19.9
	Divorced	46	12.1
	Widowed	16	4.2
Educational level	No education	214	56.2
	Informal education	27	7.1
	Primary schools (1-8)	109	28.6
	Secondary and above	31	8.1
Monthly salary (ET.Birr)	⩽3200	35	9.2
	>3200	346	90.8
Additional job	No	308	80.8
	Yes	73	19.2

One Dollar = 50 ET.Birr.

Discussion

The current study found that 230 (60.4%) of solid waste collectors were exposed to occupational injuries in the last 12 months, which was in line with the findings of other studies conducted in Egypt, which reported 64%,[24] and in Ethiopia, which reported 63.9%.[15] However, it was higher than the finding reported by a studies conducted in Thailand, which reported 36.37%,[25] Tanzania which reported 40.90%,[26] Ghana 27.8%,[20] and in Ethiopia which reported 34.3%.[10] The variation may be related to the difference in waste management systems or technology, work experience, application of occupational health and safety measures and services, or access to the PPE.

Furthermore, this study found that among 230 solid waste collectors exposed to work-related injury, 38.8% were exposed during waste collection, 27.1% during lifting waste, and 26.9% during loading waste. This finding was consistent with studies conducted in different regions of Ethiopia; Addis Ababa[10,14,15] which reported collecting waste (44.9%), followed by loading and lifting 79 (15.6%) and 71 (14.6%), respectively. But a study conducted in America in 2010 on solid waste collectors showed that lifting/pushing/pushing (22.5%) was the most common cause of injury, followed by falls (10.5%), repetitive motion (6.2%), and awkward body posture (6.2%).[27] The variation may be related to the difference in waste management practices, training, work experience, occupational health and safety measures in the study areas.

Regarding the body parts injured, the study found that the most common body parts injured were hands, legs, and back pain was 56.8%, 20%, and 19.9%, respectively. Similar findings were shown in Ethiopia, where hands (22.7%), legs (21.8%), and back pain (17.2%) were the most commonly injured parts of the body.[15] Moreover, similar investigations carried out in Ethiopia revealed significant rates of injuries to the hands, legs, and back pain.[10,14] This might be due to the fact that most solid waste collectors (SWCs) manually collect waste then place it in sacks and trucks with their hands, increasing the risk of cuts and abrasions.[14]

Furthermore, solid waste collectors, particularly those participating in collecting, routinely use their hands and legs to compact waste in sacks for easy transportation. However, a study of solid waste collectors in the United States of America (USA) found that hands (12%), legs (6%), and back pain (20%) were the most frequent problems.[27] The discrepancy between hand, leg, and back injuries is due to the capacity of bins. In

Table 2. Work-related environment and behavioral characteristics of municipal solid waste collectors in Harar town, Eastern Ethiopia, May 25 to June 25, 2021.

VARIABLES (N = 381) CATEGORY		FREQUENCY	PERCENTAGE (%)
Work experience	≤1 y	178	46.7
	>1 y	203	53.3
Working days	≤5 d per week	126	33.1
	>5 d per week	255	66.9
Availability of PPE	No	177	46.5
	Yes	204	53.5
PPE use on duty (n = 204)	No	19	9.3
	Yes	185	90.7
Reason non-use PPEs	Not comfortable to use	55	30.4
	To save time	24	13.3
	Lack of PPE	74	40.9
	Lack of safety and health education	26	14.4
	Other reasons (forgetfulness, carelessness)	2	1.1
Health and safety training before employment	No	171	44.9
	Yes	210	55.1
On job training	No	348	91.3
	Yes	33	8.7
Smoking cigarette	No	299	78.5
	Yes	82	21.5
Drinking alcohol	No	288	75.6
	Yes	93	24.4
Chewing chat	No	178	46.7
	Yes	203	53.3
Job satisfaction	No	61	16.0
	Yes	320	84.0

USA, they used litter bins located in parks and gardens which are more difficult to work with and required higher forces to push or pull a full wheel bin across soft or wet lawn, pine bark, mud or soil and the workers adopted awkward posture.[27,28] However, in this study, SWCs utilized non-puncture-proof sacks or bags. It might also be related to respondents' lack of or underuse of PPE, since the majority of respondents stated that they do not use PPE all of the time owing to a lack of PPE or discomfort in using it.

In this study, the most frequent causes of work related injury were sharp and slender pointed objects (38.8%) during waste collection, lifting waste (27.1%), and loading waste (26.9%). This finding was consistent with some studies conducted in Ethiopia.[10,14,15] But, a study conducted in America in 2010 on

solid waste collectors showed that lifting/pushing/pushing (22.5%) was the most common cause of injury, followed by falls (10.5%), repetitive motion (6.2%), and awkward body posture (6.2%).[27] The possible reasons are that sharp and slender pointed objects were the common causes of injury in this study as a result of sharp and slender pointed objects being disposed of with the general waste (mixed waste). Even workers who wore hand gloves during data collection did not wear PPE on a regular basis, and the community used punctured bags to store waste, exposing collectors susceptible to injury during waste collection and handling.

In this study, increasing educational levels have been associated with decreased occupational injuries compared to those who are not educated [AOR = 0.102, 95% CI (0.028-0.375)]

Table 3. Distribution of occupational injury and injured body parts in the last 1 year among solid waste collectors in Harar town, Eastern Ethiopia, from May 25 to June 25, 2021 (n = 381).

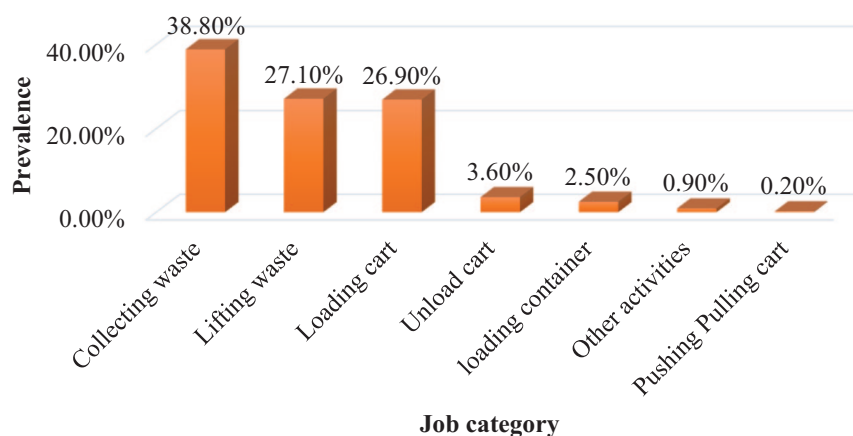|	VARIABLE	FREQUENCY	PERCENT
Occupational injury in the past 12 mo	No	151	39.6
	Yes	230	60.4
Occupational injuries in the last month (n = 381)	No	272	71.4
	Yes	109	28.6
Frequencies of injuries (n = 230)	Once	46	20.0
	Twice	49	21.3
	More than twice	135	58.7
Injured body parts	Hand	237	56.8
	Leg	85	20.4
	Back	83	19.9
	Head	6	1.4
	Eye	4	1.0
	Tooth	2	0.5

Figure 2. Types of activities or causes of injury for Harar town municipal solid waste collectors, Eastern Ethiopia.

and [AOR = 0.04, 95% CI (0.030-0.452)], respectively. This is consistent with studies conducted in Egypt, Rwanda, and Ethiopia.[15,29,30] Furthermore, solid waste collectors who had health and safety training before engaging in the job decreased the probability of injury occurrences by 90% compared to those who were not trained [AOR = 0.10, 95% CI (0.026-0.303)]. This finding was supported by another finding conducted in India and Ethiopia.[15,22]

Furthermore, solid waste collectors with 1 and above year experience had 5.975 higher odds of occupational injury compared to those solid waste collectors with 1 year and less work experience. The finding of the current study was consistent with studies conducted in Tanzania, and Ethiopia.[15,26] Additionally, this study found that the use of personal protective equipment on the job sought to minimize solid waste collectors from suffering occupational injuries that was

consistent with studies conducted in India, Egypt, Tanzania, and Ethiopia.[14,15,19,22,26,29]

Strength and limitation

This study adapted standard questionnaires from reviewing previously done studies and other materials related to the topic, like International Labour Organization (ILO) occupational injury statistics and different relevant sources with required modifications based on outcome variables and observation. This would help to compare the proportion of occupational injuries against national and international point of view. In addition, the sample size was large and representative. The limitation of this study was that it might not show the illness or the health concerns of solid waste collectors and recall biases.

Table 4. Multi-variable logistic regression of occupational injuries in Harar town municipal solid waste collectors, Eastern Ethiopia, May 25 to June 25, 2021 (n = 381).

VARIABLE	PREDICTOR	OCCUPATIONAL INJURIES IN THE PAST 12 MO (381)		COR (95% CI)	AOR (95% CI)
		YES (%)	NO (%)		
Sex	Female	157 (70.4)	66 (29.6)	2.78 (1.81-4.24)	4.33 (0.99-19.04)
	Male	73 (46.2)	85 (53.8)	1	1
Age(year)	⩽20	1 (5.6)	17 (94.4)	0.18 (0.002-0.144)	0.34 (0.012-9.986)
	21-30	37 (40.2)	55 (59.8)	0.21 (0.12-0.38)	1.51 (0.30-8.680)
	31-40	93 (66)	48 (34)	0.61 (0.36-1.03)	1.82 (0.53-6.194)
	41-50	99 (76.2)	31 (23.8)	1	1
Educational level	No education	168 (78.5)	46 (21.5)	1	1
	Can read and write	16 (59.3)	11 (40.7)	0.398 (0.173-0.917)	0.57 (0.13-2.49)
	Primary school	39 (35.8)	70 (64.2)	0.153 (0.092-0.254)	0.10 (0.03-0.38)*
	Secondary and above	7 (22.6)	24 (77.4)	0.08 (0.032-0.197)	0.04 (0.03-0.45)*
Current Marital status	Married	151 (62.1)	92 (37.9)	1	1
	Single	31 (40.8)	45 (59.2)	0.42 (0.25-0.71)	2.43 (0.414-14.23)
	Divorced	33 (71.7)	13 (28.3)	1.55 (0.77-3.09)	4.68 (0.97-22.55)
	Widowed	15 (93.75)	1 (6.25)	9.14 (1.19-70.3)	1.38 (0.101-18.79)
Work experience	⩽1 y	64 (36)	114 (64)	1	
	>1 y	166 (81.8)	37 (18.2)	7.99 (5.0-12.8)	5.975 (2.01-17.75)*
PPE use on duty	No	14 (73.7)	5 (26.3)	1	1
	Yes	50 (27)	135 (73)	0.132 (0.045-0.386)	0.089 (0.02-0.46)*
Safety training before employment	No	22 (13)	149 (87)	1	1
	Yes	129 (61.4)	81 (38.6)	0.09 (0.06-0.16)	0.10 (0.03-0.30)*
On job training	No	220 (63.2)	128 (36.8)	1	1
	Yes	10 (33.3)	23 (69.7)	0.25 (0.12-0.55)	1.37 (0.298-6.28)
Work related instability	No	154 (56.2)	120 (43.8)	1	1
	Yes	76 (71)	31 (29)	1.9 (1.2-3.1)	1.15 (0.296-4.47)
Smoking cigarette	No	179 (59.9)	120 (40.1)	1	1
	Yes	51 (62.2)	31 (37.8)	1.1 (0.7-1.8)	0.637 (0.108-3.75)
Drinking alcohol	No	169 (58.7)	119 (41.3)	1	1
	Yes	61 (65.6)	32 (34.4)	1.3 (0.8-2.2)	2.505 (0.51-12.27)
Sleeping problem	No	158 (58.1)	114 (41.9)	1	1
	Yes	72 (66.1)	37 (33.9)	1.4 (0.9-2.2)	0.925 (0.24-3.53)
Job satisfaction	No	47 (77)	14 (23)	1	1
	Yes	183 (57.2)	137 (42.8)	0.4 (0.2-0.8)	1.543 (0.36-6.57)

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio.
*Significant with $P < .05$.

Conclusion

The results of this study concluded that a higher prevalence rate of occupational injury was reported in the study areas. This study identified that educational level, work experience, utilization of PPEs, and health and safety training were the predictor factors associated with occupational injury. In general, this data, as well as those from previous research, indicated that Harar had a greater frequency of occupational injuries. Before and after hiring solid waste collectors, employers should provide personal protective equipment (PPEs) and tailored training on safety measures.

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Author Contributions

LM conceived the ideas and had a major role in conceptualization, design, data collection, analysis, interpretation, drafting, and revising the manuscript. TG, NB, DAM, STT, GM, SM, and AB contributed to data analysis, drafting, and revising the manuscript. Finally, all authors read and approved the final version of this manuscript and agreed on all issues regarding this work.

Data Availability

All data are included in this study. However, additional data will be available from the corresponding author upon reasonable request.

Ethical Consideration

Ethical approval for this study was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of College of Health and Medical Sciences of Haramaya University (protocol number: IHRERC/062/2021).

Supplemental Material

Supplemental material for this article is available online.

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