Economic Costs and Predictors of Occupation-related Injury from Employers Perspectives at Manufacturing Industries in Ethiopia: Top-down Approach and Friction Method

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Abstract

Background

Studies have documented the prevalence and associated factors of occupation-related injuries in manufacturing industries worldwide. However, sufficient information remains scarce on the economic burdens of occupation-related injuries in Ethiopia. Hence, this study aimed to bridge this gap by quantifying economic costs and predictors of occupation-related injury from employers' perspectives in Ethiopia.

Methods

A cross-sectional study was employed to estimate the employer-side economic cost of occupation-related injury from December 2021 to March 2022. This study used a top-down approach to compute direct costs, while the friction method was used for indirect costs estimation. Injury data were obtained from the Bureau of Labour and Social Affairs and the industries, while costs data were from workers' compensation records. The insurance company's injury compensation record was triangulated with industries data. The study collected primary data via a structured questionnaire from randomly selected 1,136 injured cases. Data analysis was carried out with STATA version 14 software. A generalized linear model was used to identify the predictors of the total cost. Statistical significance was accepted at $P < 0.05$. It applied Gamma distribution and identity link function. Direction and strength of association were expressed using exponentiate coefficients with a 95% confidence interval.

Results

From the perspective of the employers, the total cost of occupational–related injury was 22,587,635.32 Ethiopian birr (537,800.84 $).Indirect and direct costs accounted for 65.86% and 34.14% of the overall expenses, respectively. Long-term absence from work (exp (b) = 0.85, $p < 0.01$), having a sleeping disorder (exp (b) = 0.90, p 0.039), co-morbidity (exp (b) = 0.85, $p < 0.001$), and severity (type) of injury (exp (b) = 1.11, $p < 0.001$) were predictors significantly associated with the total cost variability.

Conclusions

Employers' toll of occupation-related injuries represents severe economic implications. The influential factors that elevated the total cost variation were; long-term absence from work, unsafe acts of the workers, having a sleeping disorder, co-morbidity, and severity (type) of injury. Therefore, the identified modifiable factors are the areas of intervention to reduce the cost of occupation-related injuries.

Introduction

Occupational injury refers to a physical injury that a worker encounters while working that caused an illness resulting in death or work absences [1]. Globally, 2.78 million workers die from occupational accidents annually, while 374 million suffer from non-fatal occupational accidents on March 10th, 2019 [2, 3].

This occupation-related morbidity and mortality are becoming a substantial public health concern associated with high economic costs. Economic costs are not only borne by those injured workers but also by the government and employers. The costs can be in the form of direct and indirect costs [4]. Despite successful declines in developed countries that could be liked with declining in occupation injury, the cost of work-related injuries is growing globally, partly in developing countries [5]. Worldwide, the cost of occupational injuries was over $3 trillion [6]. Evidence from international labor organizations showed that work-related injury's financial costs range from 1.8–6% of Gross Domestic Product [7]. In America alone, the total cost of occupational injuries was $250 billion making the compensation cost $4 million per year [8], in Thailand $14 million [9], in the United Kingdom $14 billion [10], in Turkey, the cost of workday loss caused by major occupational accidents was 19,431.75$ [11]

In Africa, the burdens of work-related injury and its economic costs are a more pervasive problem. The finding from Nigeria shows that the costs of occupational injury were $244,330,386 and $34 416.1 for fatal and severe injuries, respectively [12]. Another evidence from Kenya revealed that about 18.75% of employees missed either 1–7 days or more than one month due to occupational injuries [13].

In the context of Ethiopia, the prevalence of occupational injuries is a widespread problem [14–16]. Besides, several studies have documented considerably high magnitude of occupation-related injuries in manufacturing industries [17–20]. However, sufficient information remains scarce on the economic burdens and predictors of occupation-related injuries in Ethiopia from employers' perspectives. Hence, the study intended to estimate the economic burden of occupation-related injuries and its predictors from employers' perspectives in manufacturing industries in Ethiopia. This study provides the necessary information to the scientific communities and policymakers who intervene in the problem.

Methods

Setting, design and time –dimension

A cross-sectional study design was employed in Ethiopia's two largest manufacturing industries (Metehara and Wonji sugar industries). Data extraction was done from December 14th, 2021, to March 23rd, 2022. The study used a retrospective costing approach to estimate the employer's level of the economic burden of occupational injury. The problem was approached via an analysis of prevalence-based analysis that focuses solely on the costs incurred in a specific year, irrespective of the injury's date.

Sample size and sampling techniques

The sample size was determined using single population proportion formula with the following assumptions: prevalence of occupational injury (p) = 78.3% [21], with a 5% margin of error at a 95% confidence interval and a design effect of 1.5, the calculated sample size yielded 1,136 respondents. The calculated sample size was proportionally allocated to each industry based on the number of injured cases. Data from administrative injuries records determined the total number of injuries during the reference period (January 1st to December 30th, 2021).

Source of data

The study used data from multiple sources to minimize the limitation of the study on the utilization of workers' compensation data alone for occupational injury. Finally, similar data were combined and complemented for further analysis.

Data from secondary sources

Bureau of Labor and Social Affairs records to get all the injured cases in the reference period. The study included variables derived from insurance companies, such as the name of the industry, premium payment; the number of injured workers (both non-fatal and fatal); the amount of compensation received, and the day of work missed. The researchers interviewed the security officers, account department officers, occupational health and safety officers, and production managers. The study incorporated the data obtained via a questionnaire with administrative records due to high accident under-reporting.

Data collection techniques and procedures

Data from manufacturing industries

The study gathered industry data such as sick leave, number of injured workers, number of death, the total number of days lost, sick leave pay, and insurance premiums from manufacturing industries via interviews administered questionnaire. The safety officers, plant managers, and industry insurance dealers collected additional data.

Data from injured workers

The study collected the primary data from injured workers who have missed at least one working day to identify factors associated with the total cost variability. The study used a structured, interviewer-administered questionnaire adopted from international labor organization (ILO) injury statistics and modified into the industry context [22].

Techniques and approaches to cost estimation

Estimation of direct cost

The researcher used insurance agency data to estimate the direct costs of injury through the top-down approach (allocating portions of a known total expenditure to each of several injury categories). The

median direct costs for medical expenses and compensation costs were calculated in disability categories and multiplied by the total number of injuries. The direct medical and compensation costs were calculated separately. The study adjusted cost currency with international cash, the United States dollar (USD). For 2021, according to the commercial bank of Ethiopia, the average annual exchange rate between the USD and the Ethiopian Birr (ETB) was USD 1.0 = ETB 44.32 ETB [23].

Estimation of the indirect cost of occupation-related injury

The friction cost estimation method estimated the indirect costs of occupation-related injuries. Using a multiplier, the present study accounted for employer productivity losses in absenteeism and presenteeism.

Absenteeism cost estimation method

The study estimated absenteeism lost productivity due to the worker's absence from work to quantify costs for employers. It was multiplied by the total number of absences from sick days by the median daily wage and the fractional value of the multiplier of absences from lost productivity. The median multiplier is 1.28, suggesting that the employer's missing work cost is higher than the salary. The cost of absenteeism was calculated giving the following formula:

Formula 1: =

$$[\![\text{Absenteeism costs (AC)}]\!] = [\![(MLW \times NIE \times MDWE) \times 1.28]\!] \text{ [24].}$$

Where:

MLW = the median of lost workday's due to absenteeism for the defined period,

NIE = the total number of injured employees,

MDWE = the median daily wage of the employees,

The median multiplier supports the view that the cost to the firm of missed work is often greater than the wage =1.28.

Presenteeism cost estimation method

The researcher estimated presenteeism lost the cost of productivity due to the worker's reduced job output. The cost of presenteeism was evaluated according to the following formula:

Formula 2: =

$$[\![\text{Presenteeism costs (PC)}]\!] = [\![(MLW \times NIE \times MDWE) \times 1.5]\!] \text{ [25, 26].}$$

Where:

MLW = the median of lost workday's due to presenteeism (the problem of workers' being on the job but, because of illness or other medical conditions, not fully functioning),

NIE = the total number of injured employees,

MDWE = the median daily wage of the employees,

Presenteeism multiplier was used =1.5.

Operational definition

Absenteeism: refers to the productivity lost when someone is absent for at least one day from the workplace because of an injury or illness for which the employee is accountable.

Total cost: referred to the sum of the direct and indirect costs of occupation-related injuries.

Direct cost: referred to expenditures associated with the usage of medical facilities and reimbursement (repayment) for payments made by organizations and insurance providers.

Indirect costs: referred to losses in production due to absence from work.

Friction cost: refers to the approach that measures the indirect cost of injury by estimating the cost of replacing those killed or temporarily or permanently disabled with other existing workers during the friction period.

Occupational injury: referred to any personal injury such as a cut, fracture, sprain, and so forth those results from a work-related event resulting in an absence from work of at least one day.

Perspective (the level of analysis**)**: the point of view from which an analysis was conducted.

Presenteeism: reduced productivity, the performance of employees who work while they are sick or injured, or the practice of coming to work despite illness, injury, anxiety, etc., often resulting in reduced productivity.

Unsafe Act: Performance of a task or other activity conducted in a manner that may threaten the health and safety of workers. It includes improper use of PPE, operating equipment at an unsafe speed, bypassing or removing safety devices, using defective equipment, using tools other than their intended purpose, working in hazardous locations without adequate protection or warning, and improper equipment repair. We asked about 15 questions, and respondents' yes response scores were 1, and no scores were 0. Then, the proportions of unsafe acts were computed by pooling multiple responses.

Data quality assurance

Data were gathered by trained data collectors (n = 6) with a degree in occupational health and safety. The principal investigator trained data collectors and supervisors for two days. The training focused on the

data collection tools, the study procedures, and research ethics. The questionnaires were translated into the Amharic language by an experienced translator and back-translated into English by an independent translator for consistency. A pretest was done on 10% of the sample size outside of the study area before data collection. The principal investigator checked the collected data for completeness and consistency before further analysis. The principal investigator closely monitored the field-level data collection process daily. The investigator approached data collectors when errors were noticed, correcting the field level.

Data processing and analysis

The study was generating a codebook to pass the collected data to a code sheet. The researchers cleaned up the data, did an inspection of distributions, and cleaned contingency for accuracy. Case sorting was executed to find the missing variables. A continuous variable was coded, and it was recorded some coded variables. We provided a non-lapping numerical code. All of the compiled data was recorded in an Excel spreadsheet and exported to the STATA 14 software for further analysis. The data analysis was conducted in a step-wise procedure in which first, the characteristics of study participants were analyzed and described. The direct, indirect, and total costs of occupation-related injuries were analyzed. All cost information was converted to United States dollars (USD$). The study checked multi-collinearity using a correlation matrix at > 0.8, a variance inflation factor (VIF) > 10, and a tolerance of 0.1. It was tested for model fitness using the Hosmer and Lemeshow test at a p-value > 0.05. Next, the cost of occupational injury data was checked for normality using plots (Q–Q plots and histograms) and the Kolmogorov–Smirnov test for normality (P > 0.05). The cost data was discovered to be right-skewed, and a log transformation was performed to confirm the normality of the skewed data. The study employed a generalized linear model (GLM) with a gamma family and log link function to identify predictors of total cost by considering the non-normal distribution of the total cost. Exponentiate coefficients (exp (b) with a 95% confidence interval were used to express the direction and strength of the association. The study took variables with p-values < 0.05 at a 95% confidence level as statistically significant.

Results

Socio-demographic and injury characteristics of participants

During the reference period, 1,200 injury data sets were collected from employee injury compensation claim records. It was found that 607 (50.6%) and 476 (39.7%) of the victims experienced permanent partial disability and temporary total disability, respectively (Table 1).

Table 1: Socio-demographic characteristics of injured workers in manufacturing industries in Ethiopia, 2021 (n=1,200)

Characteristics	Frequency (%)
Sex	
Male	1175 (97.9)
Female	25 (2.1)
Type of injury characteristics	
Temporary disability	476 (39.7)
Permanent partial disability	607 (50.6)
Permanent total disability	70 (5.8)
Death	47 (3.9)
Injured body parts	
Hand and finger	720 (60)
Leg and foot	2017 (17.3)
Head, and neck	140 (11.7)
Eye	48 (4)
Ear	8 (0.7)
Back and vertebra	8 (0.7)
Chest and shoulder	8 (0.7)
Teeth	32.(2.7)
Multiple location	29.(2.4)
Cause of events	
Slippery surface	258 (21.5)
Contact with objects and equipment	123 (10.3)
Working from height / fall	271 (22.6)
Exposure to harmful substances	141 (11.8)
Transportation accidents	63 (5.3)
Fires and explosions	57 (4.8)
Machine	52 (4.3)
Miss handling	53 (4.4)
lifting heavy material	27 (2.3)

hand tools	52 (4.3)
sweaty palms	103 (8.6)

Personal and clinical characteristics of participants

In this study, long-term absence from work and having sleeping disturbances were experienced in 933 (82.13%) and 636 (55.99%). Besides, 740 (65.14%) participants reported using personal protective equipment inconsistently (Table 2).

Table 2: Personal and clinical characteristics of participants in manufacturing industries in Ethiopia, 2022.

S.N	Variables	Frequency (%)
1.	Injury prevents from work	
	Yes	684 (60.2)
	No	452 (39.8)
2.	Unsafe act	
	It is not a case	70 (6.16)
	Is a case	1,066 (93.84)
3.	Duration of absence from work	
	short –term absence	202 (17.78)
	long-term absence (>5 days)	933 (82.130)
4.	Having sleeping disorder	
	Yes	500 (44.01)
	No	636 (55.99)
5.	Co-morbidity	
	Yes	500 (44.01)
	No	636 (55.99)
6.	PPE utilization	
	Consistent use	396 (34.86)
	Inconsistent use	740 (65.140)
7.	Reasons for not using PPE	
	Factory not provide	540 (16.9)
	Not comfortable to use/lack fitness	1060 (33.2)
	Lack of knowledge on how to use it	229 (7.2)
	Decrease work performance	1361 (42.7)
8.	Severity (type) of injury	
	Minor injury	452 (39.79)
	Severe injury	684 (60.21)
9.	Timing of injury happens	
	Morning	414 (36.44)
	Afternoon	235 (20.69)

Night	487 (42.87)

Loss of workday (absence)

The present study revealed that the total number of days injured workers were away from work was 29,891 workdays during the reference period. In this regard, the median number of days away from work (absence workday) was 21.48 days. Additionally, about 894 (74.5%) and 258 (21.5%) victims were absent from work due to occupation-related injuries for 5–30 days and over 30 days, respectively (Table 3).

Table 3: Proposition of workdays loss associated with occupation-related injury in manufacturing industries in Ethiopia, 2021 (n=1,200).

S.N	Ranges of workday lost	Frequency (%)
1.	Less than five days	48 (4)
2.	5-30 days	894 (74.5)
3.	Over 30 days (%)	258 (21.5)

Economic costs of occupation-related injuries

Direct cost

The present study used the median cost of injured cases, medical costs, and disability payments and multiplied them by the total number of injuries to estimate the total direct costs. Accordingly, the total direct cost was 7,711,584 Ethiopian birr (173,997.83 USD). The median direct costs (per victim) were 6,426.32 birrs (144.99 USD). Besides, compensation payments amounted to 2,516,754.72 Ethiopian birrs (56,785.98 USD) (Table 4).

Table 4: Medical and compensation claim payment of occupation-related injuries in manufacturing industries in Ethiopia, 2021 (n=1,200).

S.n	Cost categories		estimated cost in birr (united state dollars,$)	Median ($) of Cost
1.	Medical cost		962,102.42 (21,708.08$)	3,000 (67.68$)
2	Compensation cost	Accident classification		3,426.32 ($)
		Temporary total disability	479,188.56 (10,812.01$)	
		Permanent partial disability	506,188.34 (11,421.21$)	
		Permanent total disability	752,189.02 (16,971.77$)	
		Fatal-injury	779,188.8 (17,580.97$)	
		Total compensation cost	2,516,754.72 (56,785.98)	
3.	Amount of premium pay		15,135,322.68 (341,500.96$)	
4.	Total direct cost		7,711,584 (173,997.83$)	6,426.32 (144.99$)

Indirect costs

In this study, indirect costs are incurred through lost productivity that results from injury-related absences. To estimate total production costs, the median wage of the injured employee was taken to calculate the median daily salary. The median daily wage of the employees was 207.6 Ethiopian birr (60.7 SD). Also, the median workday lost was 21.48 days, resulting in a total indirect cost of 14,876,051.32 Ethiopian birrs (303,592.88 dollars). Additionally, the presenteeism cost constitutes 8,026,646.40 Ethiopian birrs (163,809.11 dollars) of the whole production cost (Table 5).

Table 5: The indirect cost of occupation-related injury by cost components in manufacturing industries in Ethiopia, 2021 (n=1,200).

S.n	Costs component	Estimated costs in birrs (USD $)
1.	Absenteeism, estimated cost	6,849,404.92 (139,783.77$)
2.	Presenteeism, estimated cost	8,026,646.40 (163,809.11$)
3.	Total indirect cost	14,876,051.32 (303,592.88$)
4.	Average cost (total costs divided by the no of injured cases)	12,396.709 (252.99$)

Total costs of occupation-related injury

The present study found that the total cost of occupation-related injury from employers' perspectives was 22,587,635.32 Ethiopian birr (537,800.84 dollars). The indirect cost accounted for 65.86% of the whole expense, and the direct cost incurred was 34.14%. The compensation expenses accounted for approximately 2,516,754.72 Ethiopian birrs (56,785.98 $) of the total costs, while presenteeism costs accounted for 8,026,646.40 (163,809.11 $) (Table 6).

Table 6: Total costs of occupational-injury ordered by cost estimation period in manufacturing industries in Ethiopia, 2021 (n=1,200).

	Cost estimation period, 2021	
Cost category	Cost in Ethiopian Birr (USD$)	% of the total cost of injury
Direct costs	7,711,584 (173,997.83$)	34.14
Indirect costs	14,876,051.32 (303,592.88$)	65.86
Total costs	22,587,635.32(537,800.84$)	100

Predictors of total costs of occupation-related injuries

The study was fitted with a generalized linear model (GLM) to identify the potential predictors that influenced the total cost variability. The GLM analysis model found that, long-term absence from work (exp (b) =0.85, p<0.01), severity (types) of injury (exp (b) =1.11, p<0.001), unsafe acts of the workers (exp (b) = 1.44, p<0.033), sleeping disturbance (exp (b) = 0.90, p<0.039), and co-morbidity (exp (b) = 0.85, p<0.001) had a significant association with the total cost variations (Table 7).

Interpretations of generalized linear model outputs:

The long-term absence of employees from work due to work-related injuries was negatively associated with the variation of the total cost borne by employers. So, for each one-unit increase in the long-term absence total score, the odds of being in total cost variations paid by employers were increased by 15% (Exp (b) = 0.85 (95% CI = [0.80, 0.90]) after controlling for all other covariates in the model (Table 7).

Besides, the severity (types) of injury was negatively related to the total cost of occupation-related injury variation in employers' perspectives. In this manner, for every 1 point increase in the severity of injury total score, the odds of being in total cost variation were elevated by 11% (Exp (b) = 1.11, 95% CI = [1.02, 1.21]) after controlling other factors in the model (Table 7).

Similarly, an unsafe act by the workers was associated with a substantially heightened total cost of occupation-related injury variation in employers' views. In this regard, for each one-unit increase in an unsafe act's total score, the odds of being in total cost variations are raised by 44% (Exp (b) =1.44, 95% CI = [1.20, 1.72]) after controlling other covariates in the model (Table 7).

Additionally, having sleep disturbance was negatively associated with the total cost of occupation-related injury variation in the viewpoints of employers. In this way, for each one-unit increase in the sleeping disorders total score, the odds of being in total cost variations increased by 10% (Exp (b) = 0.90, 95% CI = [0.82, 0.98]) after controlling other covariates in the model (Table 7). Likewise, for each one-unit increase in co-morbid illness, the total score, the odds of being in total cost variations were elevated by 15% (Exp (b) = 0.85, 95% CI = [0.78, 0.92]) after controlling other covariates in the model (Table 7).

Table 7: Generalized linear model analysis to identify the predictors of the total cost of occupation-related injury during the cost estimation period in Ethiopia, 2022 (n=1,136).

Total costs of occupation-related injury	Exp(b) the corresponding adjusted odds ratios (AOR).	Std.error	p-value	[95% Conf. Interval]	
				Lower	Upper
Duration of absence from work Long-term absence (>5 working days)	0.85	.004	0.001	0.80	0.90
Severity (types) of injury Severe injury (was a case)	1.11	0.03	0.01	1.02	1.21
Unsafe act of the workers Yes (it was a case)	1.44	0.01	0.033	1.20	1.72
Having sleeping disorder Yes	0.90	0.004	0.039	0.82	0.98
Having co-morbid illness Yes	0.85	0.004	0.001	0.78	0.92
PPE utilization Inconsistent use	0.96	0.004	0.67	0.89	1.05

Discussions

This study estimated the costs of occupation-related injuries and their predictors from the employer's perspective to provide empirical estimates. The data-driven evidence on the economic cost of occupational injuries should provide relevant stakeholders with a better understanding. This insight assists them in making improvements to the working conditions of industrial workers and can positively impact policymakers'decisions.

Moreover, comparing the costs of work-related injuries is challenging due to the dissimilarity in currency and exchange rates across countries. But, the present study found that the total cost of occupation-related damage incurred by employers was incredibly higher than what had been previously estimated in Ghana [27],America [8],Croatia [28], India [29],Malaysia [30], Netherland [31], and Thailand [9]. This substantial amount of cost variation was explained by cost estimates, the particular costing approaches and the perspectives used the data collection methods, and the sizes or composition of industries.

Conversely, our cost estimates are considerably lower when compared to a similar study done in South Africa [32], Poland [33], other parts of the United States [34], Australia [35], Finland [36], and Mexico [37]. The estimated disparity is explained by the differences in the sources of data used, the range of cost components included, and the reference period considered. Besides, the cost computations in our study were limited to medical care, compensation, and productivity loss. Also, our cost estimates were limited to the employer side in one calendar year. The previous literature has estimated the cost of work-related injuries from employers, employees, and social perspectives, which might heighten the discrepancy.

Furthermore, a substantial literature has shown that occupation-related fatality is becoming the overwhelming issue accountable for huge economic losses. For instance, the pooled prevalence of occupational injury in Ethiopia was 44.66% [38], in Ghana 57.91% [39], and 57% in the Africa region [40]. These imply that the burdens of work-related injury are elevating; the economic burdens associated with work-related injury will be expected to be high. Additionally, a researcher with different costing approaches and perspectives reported that the total cost of a workplace injury is often underestimated because some cost components are challenging to quantify, and there is an underreporting of uninsured injuries. Also, the indirect costs could be four times higher than the direct costs [41]. Similar to the above study, the present study found that the indirect cost comprised the largest component of the total cost and was much greater than the direct cost incurred. Compared to the direct costs, there are many variations in the proportion of the expenses, but usually, the proportion of indirect costs is potentially more costly than direct costs. This is consistent with evidence from five European Union countries [42], Canada [43], Turkey [44], Malaysia [45], and German [46]. Evidence showed that direct cost is usually something that can be known at the time of the accident. In contrast, indirect cost needs to be quantified after the accident [47, 48].

Moreover, the present study revealed that the total indirect cost incurred was much higher than the finding from Mexico [37, 49], Ghana[50], and Europe [42]. The possible reason for this discrepancy might be due to the cost categories considered and the costing approach used. However, our study estimated the indirect cost only from productivity losses, and other indirect cost components were not included. In our research, presenteeism cost was the largest component of indirect costs than absenteeism borne by employers. These increased costs of productivity losses imply that the injured worker was present at work but contributed a sub-normal individual output due to incomplete recovery, which could be leading to lower productivity. The other literature supported our findings [51, 52]. Additionally, the decrease in productivity translates to the inability to perform routine tasks [53]. Also, reduced on-the-job productivity due to health issues affecting the overall performance of companies with negative economic implications to be associated with presenteeism [52, 54].

Similarly, the compensation cost consists of the most significant direct cost component compared to direct medical costs. On the other hand, the direct medical price is much higher than the finding in Turkey [55]. The more accidents organizations have, the more expensive the coverage gets. Workers' compensation payments are determined by the cost of worker injuries that could be elevated then next year's premiums more likely. Also, it might be related to the nature and the size of the industries.

Furthermore, knowing the factors influencing cost variability allows employers and policymakers to identify the area of focus for better decision-making. Our generalized linear model indicates that long-term absence from work considerably increases the total cost variation, which is in line with previous studies conducted in different countries [56, 57]. Employers' economic expenses are quite significant when people are absent from their occupations for an extended period of time, which affects productivity. Employers also have a legal obligation to provide compensation and cover the costs of a long absence, which adds to the cost disparity. Long-term sick leave also raises the likelihood of chronic impairment, putting employers under additional hardship.

In our scope of searching, no literature has examined the influence of unsafe actions of workers on employers' 'side total cost variability. Yet, our findings revealed that an unsafe act by the workers was a significant predictor of the total costs. This is mainly associated with unsafe acts of workers that could lead to severe injury or death and which raise the economic burdens of employers as unsafe behaviors of workers are essential contributors to occupational injuries. Related studies found that 88% of workplace incidents in the industry were caused by unsafe behaviors and 10% by unsafe physical conditions [58–60].

Likewise, our finding documented that having co-morbid illness causes raised employers' expenditures. This could be because when individual workers are absent from work due to poor progress health, the financial expenses born by employers are expected to be elevated. Also, co-morbid health problems may reduce the workers' work performance and efficiency and potentially impact the workers' skills. Thus, our finding was supported by evidence from Florida [61], and England [62]. Similarly, our results indicated that sleep disturbance significantly influenced the total costs, which ultimately can lead to a significant economic weight on employers. This means that as sleep disturbance is responsible for a significant driver of fatigue, the cost of work-related injury was hugely higher among employees presented with sleeping disturbance. The present finding is supported by the result from Australia [63], Iran [64], Switzerland [65], America Insomnia Survey [66], and Korea [67]. However, we suggest an in-depth estimation of the real cost of sleeping disorders; such a study would have paramount importance.

Besides, our results demonstrated that the severity of the injury was suggested as the predictor of the variation of the total cost. This means that as the injured workers didn't recover in the shortest period due to the severity of injured body parts and associated complications, the prices of injury from employers' views were considerably large. One study has also revealed similar results as we did [68]. The literature showed that most common costs are sickness absenteeism, health care, individual productivity losses or presenteeism, insurance and pension costs, and indirect costs, such as hiring a replacement and paying for overtime [69, 70].

Public Health Implication

The present study findings increase our knowledge of the economic consequences of injury and provide vital information for further economic analyses. Knowledge of occupation-related injury costs can help

decision-makers decide which occupational health problems need to be addressed first and efficiently allocate health and safety resources. Also, it is implied that these substantial economic costs of injuries reflect negatively on productivity due to increased absenteeism, decreased production, and higher insurance and workers' compensation premiums. Additionally, for specific stakeholders, such as the Ministry of Labour and Social Affairs and the Ministry of Health, the cost of an occupation-related injury study can show the injury's financial impact on industrial productivity and motivate them to undertake injury prevention initiatives.

Strength and limitations of the study

One of the study's strengths was selecting the most significant manufacturing industries to make results representative of most of Ethiopia's manufacturing industries. We also applied a generalized linear model that is more robust to the non-normal distribution of estimates. The other strength of our study was that we incorporated a top-down approach and friction cost estimation method.

The findings from our research have their own set of limitations. One limitation is that we didn't consider occupational diseases. The other limitation is that the costs of occupational injury from workers' perspectives and societal levels were not considered. In addition, all components of indirect costs and direct non-medical costs – incurred by employers were not covered within the scope of the current study. Finally, the lack of similar research hinders us from comparing time and across industries in Ethiopia.

Conclusions

Occupation-related injuries exert a substantive impact (cost) on employers and have severe economic implications. This study adds to the growing body of evidence that improving the working conditions of industrial workers could positively affect the economic burden of work-related injuries. Moreover, the long-term absence from work, unsafe acts of the workers, co-morbidity, sleeping disorders, and severity of injury were influential factors that elevated the total cost variation.

Therefore, the identified modifiable factors are the areas of intervention to reduce the expense of occupation-related injury. Besides, employers should enhance the dissemination of information to workers on safety matters. Also, the issue of occupational safety and health needs to be kept high on the public policy agenda. Finally, the researcher should do a follow-up study to examine whether there will be a rise in the economic burden of occupational injury from both the employee and societal perspectives to get a complete picture of the burden.

Declarations

Ethics approval and consent to participate

Proposal for the study was reviewed and obtained approval on December 14, 2021 from the Ethical Review Committee of College Medicine and Health Sciences at Bahir Dar University (protocol

number: 342/2021). Written informed consent was obtained from every participants or the organizations to participate in the study following the distribution of written information sheets in “Amharic” (both official & study area language) to all participants. The informed consent process emphasized voluntary participation and consent to participation could be withdrawn at any time, without giving a reason and without affecting their current or future benefits to which the participant was entitled. In addition, no investigation was performed beyond the approved proposal and all data were analyzed anonymously. This study was conducted per the Declaration of Helsinki. All study participants were well informed about the aim of the study, benefits, and risks. Written informed consent procedure was approved by the ethics committee. The full name of the ethics committee: Dr.Mulusew Andualem (the chairman of institutional review board of Bahir Dar University College of Medicine and Health Sciences).

Consent for publication

We were preparing a manuscript and presenting the findings at conferences.

Availability of data and materials

Data reported in this manuscript are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no conflict of interest.

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Authors’ contributions

All authors contributed to data analysis, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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