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Prevalence of Occupational Injury among Workers in the Construction, Manufacturing, and Mining Industries in Africa: A Systematic Review and Meta-analysis

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Abstract

Background: Despite the volume of existing literature on the prevalence of occupation-related injuries in Africa, it is fragmented across a broader spectrum and difficult to quickly understand the average magnitude. Besides, there is a lack of empirical shreds of evidence on the regional pooled estimate. Hence, the study aimed to develop the regional pooled estimates of occupation-related injuries among workers in Africa's industries.
Materials and Methods: The study followed preferred reporting items for systematic reviews and meta-analyses guidelines. The used databases included Scopus, PubMed, Science Direct, and Cochrane Library. Further, a modified version of the Newcastle-Ottawa Quality Assessment was used for the critical appraisal of studies. The pooled prevalence of injury was computed using STATA version 14 statistical software. Funnel plot and Egger's tests were conducted to evaluate publication bias. The study assessed the heterogeneity using the I-squared test and Galbraith plot.
Results: Out of 603 accessed studies, 20 that met the eligibility criteria were included. The pooled prevalence of occupational injury in Africa was 57% (95% CI: 48, 67). Totally, 62% (95% CI: 44, 77), 57% (95% CI: 38, 76), and 51% (95% CI: 32, 69) of injuries were identified in the manufacturing, construction, and mining sites, respectively, based on the subgroup analysis.
Conclusions: The rate of occupation-related injuries is dramatically increasing. Such injury is one of the immense concerns for workers' health and safety in Africa. Hence, the stakeholders should carry out rigorous law enforcement to ensure compliance with health and safety measures.

Keywords: Construction, Occupational Injury, Prevalence, Manufacturing, Mining, Systematic Review, Africa.

Introduction

Any personal injury, illness, or death resulting from an occupational accident that constitutes a significant global burden is occupational injury [1, 2]. Such injuries at work pose a significant public health issue and lead to severe social and economic implications. Workplace injury represents a large portion of the global injury burden, accounting for almost 30% of all medically treated injuries to adults aged 18 to 64 years [3].

Globally, occupational injury contributed to over 2.78 million deaths and 374 million non-fatal injuries in 2017 [4, 5]. Besides, it is estimated that the number of non-fatal workplace injuries is considerably rising (started from 2010) [6]. World Health Organization (WHO) recently has reported that 20%-50% of industrial workers worldwide are exposed to various occupational hazards. This figure is likely to be higher in developing counties [7]. Moreover, in 2018, the finding in the U.S showed that 5,250 workers died from work-related accidents. In 2019, non-fatal workplace accidents among the private sector workers were 2.8 cases per 100 full-time equivalent employees with eight median days away from work [8].

In developing countries, where manufacturing is mainly concentrated, health and safety regulation is not well enforced; thus, the burden of workplace injuries is incredibly high [9, 10]. African countries are among developing countries where occupational injuries are more serious [11, 12]. Evidence from the Ghana gold mining industry alone revealed that the occupational injury burden from 2015 to 2016 was 26% [13]. Evidence from Zambia's largest copper mining industry showed that over 165 workers were sustained occupational injuries [14]. In Congo, the prevalence of occupational injury was 24% [15]. Another finding from Tanzania indicated that the prevalence of occupational injury was 58.5% [16].

Moreover, studies from Ethiopia reported inconsistent magnitude of occupational injuries. For example, one study showed that about 1,356 working days were lost, and 35% of workers were absent from work for 15 to 30 days due to injuries [17]. Another study from the southwest region of Ethiopia showed the prevalence of occupational injury to be 45.2% [18]. Similarly, evidence from the northern part of Ethiopia indicated the prevalence of occupational injury to be 58.2% [19]. Besides, findings in Addis Ababa showed the prevalence of occupational injury among workers in manufacturing industries to be 91% [20].

In conclusion, the occupation-related morbidity and mortality rate is becoming a substantial public health concern for many industrial workers worldwide, as reported by the International Labor Organization. Despite the volume of existing literature on the prevalence of occupation-related injuries in Africa, it is fragmented across a broader spectrum and difficult to quickly understand the average magnitude. For instance, findings have shown a range from 9.7% to 97.5% in Ethiopia [21, 22], 19.2% to 98.1% in Kenya [23], 39.25 to 69% in Nigeria [24, 25], 23.7% to 72.2% in Congo [15, 26], and 35.6% to 86.3% in Rwanda [27]. Besides, there is a lack of empirical shreds of evidence on the regional pooled estimate of occupation-related injuries among workers in Africa's construction, manufacturing, and mining industries. Therefore, understanding the pooled prevalence of occupational injury is paramount to design health and safety strategies to reduce such injuries and associated economic costs.

According to the present study, although much has been written on work-related injuries among workers in the construction industry, limited studies have attempted to pool the extent of such injuries in other occupational groups (mining and manufacturing sugar industries). The present review incorporates heterogeneous occupational groups, thus appreciably advancing fundamental understanding or knowledge in the area. In addition, data from prominent sources (occupational groups) were combined, providing an opportunity to develop novel theoretical perspectives.

Hence, the study aimed to develop the regional pooled estimates of occupational-related injury among workers in Africa's construction, manufacturing, and mining industries and provide the necessary information for the scientific communities and policymakers who intervene in the problem.

Materials and Methods

This systematic review and meta-analysis protocol estimated the pooled prevalence of occupational injury among workers in Africa's construction, manufacturing, and mining industries. The whole review project was conducted from 10/1/2020 to 10/2/2021. According to the latest United Nations estimates (2021), the population of Africa is 1,361,684,609. The population density and the total land area in Africa are 45 persons per km2 and 29, 648, 48 km2, respectively. Nigeria is the most populous African country, with over 206 million inhabitants as of 2020 [28, 29].

The databases of Cochrane Library, Joanna Briggs Institute (JBI), and PROSPERO were checked for ongoing review projects related to the prevalence of occupational injuries in Africa. Preferred reporting items for systematic review and meta-analysis (PRISMA-P 2015) guidelines were followed to show accessed, screened, rejected, and included articles systematically or as per predesigned searching strategies.

The Cochrane Library, Joanna Briggs, SCOPUS, PubMed, Science Direct, Cochrane Library, and African journals online databases were systematically searched from January 1/2010 to February 10/2021 using the following keywords: (prevalence) OR (epidemiology) OR (burden) OR (magnitude) OR (distributions) AND (workplace injuries) OR (occupational accident) OR (occupational illness) OR (work-related injury) OR (work-related accidents) AND Africa. The key terms were combined using Boolean operators like

"OR" or "AND." The review was restricted to full texts, free articles, and English language publications. It was used in all fields and Mesh words during the advanced PubMed search. The first reviewer performed the initial search and completed it on 10/02/2021. Then, the literature was scanned for updates.

The review considered all primary studies conducted in Africa on the prevalence of occupational injury. It incorporated an observational study design published from a time frame of 1/1/2010 up to 10/2/ 2021. In addition, the study included both published and unpublished studies in English. It also included studies with the outcome of interest (occupational injury).

This review omitted primary studies not entirely accessed during the searching process, as well as those without a report on the outcome of interest and with methodological problems. Besides, studies with low quality as the pre-settled parameters were also removed. The full-text review was limited to studies that met the requirements for inclusion.

Duplicates were removed, and database search results merged using Endnote (version X8). A modified version of the Newcastle-Ottawa quality assessment scale was also adapted to assess the methodological qualities of the included studies [30]. The three authors (MB, MA, and AM) independently evaluated the quality of included research articles. Disagreements were solved by discussion among the reviewers. Primary studies that scored ≥7 out of 10 were considered as high quality, thus being included in the final meta-analysis.

Data were extracted using a data extraction tool adapted from a meta-analysis of statistics assessment and review instruments. The corresponding author of the original research was contacted for incomplete or ambiguous information or to clarify method details as needed. First, the title and abstract of the paper were critically reviewed; duplicated data and articles whose titles were irrelevant to the study were excluded. Then, full documents of the papers were read and reread. The abstracts were extracted. Data were defined and extracted by MB and double-checked by a second reviewer. Also, two authors (MB and MA) independently extracted all the required data. The outcome of interest (prevalence) data extraction format consisted of the first author's name, publication year, study location, analysis design, sample size, number of participants with the outcome (case), a sub-region of the study, site of injury, scale or scope of the industry, and response rate.

The PROSPERO registration number (CRD42021230787) was obtained. The study reported the prevalence of occupational injury as a percentage or as the number of cases (n)/total number of participants in the sample (N). Therefore, the prevalence rate was determined by dividing the number of individuals injured by the total number of participants in the study (sample size) multiplied by 100.

The necessary data were extracted from each article using the Microsoft Excel spreadsheet to estimate the pooled prevalence. Then, the analysis was conducted using STATA 14 version software. First, the pooled prevalence of occupational injury was computed with Metaprop on Stata command and presented in a forest plot with a corresponding 95% confidence interval.

Next, publication bias was checked by funnel plot (subjectively), as well as Begg's and Egger's tests (objectively). The study used a cutoff point of a p-value of less than 0.05 for Begg's and Egger's tests to declare the existence of publication bias. Then, the Galbraith and forest plots were used to visualize the presence of heterogeneity. Further, Higgins I-Squared (I2) and Cochran's Q statistic were applied objectively to figure out the heterogeneity. Finally, the I-square statistics used a cutoff point of 50% to declare significant heterogeneity.

A random-effect model that accounts within and between-study variability was used to estimate the pooled effect size. The results were presented via forest plot with the corresponding odds ratio and 95% confidence intervals. Also, the prevalence rate, the prevalence logarithm, and the standard error (SE) of the prevalence logarithm were computed. An output in meta-analyses was double-checked for internal consistency by the same person.

Results

A total of 603 papers were accessed from PubMed databases, SCOPUS, Science direct, and other sources. Among them, 326 studies were rejected due to duplication. After reading the title and the abstract, 48 studies were omitted since they did not align with this review's purpose and had a methodological deficit. Sixty studies were screened for full-text review, 20 of which were included for the systematic review and meta-analysis. The detailed steps of the screening process are shown in the study selection PRISMA flow map (Fig. 1).

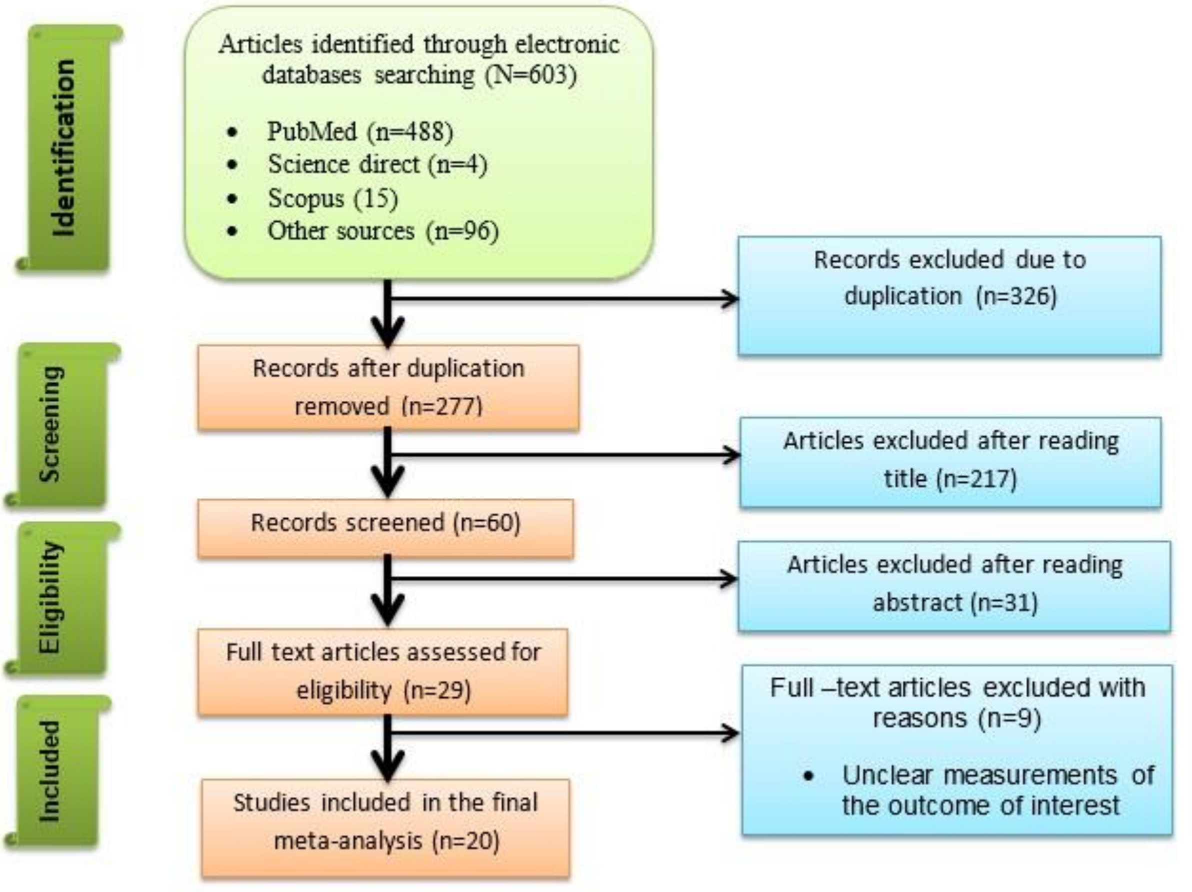

Fig. 1. PRISMA 2009 Flow diagram for identification and selection of articles to be included in the review on the prevalence of occupational injury among workers in the industry in Africa, 2021 (n=20)

The review included original studies with a total sample size of 10,155. About 17 of the 20 reviewed studies were cross-sectional [31-53]. Concerning the geographical distribution of the studies, 13 were obtained from East African countries [31, 32, 36-43, 45, 46, 52]. Finally, the quality score of the studies ranged from 7 to 9 out of 10 points (Table 1).

Table 1. Overview of included studies in the systematic review and meta-analysis of the prevalence of occupational injury among workers in the industry in Africa, 2021 (n=20)

First author/ Year	Country	Sample size	Event	Key findings	Site of injury	Scale of industry	Quality score
Eric et al., 2017	Ghana	635	368	57.95%	Construction	Large	7
Chipo etal., 2015	Zimbabwe	312	156	50%	Mining	Large	7
Serole et al., 2016	South Africa	250	204	81.6%	Construction	Large	7
Daniel et al., 2017	Ethiopia	449	165	36.74%	Manufacturing	Large	7
Yitagesu et al., 2014	Ethiopia	829	489	58.98%	Manufacturing	Large	8
Gebrekiros et al., 2015	Ethiopia	433	314	72.51%	Manufacturing	Large	9
Edward et al., 2015	Rwanda	220	190	86.3%	Manufacturing	Large	8
Patrick et al., 2018	Ghana	389	218	56.04%	Construction	Medium	8
Nagasa et al., 2019	Ethiopia	574	432	75.26%	Manufacturing	Medium	9
Richard et al., 2013	Zambia	500	213	42.6%	Manufacturing	Medium	9
Kunar et.al 2010	South Africa	170	85	50%	Mining	Large	8
Eshetie et al., 2020	Ethiopia	446	399	89.46%	Manufacturing	Large	8
Hanna et al., 2017	Ethiopia	809	683	84.42%	Construction	Medium	9
Getnet et al., 2015	Ethiopia	983	336	34.18%	Manufacturing	Medium	7
Getachew et al., 2017	Ethiopia	594	278	46.8%	Construction	Large	9
Myriam et al., 2013	Congo	180	130	72.2%	Manufacturing	Medium	8
Christophere et al., 2015	Nigeria	1200	471	39.25%	Construction	Medium	7
Immaculate et al., 2019	Uganda	343	206	60.05%	Manufacturing	Medium	7
Michael etal., 2020	Kenya	384	74	19.27%	Mining	Medium	7
Arthur et al., 2015	Uganda	319	103	32.2%	Manufacturing	Large	8

In this review, the pooled prevalence of occupational injury among workers in African's construction, manufacturing, and mining industries was 57% (95% CI: 48, 67), as shown in the forest plot (Fig. 2).

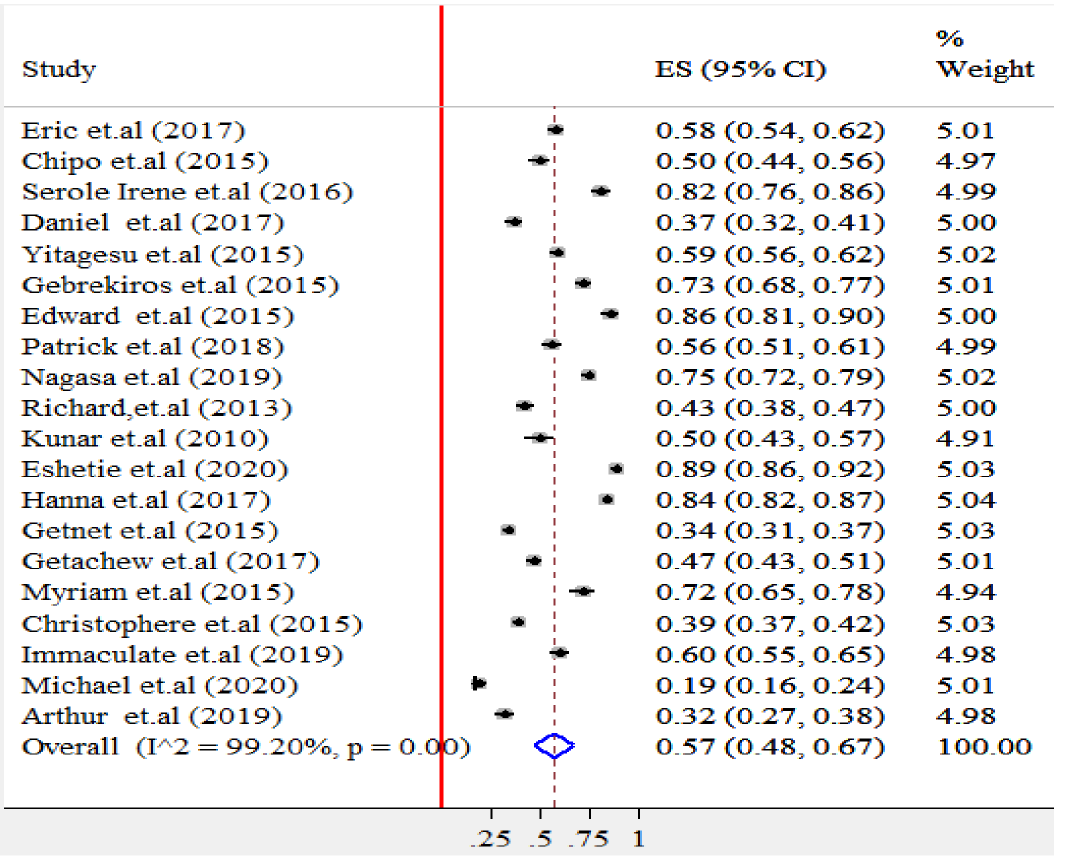

Fig. 2. Forest plot of the pooled prevalence of occupational injury among workers in the construction, manufacturing, and mining industries in Africa, 2021 (n=20)

In this systematic review and meta-analysis, the studies' effect sizes were normally distributed around the center of a funnel plot. Each study's scatter plot was clustered near zero, suggesting no publication bias (Fig. 3).

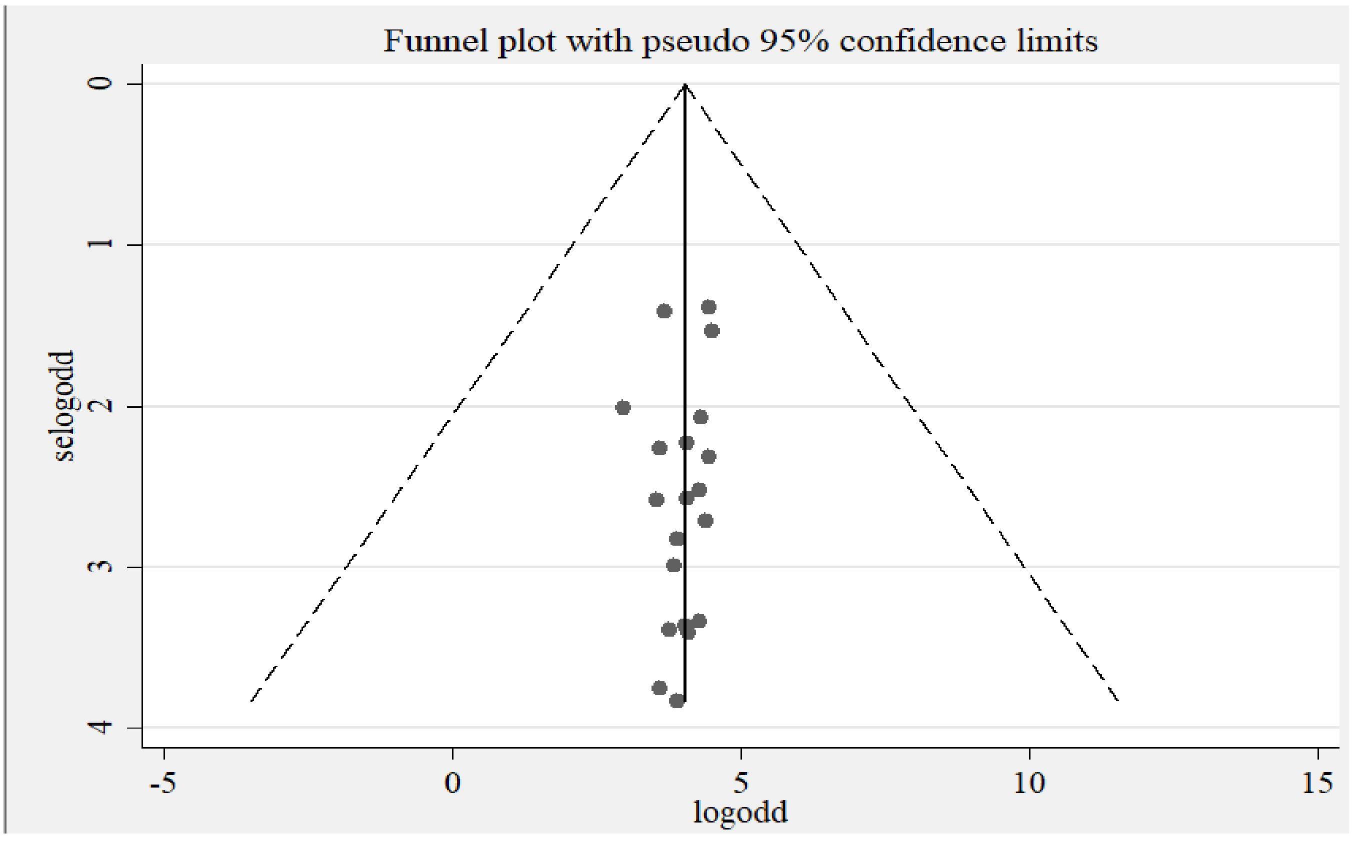

Fig. 3. Funnel plot with 95% confidence limits of the prevalence of occupational injury among workers in construction, manufacturing, and mining industries in Africa, 2021 (n=20)

The publication bias was objectively assessed using Begg's and Egger's tests to rule out no small-study effects. The estimated bias coefficient (intercept) was 0.13 with a standard error of 0.18, giving a p-value of 0.46. Furthermore, using Egger's regression test with a p-value of 0.46 provided strong evidence for the absence of small-study effects (no publication bias). Lastly, with a p-value > 0.05, there was no statistical evidence of publication bias using the Begg's test for estimating the prevalence of occupational injury among workers in the construction, manufacturing, and mining industry in Africa ((p = 0.23) and (p = 0.46) for Begg's test and Egger's test, respectively) (Fig. 4).

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Begg's Test

  adj. Kendall's Score (P-Q) =     -38
          Std. Dev. of Score =   30.82
           Number of Studies =      20
                           z  =  -1.23
                    Pr > |z| =   0.218
                           z  =   1.20 (continuity corrected)
                    Pr > |z| =   0.230 (continuity corrected)

Egger's Test
```

Std_Eff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
slope	4.324496	.3488954	12.39	0.000	3.591494	5.057499
bias	-.1392823	.1859408	-0.75	0.463	-.5299295	.2513648

Fig. 4. Begg's and Egger's tests to detect publication bias in studies included for estimating the pooled prevalence of occupational injury among workers in industries in Africa, 2021 (n=20)

Considerable heterogeneity was identified across 20 included studies in the current systematic review and meta-analysis. Thus, a subgroup analysis was conducted through stratification using the variables such as the type of industry, the scale (size) of the industry, and the sub-region of study to figure out the sources of heterogeneity. According to the results, the prevalence of occupational injury was higher in some groups; however, it did not significantly vary in studies conducted in manufacturing sites (62% (95% CI: 44, 77) and construction sites (57% (95% CI: 38, 76)) as compared with their counterpart (Fig. 5).

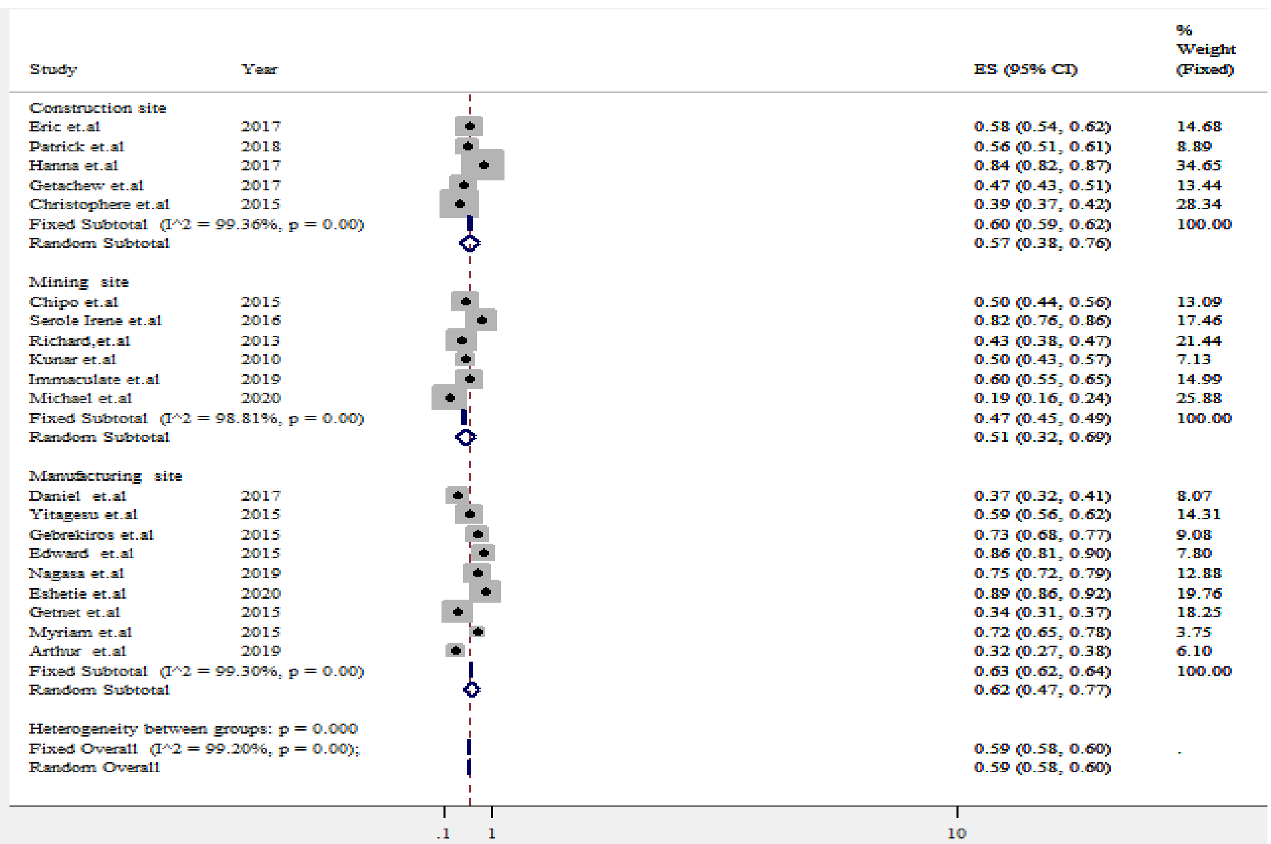

Fig. 5. Subgroup analysis of the pooled prevalence of occupational injury by the injury site among workers in construction, manufacturing, and mining industries in Africa, 2021 (n=20)

The review performed subgroup analysis based on the size of the industry. The highest prevalence of occupational injury was reported in studies conducted in the large-scale industry (60% (95% CI: 48, 72)); however, there was no statistically significant variation between large and medium scale industries (Fig. 6).

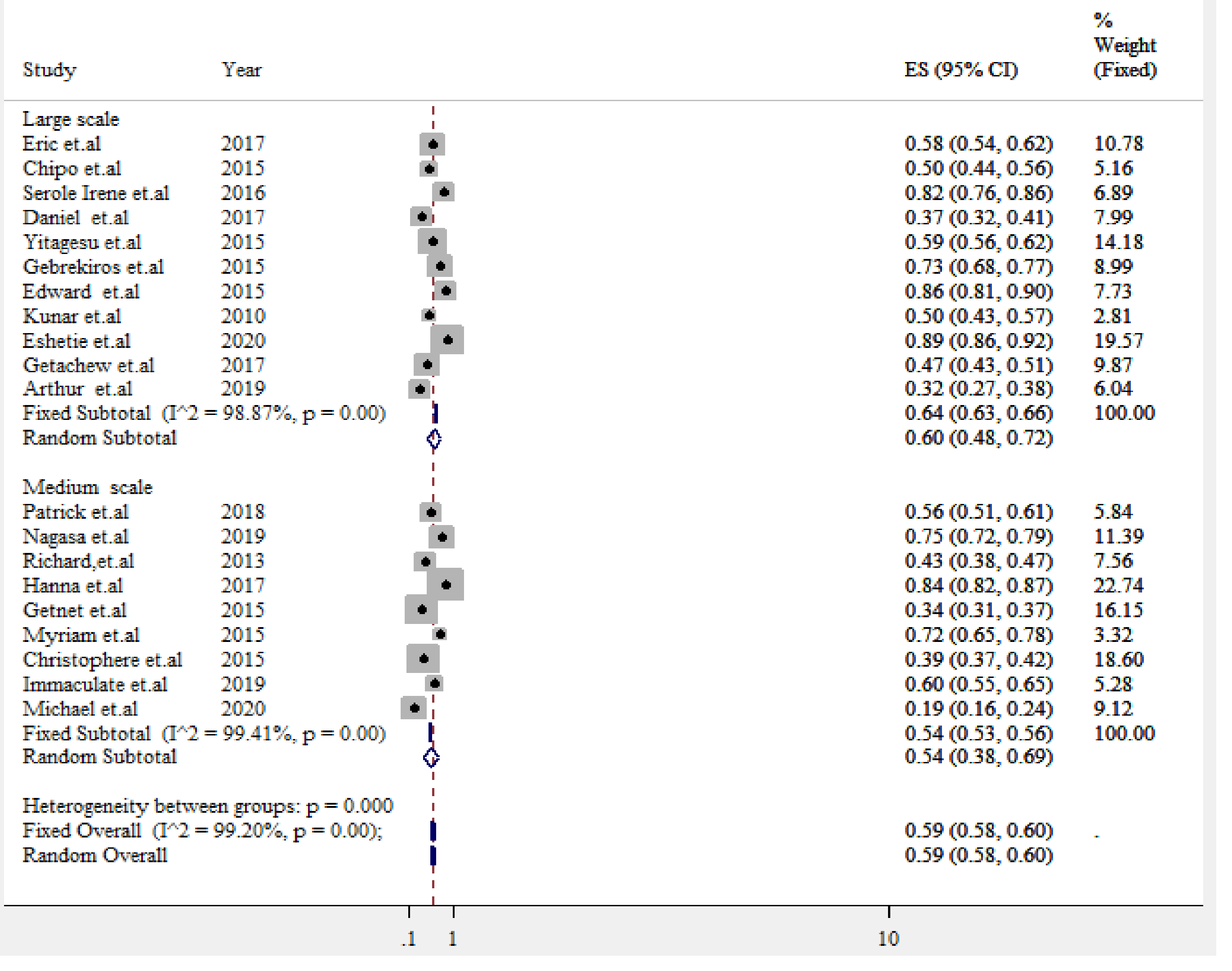

Fig. 6. Subgroup analysis of the prevalence of occupational injury by the industry scale among workers in construction, manufacturing, and mining industries in Africa, 2021 (n = 20)

A subgroup analysis was conducted based on the sub-region of Africa. The highest prevalence of occupational injury in studies done in the western-southern and eastern parts of Africa was 59% (95% CI: 58, 60) and 56% (95% CI: 44, 69), respectively (Fig. 7).

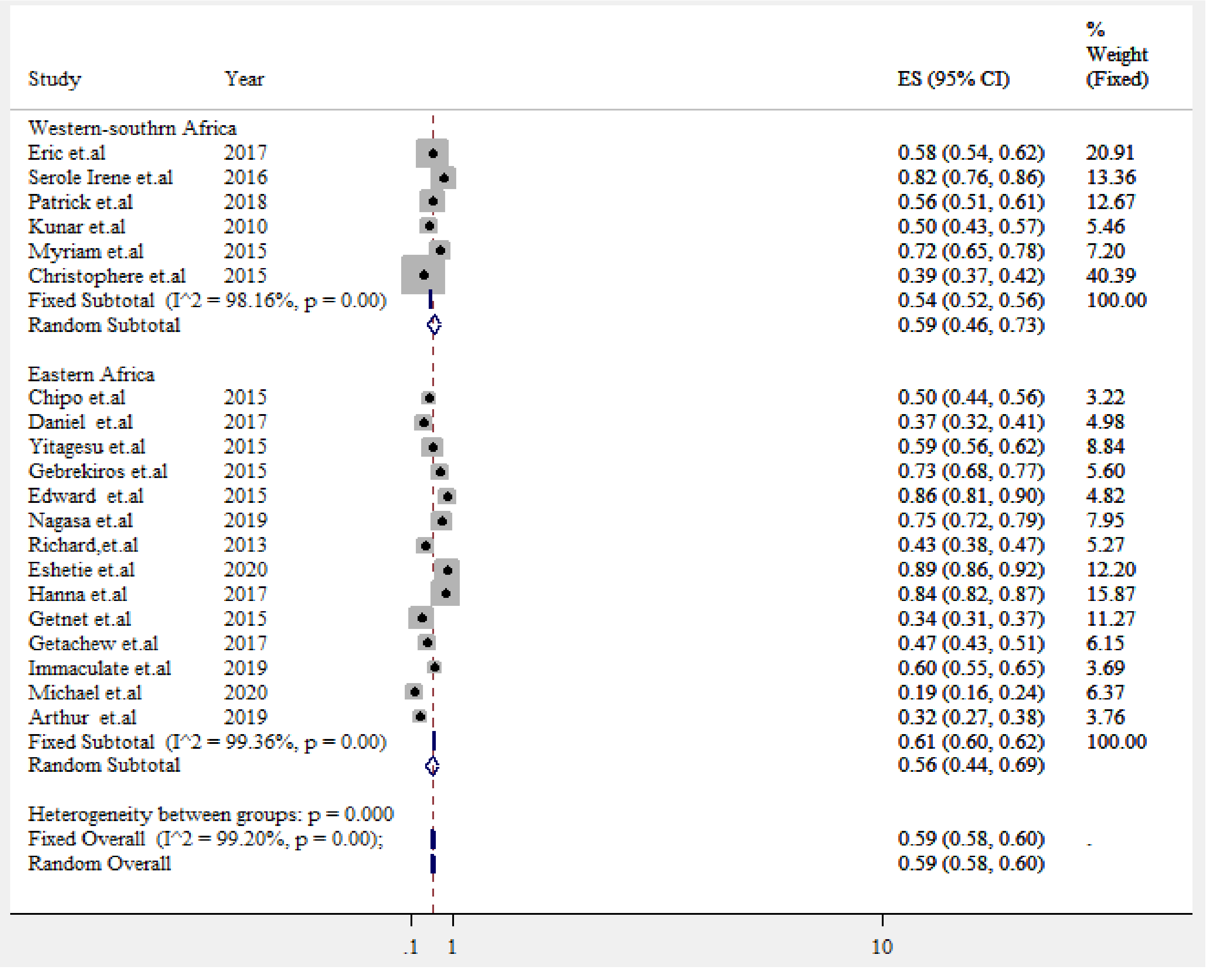

Fig.7. Subgroup analysis of the prevalence of occupational injury by sub-region among workers in construction, manufacturing, and mining industries in Africa, 2021 (n = 20)

Although the meta-regression for the 20 included studies was performed to classify causes for heterogeneity in addition to subgroup analysis, there was no statistical significance (Fig. 8).

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Meta-regression                                  Number of obs  =       20
REML estimate of between-study variance          tau2           =        0
% residual variation due to heterogeneity        I-squared_res  =    0.00%
Proportion of between-study variance explained   Adj R-squared  =       .%
Joint test for all covariates                    Model F(7,12)  =     0.05
With Knapp-Hartung modification                  Prob > F       =   0.9997
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logodd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Largescale	.5387726	1.628971	0.33	0.747	-3.010451	4.087997
Mediumscale	.758252	1.665301	0.46	0.657	-2.870128	4.386632
WesternsouthrnAfrica	.1645931	3.713575	0.04	0.965	-7.926591	8.255778
EasternAfrica	-.1789299	3.725499	-0.05	0.962	-8.296094	7.938234
Constructionsite	.4033037	1.627945	0.25	0.809	-3.143685	3.950292
Miningsite	.0165352	1.535899	0.01	0.992	-3.329901	3.362972
Manufacturingsite	.296155	1.580198	0.19	0.854	-3.146801	3.739111
_cons	3.167438	4.532522	0.70	0.498	-6.708079	13.04295

Fig. 8. Meta-regression of included studies to estimate the pooled prevalence of occupational injury among workers in construction, manufacturing, and mining industries in Africa, 2021 (n=20)

In this study, a sensitivity analysis was performed to identify the effect of individual studies on the pooled prevalence of occupational injury using the random-effect model. The sensitivity analysis result showed that no single study influenced (no outlier studies) the pooled prevalence of occupational injury. Furthermore, the estimate was not away from each corresponding article either from its lower or upper confidence intervals (Fig. 9).

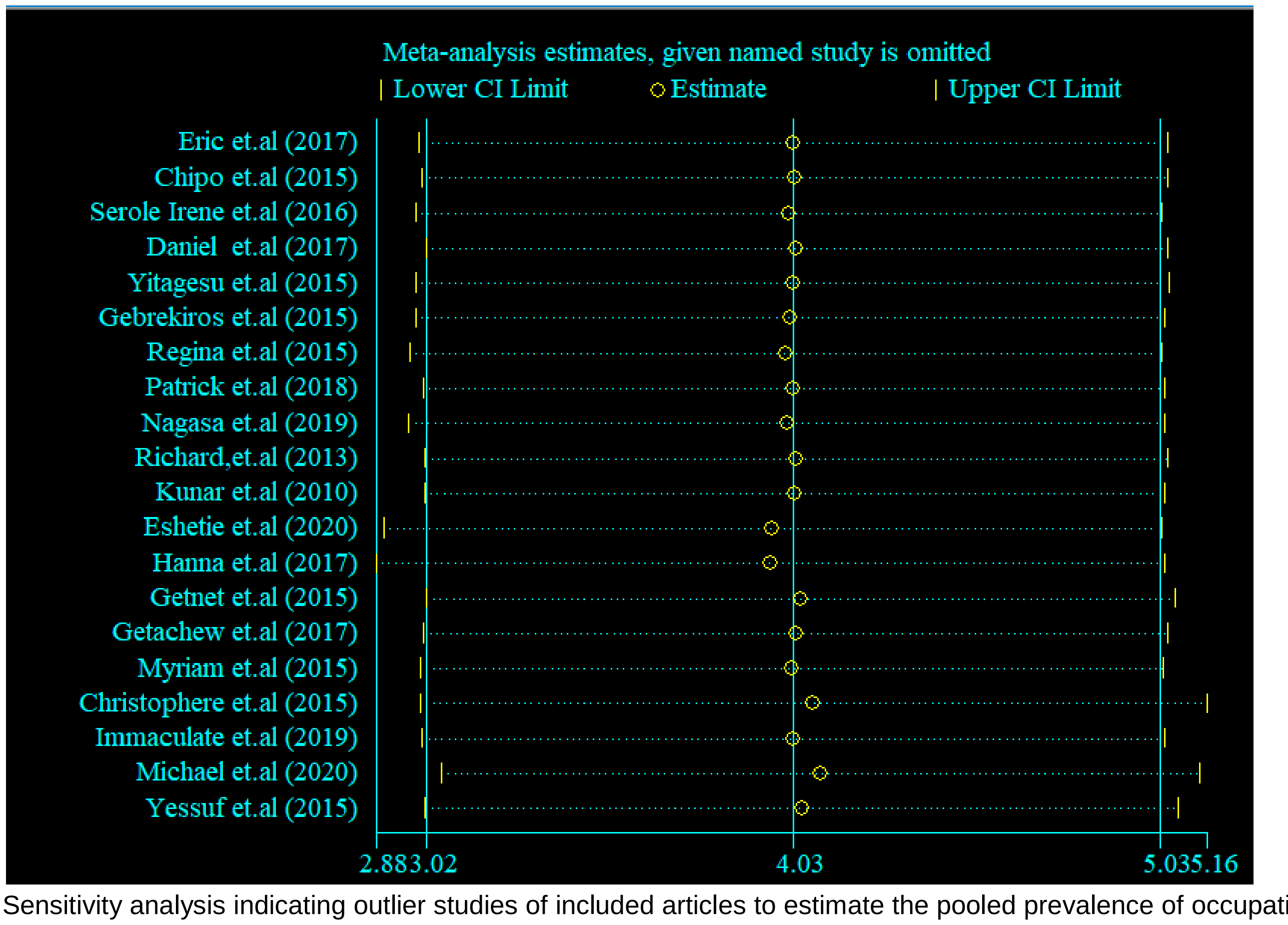

Fig. 9. Sensitivity analysis indicating outlier studies of included articles to estimate the pooled prevalence of occupational injury among workers in industries in Africa, 2021 (n=20)

The Galbraith plot shows the absence of variation between studies (Fig. 10).

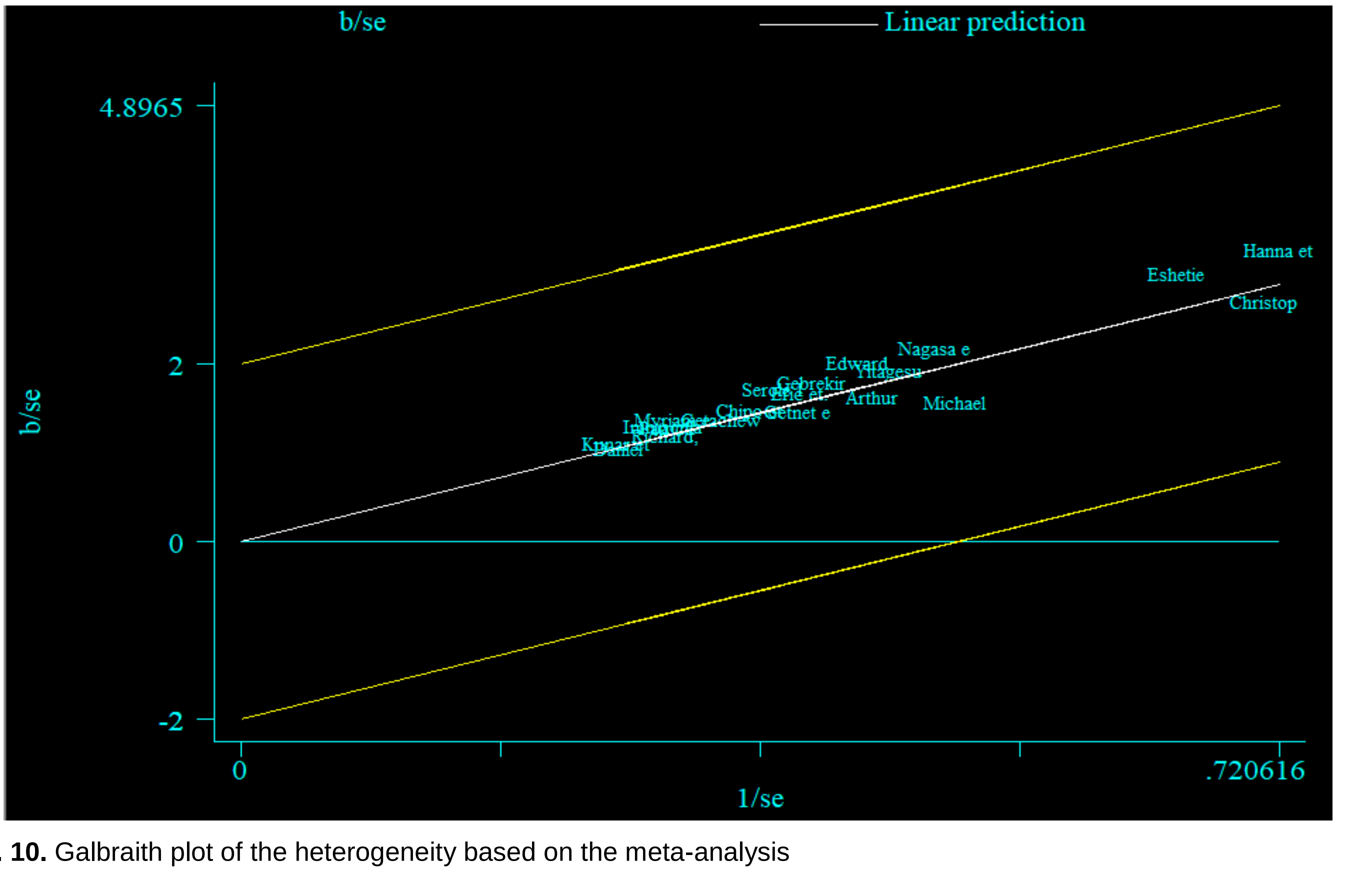

Fig. 10. Galbraith plot of the heterogeneity based on the meta-analysis

Discussion

To design more adaptable policies and strategies in occupational health and safety to the local context, concrete evidence on the regional estimate is essential. This evidence could significantly address health and safety problems more relevant to government, occupational health and safety authorities, regulatory bodies, and policymakers. The present systematic review and meta-analysis indicate that considerable workers in Africa's construction, manufacturing, and mining industries experience occupational injury.

The present review's pooled prevalence rate of occupation-related injuries is much higher than that reported in different parts of the world. For instance, it is higher than the rate reported in Ethiopia [51-52], Korea [53], Mexico [54], Thailand [55], China [56], Turkey [57], Iran [58], and Malaysia [59]. Methodological variation in estimating the outcome of interest and the injury site (where the studies were done) may credit the potential explanations for the above interpretation. Moreover, most previous studies were performed only on the construction work sites. However, the present review has incorporated substantial work sites. In addition, the possible disparity may also rationalize the inadequate difference enforcement of health and safety legislation. The other potential explanation for this variation may be that occupational injury occurs in developing countries with insufficient safety measures. This review implies that there are more likely minimal safety audits, inadequate labor inspection, and limited occupational surveillance systems in the region. Therefore, governments, employers, and regulatory bodies must pay special attention to law enforcement of occupational health and safety policies and programs to reduce the consequences of injuries.

Moreover, the subgroup analysis of the present study revealed the prevalence of occupational injury to be varied across the site of injury, the scale (size) of the industry, and the sub-region where the studies were done. Based on the injury site analysis, the prevalence of occupational injury at the manufacturing site was higher compared to the construction site; however, it was not significantly different. Likewise, according to the scale analysis, the high prevalence of occupational injury was reported in the large-scale industry relative to that of the medium-scale. The pooled prevalence of work-related injuries in the present study was in line with that found in Ethiopia [60], Kenya [61], China [62], and Britain [63]; however, it was higher than that reported in Belgium [64], Botswana [65], Brazil [66], Ghana [67], Norway [68], Canada [69], and Turkey [70]. The possible explanation for the above variations across the countries may be related to the practices of health and safety measures and workers' adherence to safety protocol. The construction, manufacturing, and mining industries are placed top of the list according to workplace accidents, unsafe working conditions, and dangerous acts that may raise problems. Furthermore, inadequate compliance with industrial hygiene programs and the nature of the work, such as prolonged poor working postures, manual handling of heavyweights, may elevate the variation. Also, the industries are frequently labor-intensive and usually employ a semi-skilled or unskilled workforce with low mechanization levels, raising occupational injury variety in countries.

According to a subgroup analysis by sub-region of African countries, relatively the highest prevalence of occupational injury was reported in studies done in the western and southern part of Africa. It implies that the implementation of industrial hygiene programs varies across African countries. Therefore, the concerned body should consider the construction, manufacturing, and mining work site's health and safety condition to minimize the burden of occupational injury and its associated economic costs.

According to the present review, the costs of an occupational injury can be observed when the resulting product is not successful and sustainable. The nature of workers 'exposure to occupational hazards depends on the type of work being carried out and adherence to the work's safety protocols. Small workers' safety coverage, significant underreporting of workplace injury, disorganized documentation, and inadequate documentation of all data system forms are the key factors contributing to underestimating occupational injury-related illness and deaths [71, 72. Based on the current review result, there is a lack of a robust national surveillance and notification framework for occupational injury in Africa. This implies that the number of work-related injuries seems to be underreported. As a result, underreporting of workplace injuries limits the ability to present occupational health problems. It influences both workers and cultures, as both involve comprehensive study. Identifying the causes of underreporting occupational injuries in Africa must create a new paradigm (programs, models, and approaches).

The present review analyzed evidence from primary studies in Africa in compliance with PRISMA P-2015 guidelines. One of this review's strengths was that it covered a large geographic region. Our search was conducted in close collaboration with a specialist research librarian, with three experienced researchers screening and extracting data using a standardized extraction form. In the selection process, the inter-rater agreement between reviewers was statistically evaluated. Furthermore, this systematic analysis and meta-analyses were the first of their workplace injuries in African countries.

This review, like other systematic reviews and meta-analyses, had its own set of limitations. For instance, most of the studies included were cross-sectional. Furthermore, the researches conducted in small-scale industries were omitted. Also, the heterogeneity of the studies made it difficult to pool information and deliver reliable proof. In addition, many analyses only had a few reports, lowering the intensity of the evidence. Finally, although identifying articles published in languages other than English were compatible, we only looked at articles published in English.

We suggest future researches in occupational health and safety issues consider appropriate and multi-level approaches regarding the working conditions in the construction, manufacturing, and mining industries.

Conclusion

The degrees of occupation-related injuries are incredibly elevating. Such injury is an immense workers' health and safety concern in Africa's construction, manufacturing, and mining industries. This high pooled prevalence of occupational injuries needs immediate action. Hence, the stakeholders should carry out rigorous law enforcement to ensure compliance with and implementation of health and safety measures and multifaceted methods to cover the action areas.

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