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Review Article

Determinants of safety performance in healthcare settings: A meta-analysis

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Abstract

Safety performance among healthcare workers is an important issue, and currently, the factors related to it remain unclear. The aim of this study was to identify the factors related to safety performance among the healthcare worker population. This meta-analysis study was conducted in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) standards. Data on the factors affecting safety performance in the healthcare population were collected from each article to determine pooled point estimates. Data heterogeneity was evaluated using the Q statistic. Numerical data were analyzed using the inverse variance test, and the Mantel-Haenszel test was used for categorical data analysis. Pooled point estimates were presented as mean difference (MD) or odds ratio (OR) along with a 95% confidence interval (95%CI). Fifty articles were included in this study. Our results showed that nurses had lower safety performance compared to other professions (OR: 0.66; 95%CI: 0.56–0.79; *p*-Egger: 0.3739; *p*-Heterogeneity <0.0001; *p*<0.0001). On the other hand, it was also identified that housekeepers were associated with better safety performance compared to other professions (OR: 1.90; 95%CI: 1.08–3.35; *p*-Egger: 0.1577; *p*-Heterogeneity: 0.0950; *p*=0.0220). Furthermore, our findings revealed that healthcare workers who had undergone work safety training had better safety performance compared to those who had not (OR: 1.40; 95%CI: 1.01–1.95; *p*-Egger: 0.6124; *p*-Heterogeneity <0.0001; *p*=0.0430). In conclusion, this study has identified the factors contributing to safety performance in the healthcare population. These findings can inform policymakers in developing regulatory improvements regarding safety performance in healthcare workers.

Keywords: Safety performance, healthcare workers, predictors, work safety, meta-analysis

Introduction

Safety in the workplace within healthcare settings is a crucial issue because workers within this sector experience high risks of various kinds of injuries, including musculoskeletal disorders, needle-stick injuries, and infectious diseases [1]. Variations exist concerning the global incidence of accidents in the workplace in the healthcare sector. The Occupational Safety and Health Administration reported that workers in the health sector have more occupational injuries than other sectors globally [2]. The most astonishing statistics on accidents among workers in the healthcare sector were given by the Bureau of Labor Statistics, which estimated that in 2020, there were about 650,000 accidents among workers in this industry. The statistics further indicate that the most affected groups include nurses and nursing assistants [3]. Additionally,

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besides impacting individual health, the outcome of work-related injury has affected patient care and general healthcare costs since injured employees may be absent for extended periods, which can reduce productivity and raise medical costs [4,5]. Indirectly, therefore, the quality of service delivered to patients has been affected by the situation [6,7]. To date, no adequate data have been reported by previous narrative reviews with respect to factors influencing safety performance in the population of health workers [8-10]. It is, therefore, important to note that the identification of factors that affect safety performance by healthcare workers enhances effective intervention [11].

Several factors are involved that may contribute to the safety performance of the population of healthcare workers, including the type of profession, age, gender, marital status, work experience, training on work safety, working hours, vaccination history, and the total number of patients [8]. The type of profession has been considered as one of the main important factors in determining safety performance within healthcare settings. Nurses, physicians, and other allied health professionals, together with support staff (administrative staff, cleaning staff, medical records personnel, food service workers, and security personnel), have particular challenges and risks associated with the nature of their job [9]. These differences are crucial for targeting safety interventions effectively and improving overall safety outcomes. Each healthcare profession differs in the risks that may be exposed to because of the nature of the work involved [10]. For example, nurses are at a higher risk of exposure to infectious diseases, needle-stick injuries, and physical strain from lifting or moving patients [12]. Physicians may face the risk of burnout due to high stress, long working hours, and decision-making pressure [1]. Support staff may be exposed to physical hazards, such as cleaning chemicals, and biological hazards [13]. Also, regular training on work safety may be another factor that determines the safety performance in the population of healthcare workers [14]. In addition, other workload aspects, such as the number of working hours and the number of patients, may also be the predictors of the safety performance [15]. Moreover, individual factors such as age, sex, marital status, work experience, and vaccination history may also serve as predictors of safety performance [16,17]. Furthermore, regarding vaccination history, it is likely that individuals with a vaccination history have a positive attitude toward disease prevention programs and workplace accident prevention. This could potentially influence the study results [17]. Given the lack of clear reports, identifying factors influencing healthcare workers' safety performance is crucial. This meta-analysis study examined these factors and highlighted their importance in developing effective safety strategies.

Methods

Designs

Between August and September 2024, we conducted a meta-analysis study (prospective register of systematic reviews (PROSPERO) No: 597149) to identify factors associated with safety performance among healthcare workers. To achieve the objectives of this study, we collected data from articles in Scopus, Embase, and PubMed. This data was used to determine pooled point estimates. All study procedures were conducted following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol [18]. The PRISMA checklist for this study is outlined in the supplementary files.

Eligibility criteria

Before conducting the article search in the databases, the inclusion criteria were first established, which included observational studies that evaluated factors related to safety performance among healthcare workers. The articles included were those published in English and up to September 15, 2024. Additionally, the articles included had to have complete data for calculating cumulative point estimates. Articles with irrelevant contexts and those that were reviews or commentaries were excluded from our study.

Quality assessment

To evaluate the quality of the articles, the Newcastle–Ottawa Scale was used. This assessment method evaluated three key components: sample selection, comparability, and outcome. The method uses a score range from 0 to 9. Articles were considered to be of low quality if they scored 0–3. A score of 4–6 indicate that the article was of moderate quality. Furthermore, if a score of 7–9 was obtained, the article was concluded to be of good quality [19]. The quality assessment of the articles in this study was conducted by SP and JKF. If any discrepancies in the assessment were found, discussions were held to resolve them.

Search strategy

To obtain articles for this study, Scopus, Embase, and PubMed were designated as our search sources. The keywords used in the article search for this study were aligned with Medical Subject Headings (MeSH). The keywords were: "risk factors" OR "predictors" OR "determinants" AND "safety performance" OR "injury" OR "accident" AND "healthcare workers" OR "practitioners." Additionally, to obtain more articles, the reference lists of related articles were manually searched. The article search process in this study was conducted by SP and JKF.

Data extraction

To determine the pooled point estimates, data were extracted from each article. The data extracted in this study included the name of the principal investigator, the year the article was published, the location where the study was conducted, the age of the study sample, the study design, the type of accident, Newcastle–Ottawa Scale, and the percentage of samples between the safety and non-safety groups. This data extraction process was carried out by SP, TM, and NW.

Covariates

In this study, we established safety performance as the outcome variable. Safety performance in this study was defined as individuals who had never experienced an accident [20]. Meanwhile, the predictor variables in this study included age, gender, marital status, profession, work experience, history of work safety training, total working hours, total number of patients per week, and history of hepatitis vaccination. These predictor variables were established after we conducted an initial data search and ensured that these variables had complete data for calculating the pooled point estimates.

Statistical analysis

In this study, the data were presented as mean ± standard deviation (SD) for numerical variables and n (%) for categorical variables. All statistical analyses were conducted using Comprehensive Meta-Analysis software version 3.0 (Biostat, Inc., New Jersey, United States) and Review Manager Version 5.2 (RevMan, Cochrane, London, United Kingdom). The stages of statistical testing in this study included tests for potential publication bias, data heterogeneity, and tests to determine pooled point estimates. First, to determine whether our data contained potential publication bias, we conducted the Egger test and Funnel Plot, where a *p*-value from the Egger test of <0.05 and an asymmetric shape of the Funnel Plot indicated the presence of potential publication bias. Furthermore, if potential publication bias was found, the calculation of pooled point estimates was adjusted using the Trim and Fill method [21]. Second, to determine whether our data contained heterogeneity, the Q statistic test was used, where a p-value of less than 0.10 indicated the presence of potential data heterogeneity. If data heterogeneity was found, the calculation of pooled point estimates in this study used a random effects model. On the other hand, if potential data heterogeneity was not found, a fixed-effects model was used [22]. Third, to determine pooled point estimates, the inverse variance test was used for numerical variables, and the Mantel–Haenszel test was used for categorical variables. Pooled point estimates were presented in a Forest Plot as mean differences (MD) for numerical variables and odds ratios (OR) for categorical variables.

Results

Article selection and baseline characteristics of articles

Article selection process in this study is shown in detail in **Figure 1**. The initial search identified 2,443 articles from the database. Additionally, thirty-two articles were also obtained from the reference lists of related articles. Of the total, several articles were excluded, including 139 duplicates and 2,201 articles with contexts irrelevant to our study. This initial selection process left 135 articles for further evaluation in full text. From these articles, 18 review articles were excluded for being review articles and 67 articles were also excluded due to uncomplete data for calculating pooled point estimates (supplementary files). Overall, this article selection process left 50 articles to be included in our study [12,13,23-70].

The basic characteristics of the 50 articles included in this study are detailed in **Table 1**. A total of 48 studies employed a cross-sectional design [12,13,23-33,35-38,40-70], while 2 studies used a retrospective design [34,39]. These studies were conducted across various countries, with one study each in Afghanistan [59], Bosnia and Herzegovina [57], Egypt [27], Kenya [54], Montenegro [38], Pakistan [26], Switzerland [62], Tanzania [36], Thailand [49], and Togo [41]. Two studies were conducted in Indonesia [34,63], Iran [12,43], South Africa [53,55], Turkey [39,42], and the United Arab Emirates [61,69]; three studies in India [32,44,56] and Nigeria [31,48,58]; five studies in China [37,51,64,66,70]; six studies in Saudi Arabia [13,23,28-30,52]; and thirteen studies in Ethiopia [24,25,33,35,40,45-47,50,60,65,67,68]. Sample sizes varied widely, ranging from 95 [63] to 61,309 participants [51], with participant ages ranging from 18 to 60 years. Based on the types of accidents evaluated, 15 articles assessed blood and body fluid splashes (BBFS) [24,36,38,43,47,49,53,54,58,60,61,66-69], 24 articles assessed needlestick injuries (NSI) [12,13,23,25,26,29,31,36-38,41,42,44,45,48,50,54-56,58,59,61,63,64], 18 articles assessed non-needlestick injuries (NSSI) [27,30,32-35,39,40,46,47,49,51,52,57,62,65,66,70], and 2 articles evaluated work-related injuries [13,28]. Regarding article quality, 30 were rated as high-quality [12,13,23-26,30-34,37,39,48-64], while the remaining 20 were of moderate quality [27-29,35,36,38,40-47,65-70]. The details of the quality assessment can be found in the supplementary data.

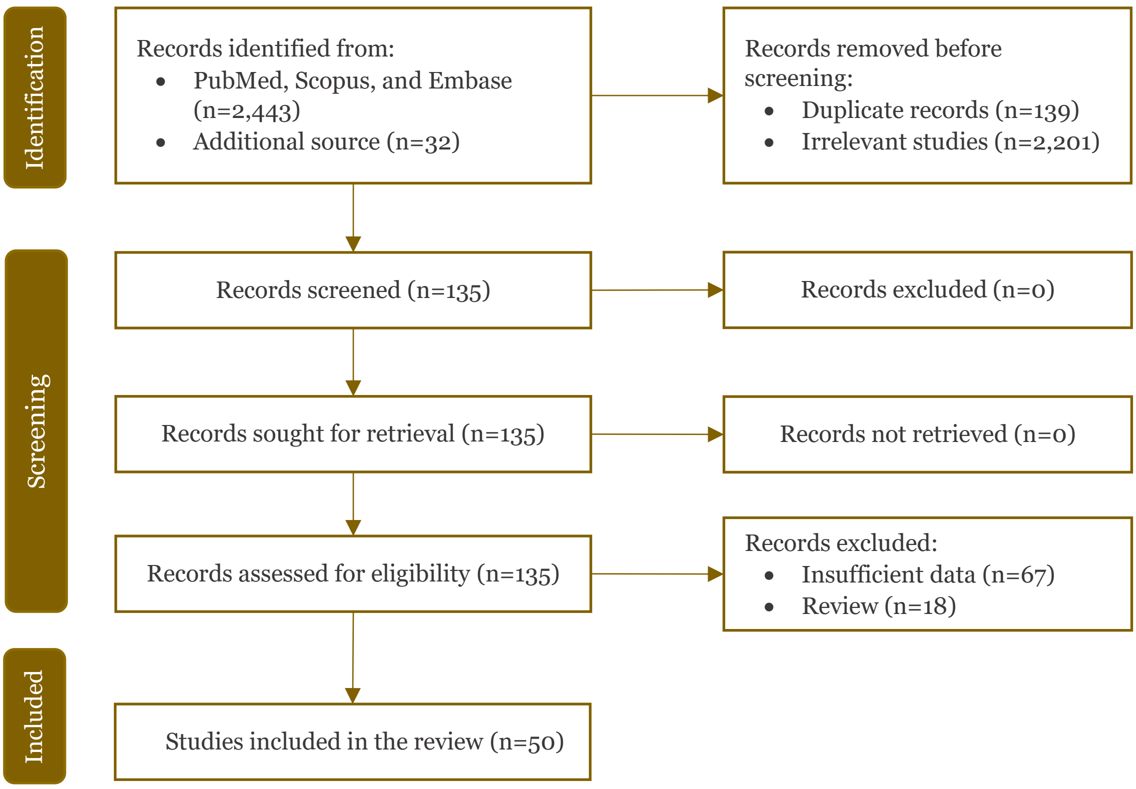

Figure 1. A flowchart of the article selection process in the study.

Factors associated with safety performance among healthcare workers

Among the several potential risk factors evaluated, it was found that the nursing profession had lower safety performance compared to other professions (OR: 0.66; 95%CI: 0.56–0.79; p-Egger: 0.3739; p-Heterogeneity <0.0001; p<0.0001) (**Figure 2A**). Furthermore, the housekeeping profession demonstrated significantly higher safety performance compared to other occupational groups (OR: 1.90; 95%CI: 1.08–3.35; p-Egger: 0.1577; p-Heterogeneity: 0.0950; p=0.0300

(**Figure 2B**). Additionally, healthcare workers who received safety training exhibited better safety performance compared to those without such training (OR: 1.40; 95%CI: 1.01–1.95; *p*-Egger: 0.6124; *p*-Heterogeneity <0.0001; *p*=0.0400 (**Figure 3**). On the other hand, the association between safety performance and several variables such as age, gender, marital status, work experience, total working hours per day, total number of patients per week, and history of hepatitis vaccination were unable to be demonstrated. Age was analyzed as both a numerical and categorical variable (≤30 years and >30 years). For age as a numerical variable, no differences were found between the safety performance and non-safety performance groups (MD: -0.91; 95%CI: -0.29–0.46; *p*-Egger: 0.7062; *p*-Heterogeneity: 0.5990; *p*=0.1930).

Similarly, age as a categorical variable was not significantly differ between the safety and non-safety groups for both those aged ≤30 years (OR: 1.08; 95%CI: 0.75–1.58; *p*-Egger: 0.0150; *p*-Heterogeneity <0.0001; *p*=0.6700) and those over 30 years (OR: 0.92; 95%CI: 0.64–1.34; *p*-Egger: 0.0150; *p*-Heterogeneity <0.0001; *p*=0.6700). The same trend was observed for gender, with males and females showing no notable difference between the two groups.

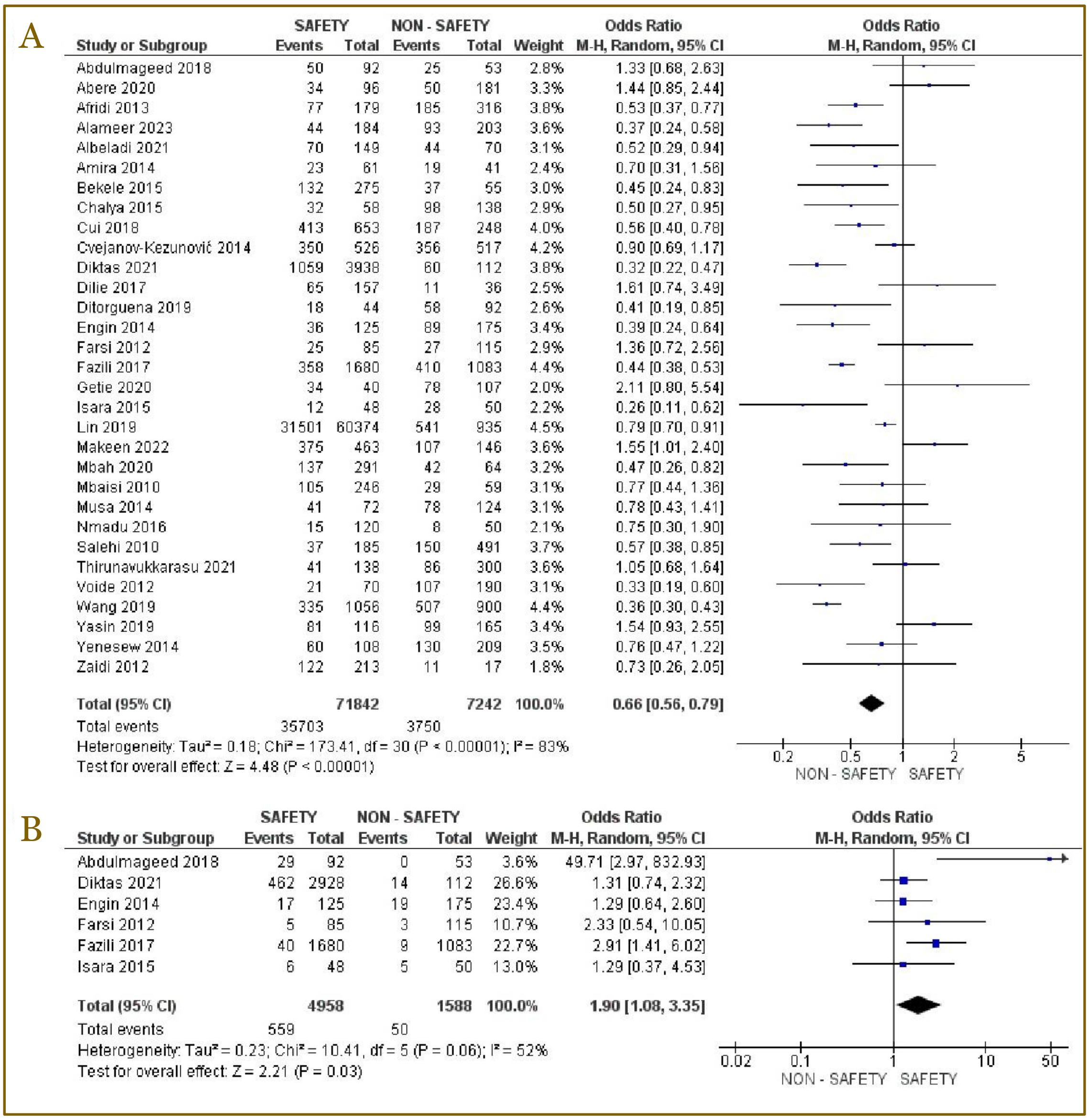

Figure 2. The impact of professions on safety performance among healthcare workers: (A) Nurses had lower safety performance compared to other professions (OR: 0.66; 95%CI: 0.56–0.79; *p*-Egger: 0.3739; *p*-Heterogeneity <0.0001; *p*=<0.0001). (B) Housekeepers had better safety performance compared to other professions (OR: 1.90; 95%CI: 1.08–3.35; *p*-Egger: 0.1577; *p*-Heterogeneity: 0.0950; *p*=0.0300.

In assessing the marital status, no significant variations between married and single individuals were found. Similarly, in professional roles, neither physicians nor laboratory staff exhibited any differences in safety performances. Further analysis of work experience showed no distinction between individuals with ≤5 years and those with >5 years. Likewise, working hours (≤8 hours/day: OR: 1.58; 95%CI: 0.79–3.14; *p*-Egger: 0.6569; *p*-Heterogeneity <0.0001; *p*=0.1930; >8 hours/day: OR: 0.63; 95%CI: 0.32–1.26; *p*-Egger: 0.6569; *p*-Heterogeneity <0.0001; *p*=0.1930) did not show any significant impact on safety outcomes.

The number of patients treated per week was also considered, whether ≤100 or >100, did not exhibit significant impact on safety performance (OR: 1.06; 95%CI: 0.63–1.78; *p*-Egger: 0.7403; *p*-Heterogeneity <0.0001; *p*=0.8380). A summary of the analysis results regarding the factors contributing to safety performance among healthcare workers in this study is presented in **Table 2**.

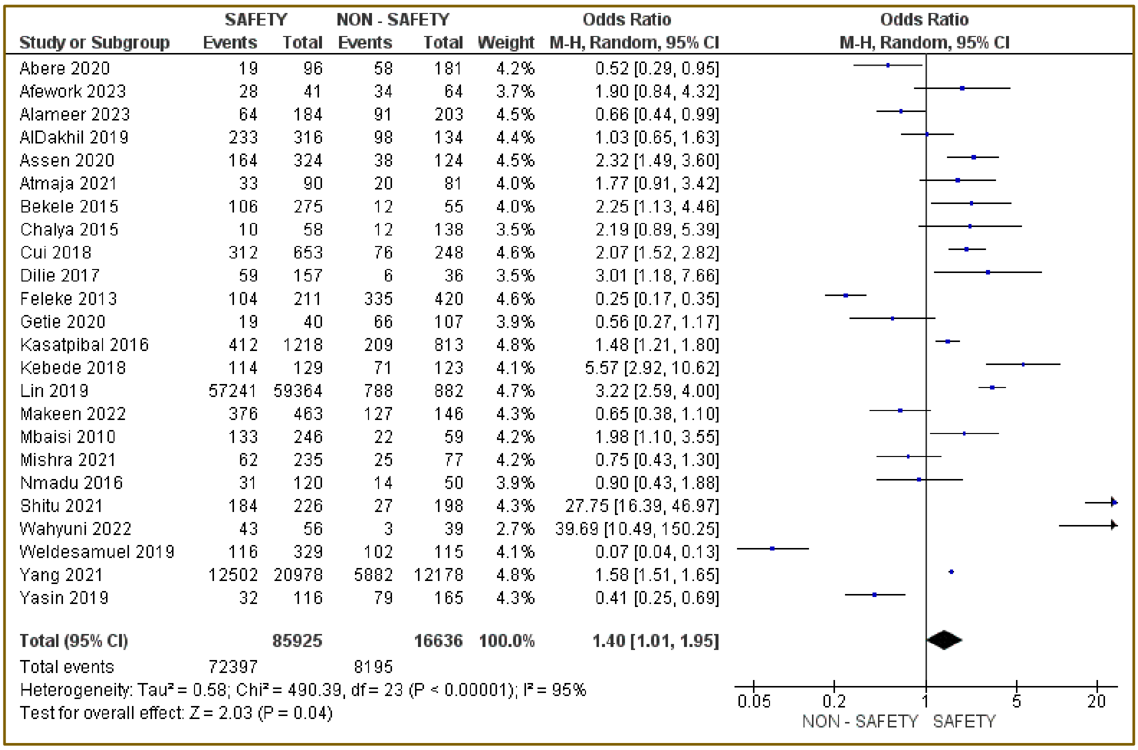

Figure 3. The impact of work safety training on safety performance among healthcare workers (OR: 1.40; 95%CI: 1.01–1.95; *p*-Egger: 0.6124; *p*-Heterogeneity <0.0001; *p*=0.0400.

Heterogeneity among studies and potential publication bias

The Egger test in this study identified that the age group variable had potential publication bias (*p*-Egger: 0.0150), and therefore, adjustments were used based on the trim and fill method to determine the pooled point estimates. Moreover, the Q statistic test in this study identified that the age variable (numerical) did not contain potential data heterogeneity (*p*-Heterogeneity: 0.5990). Therefore, the calculation of pooled MDs for this variable used a fixed effects model. Meanwhile, the other variables exhibited potential data heterogeneity (*p*-Heterogeneity <0.10), and as a result, a random-effects model was used to determine the pooled point estimates. The findings regarding heterogeneity testing and potential publication bias are summarized in **Table 2**.

Table 1. Baseline characteristics of studies included in our analysis

Study	Country	Design	Age, years	Sample size	Type of accident	Quality assessment
Abdulmageed, 2018 [23]	Saudi Arabia	Cross-sectional	Not specified	161	NSI	High
Abere, 2020 [24]	Ethiopia	Cross-sectional	25–32	286	BBFS	High
Afework, 2023 [25]	Ethiopia	Cross-sectional	≤25, 26–35, ≥36	105	Chemical splash, NSI	High
Afridi, 2013 [26]	Pakistan	Cross-sectional	Not specified	497	NSI	High
Ahmed, 2014 [27]	Egypt	Cross-sectional	Not specified	236	NSSI	Moderate
Alameer, 2023 [28]	Saudi Arabia	Cross-sectional	24–60	387	Work-related injuries	Moderate
Albeladi, 2021 [29]	Saudi Arabia	Cross-sectional	20–40	219	NSI	Moderate
AlDakhil, 2019 [30]	Saudi Arabia	Cross-sectional	Mean 31.1	450	NSSI	High
Amira, 2014 [31]	Nigeria	Cross-sectional	22–57	102	NSI	High
Archana Lakshmi, 2018 [32]	India	Cross-sectional	21–70	950	NSSI	High
Assen, 2020 [33]	Ethiopia	Cross-sectional	22–59	438	NSSI	High
Atmaja, 2021 [34]	Indonesia	Case control	24 (IQR 8)	171	NSSI	High
Bekele, 2015 [35]	Ethiopia	Cross-sectional	18–55	362	NSSI	Moderate
Chalya, 2015 [36]	Tanzania	Cross-sectional	18–54	436	NSI and BBFS	Moderate
Cui, 2018 [37]	China	Cross-sectional	Not specified	901	NSI	High
Cvejanov-Kezunović, 2014 [38]	Montenegro	Cross-sectional	Mean 41.78	1,043	BBFS, NSI	Moderate
Diktas, 2021 [39]	Turkey	Case-control	Not specified	3,816	NSSI	High
Dilie, 2016 [40]	Ethiopia	Cross-sectional	Mean 28.25	193	NSSI	Moderate
Ditorguena, 2019 [41]	Togo	Cross-sectional	Mean 39.6	136	NSI	Moderate
Engin, 2014 [42]	Turkey	Cross-sectional	Mean 30.3	300	NSI	Moderate
Farsi, 2012 [43]	Iran	Cross-sectional	Mean 30	200	BBFS	Moderate
Fazili, 2017 [44]	India	Cross-sectional	Mean 40.46	2,763	NSI	Moderate
Feleke, 2013 [45]	Ethiopia	Cross-sectional	Mean 29.85	631	NSI	Moderate
Getie, 2020 [46]	Ethiopia	Cross-sectional	<30 (74.8%)	147	NSSI	Moderate
Girmaye, 2018 [47]	Ethiopia	Cross-sectional	18–45	244	NSSI, BBFS	Moderate
Isara, 2015 [48]	Nigeria	Cross-sectional	Mean 31.3	98	NSI	High
Jahangiri, 2016 [12]	Iran	Cross-sectional	Mean 29.67	168	NSI	High
Kasatpibal, 2016 [49]	Thailand	Cross-sectional	Not specified	2,031	NSSI, BBFS	High
Kebede, 2018 [50]	Ethiopia	Cross-sectional	20–49	258	NSI	High
Lin, 2019 [51]	China	Cross-sectional	Not specified	61,309	NSSI	High
Makeen, 2022 [52]	Saudi Arabia	Cross-sectional	Not specified	609	NSSI	High
Mbah, 2020 [53]	South Africa	Cross-sectional	Not specified	444	BBFS	High
Mbaisi, 2013 [54]	Kenya	Cross-sectional	19–56	305	NSI, BBFS	High
McDowall, 2019 [55]	South Africa	Cross-sectional	25–29	240	NSI	High
Mishra, 2021 [56]	India	Cross-sectional	18–26	312	NSI	High
Musa, 2014 [57]	Bosnia and Herzegovina	Cross-sectional	Not specified	203	NSSI	High
Nmadu, 2016 [58]	Nigeria	Cross-sectional	36.7±8.6	172	NSI and BBFS	High
Salehi, 2010 [59]	Afghanistan	Cross-sectional	Not specified	676	NSI	High
Shitu, 2021 [60]	Ethiopia	Cross-sectional	30.11±5.37	424	BBFS	High
Sreedharan, 2010 [61]	United Arab Emirates	Cross-sectional	29.59±5.96	101	NSI, BBFS	High
Thirunavukkarasu, 2021 [13]	Saudi Arabia	Cross-sectional	38.2±8.8	438	NSI, work-related stress	High

Study	Country	Design	Age, years	Sample size	Type of accident	Quality assessment
Voide, 2012 [62]	Switzerland	Cross-sectional	Mean 40.2	2,691	NSSI	High
Wahyuni, 2022 [63]	Indonesia	Cross-sectional	Adults (mean age not specified)	95	NSI	High
Wang, 2019 [64]	China	Cross-sectional	Mean 30–40	1,956	NSI	High
Weldesamuel, 2019 [65]	Ethiopia	Cross-sectional	34±9.6	444	NSSI	Moderate
Yang, 2021 [66]	China	Cross-sectional	Mean 26–45	33,156	NSSI and BBFS	Moderate
Yasin, 2019 [67]	Ethiopia	Cross-sectional	Mean 30.51±5.86	282	BBFS	Moderate
Yenesew, 2014 [68]	Ethiopia	Cross-sectional	Mean 29 (range not specified)	317	BBFS	Moderate
Zaidi, 2012 [69]	United Arab Emirates	Cross-sectional	Mean 33 (20–55)	230	BBFS	Moderate
Zhang, 2015 [70]	China	Cross-sectional	<36 (76.6%); >45 (8.9%)	402	NSSI	Moderate

BBFS: blood/body fluid splash; NSSI: needlestick and sharps injury; NSI: needle-stick injury

Table 2. Summary of the analysis regarding factors related to work safety among healthcare workers

Covariates	Mean±SD or n (%)		Model	NS	MD*/OR	95%CI	*p*-Egger	*p*-Het	*p*
	Safety	Non-safety							
Age, mean±SD (years)	33.59±8.08	34.28±6.94	Fixed	3	-0.91*	-0.29–0.46	0.7062	0.5990	0.1930
Age group									
≤30 years, n (%)	917 (41.70)	903 (40.77)	Random - TF	9	1.08	0.75–1.58	0.0150	<0.0001	0.6700
>30 years, n (%)	1282 (58.30)	1312 (59.23)	Random - TF	9	0.92	0.64–1.34	0.0150	<0.0001	0.6700
Gender									
Male, n (%)	7649 (25.86)	4998 (25.72)	Random	33	1.10	0.92–1.31	0.6165	<0.0001	0.3040
Female, n (%)	21924 (74.14)	14432 (74.28)	Random	33	0.91	0.76–1.09	0.6165	<0.0001	0.3040
Marital status									
Married, n (%)	321 (58.58)	342 (48.79)	Random	3	1.77	0.91–3.45	0.8863	<0.0001	0.0910
Single, n (%)	227 (41.42)	359 (51.21)	Random	3	0.56	0.29–1.10	0.8863	<0.0001	0.0910
Professions									
Nurses, n (%)	35703 (49.70)	3750 (51.78)	Random	31	0.66	0.56–0.79	0.3739	<0.0001	<0.0001
Physicians, n (%)	22273 (31.07)	2093 (29.54)	Random	29	0.98	0.74–1.31	0.5028	<0.0001	0.9050
Housekeepers, n (%)	559 (11.27)	50 (3.15)	Random	6	1.90	1.08–3.35	0.1577	0.0950	0.0300
Laboratory staff, n (%)	425 (10.51)	382 (11.20)	Random	16	1.10	0.87–1.40	0.4102	0.0550	0.4130
Work experience									
≤5 years, n (%)	2717 (49.21)	2474 (53.25)	Random	25	0.97	0.69–1.37	0.0926	<0.0001	0.8710
>5 years, n (%)	2804 (50.79)	2172 (46.75)	Random	25	1.03	0.73–1.45	0.0926	<0.0001	0.8710
Has a history of work safety training, n (%)	72397 (84.26)	8195 (49.26)	Random	24	1.40	1.01–1.95	0.6124	<0.0001	0.0400
The total working hours									
≤8 hours/day, n (%)	2120 (73.71)	1184 (66.00)	Random	8	1.58	0.79–3.14	0.6569	<0.0001	0.1930
>8 hours/day, n (%)	756 (26.29)	610 (34.00)	Random	8	0.63	0.32–1.26	0.6569	<0.0001	0.1930
The total number of patients per week									
≤100 patients/week, n (%)	308 (77.00)	238 (70.62)	Random	2	1.44	0.67–3.06	NA	0.0230	0.3510
>100 patients/week, n (%)	92 (23.00)	99 (29.38)	Random	2	0.70	0.33–1.49	NA	0.0230	0.3510
Has a history of hepatitis vaccination, n (%)	937 (76.06)	975 (71.32)	Random	8	1.06	0.63–1.78	0.7403	<0.0001	0.8380

CI: confidence interval; MD: mean difference; NA: not available; NS: number of studies; OR: odds ratio; *p*-Het: *p*-Heterogeneity; SD: standard deviation; TF: trim fill method

Discussion

Our results identified that better safety performance was found among housekeepers and healthcare workers who had undergone safety training. On the other hand, it was also found that the nursing profession had lower safety performance compared to other professions. The present study was the first meta-analysis evaluating factors related to safety performance in the healthcare worker population. Therefore, our results could not be compared with previous studies. Nevertheless, in a similar context, several studies have been conducted by Debelu [16], Mengistu (2020, 2021, 2022) [17,71,72], and Zabarmawi [73]. Debelu's study (2023) aimed to identify factors related to occupational-related injuries in the healthcare worker population using a systematic review approach. This study involved 36 articles, indicating that approximately 39–60% of healthcare workers had experienced occupational-related injuries, and these incidents were associated with gender, working hours, workplace stress, type of job, age, infection prevention training, the use of universal precautions, syringe reuse, experience working inwards, staffing and resource adequacy, awareness, outdated guidelines, and previous exposure to sharp injuries [16]. Furthermore, Mengistu's study (2020), which involved 13 articles, was conducted to determine the global prevalence and factors associated with needle stick injuries in the healthcare worker population using a systematic review approach. This study showed that the prevalence of needle stick injuries ranged from 19.9% to 54.0% and was associated with gender, workload, syringe reuse, excessive injection use, implementation of universal precautions, training, job type, work experience, and personal protective equipment [17]. Additionally, Mengistu in 2021 [71] and 2022 [72] also conducted studies to determine the global prevalence of occupational exposure to needle stick injuries and occupational exposure to blood and body fluids among healthcare workers using a meta-analysis approach. Moreover, Zabarmawi's study (2024) evaluated deoxyribonucleic acid (DNA) damage in healthcare workers exposed to radiation [73]. Compared to these studies, our study had several advantages. Our study involved 50 articles, which was a larger number than in previous studies [16,17,71,72]. Additionally, regarding the identification of risk factors for safety performance in the healthcare worker population, previous studies only used a systematic review approach without conducting meta-analysis calculations [16,17]. This may explain the discrepancy between our findings and those of earlier studies. Previous studies relied solely on a systematic review approach without incorporating meta-analysis [16,17,71-73]. The systematic review approach can indeed be more convenient for gathering data and drawing conclusions. However, the accuracy of the information presented is generally better in a meta-analysis [74]. As a result, their conclusions were based on identifying contributing factors without calculating cumulative point estimates. Meanwhile, our study performed pooled point estimate calculations to determine whether a factor truly contributes to safety performance among healthcare workers. Thus, the results of our study provided more accurate findings in terms of sample power and the conclusion methods used in the meta-analysis calculations.

Our results indicated that lower safety performance was found among nurses compared to other professions. The underlying reasons for this are complex and may be due to several factors, such as high job demands [10,75], inadequate job resources [76], emotional exhaustion, and a lack of motivation and professionalism [77]. Regarding high job demands, it is well known that the nursing profession faces heavy workloads and significant job demands. Furthermore, as a consequence, decreased job satisfaction and increased emotional exhaustion may be triggered by these high workloads and job demands [10,75]. This is supported by studies that found that workload negatively impacts patient safety practices and professionalism among nurses [78,79]. Concerning inadequate job resources, it is known that the nursing profession has the highest number among other healthcare workers. The large number of nurses may result in challenges in managing compliance with safety performance [76]. Additionally, nurses also have a very diverse range of job types, including delivering holistic patient care, assisting with patient hygiene, following doctors' instructions, setting up patient rooms, handling administrative duties, and more [80]. This likely implies challenges regarding the capability of inadequate job resources. As a result, this condition may further trigger increased emotional exhaustion, a lack of motivation, diminished professionalism, and reduced compliance with safety performance [77]. This explanation may serve as a foundation for findings of the present study, which indicated that nurses have lower safety performance compared to other professions.

It was also identified that housekeepers had better safety performance compared to other professions. The explanation for this result is still not fully understood. However, several speculations may provide a basis for our findings. Briefly, factors that might explain this outcome could include a controlled work environment, focused safety training, a supportive psychosocial climate, reduced exposure to high-risk situations, and manageable workloads [81]. Regarding the controlled work environment, it is known that housekeepers have predictable and repetitive tasks that focus on cleaning and sanitation. Such a work environment can be categorized as controlled. Therefore, this profession likely has a more manageable workload and higher compliance with safety performance compared to other professions that operate in highly dynamic environments [82]. This is supported by theories proposed by Clarke, who stated that a positive safety climate directly influences employees' willingness to engage in safety practices and report safety issues [83]. Concerning focused safety training, it is well known that housekeepers often undergo training in occupational safety and infection control. This may have implications for improving safety performance [84]. Furthermore, studies have also revealed that simulation-based training has shown a positive impact on safety performance in the housekeeper population [84,85]. Additionally, it is also known that housekeepers have less exposure to high-risk situations [1]. This may also contribute to a lower incidence of work accidents among housekeepers compared to other professions.

Our study also found that health workers who had undergone safety training were able to perform better in terms of safety compared to those who did not have any form of safety training. This may probably be due to factors such as improved knowledge of safety, modified behavior on safety, increased confidence, reduction in workplace incidents, and well-entrenched organizational support for safety programs. Health professionals who participate in safety training would, therefore, be likely to have more comprehensive knowledge regarding hazards, risk management, and practices concerning safety [14]. Studies support the fact that effective methods of safety training lead to better knowledge and improved implementation of safety [86,87]. Further, health workers involved in safety are most likely confident when reporting or implementing safety. Such confidence comes about because of a more profound realization of safety protocols and procedures [9]. On the other hand, medical institutions that make training about safety a priority would be willing to further provide the resources to have a safe working environment through Personal Protective Equipment (PPE) and ergonomic tools, which may also directly imply a strengthening in the importance of safety practices [88].

Our study has several strengths and advantages. First, this is the first meta-analysis evaluating factors related to safety performance in the healthcare worker population. Second, since this study revealed that improved safety performance was found among housekeepers and individuals who had undergone safety training, healthcare institutions may need to conduct regular safety training using efficient methods. Third, with the study's findings about the poorer safety performance of nursing profession compared to other professions, safety training may need to be focused on nurses. Furthermore, to improve nurses' safety performance, these results highlighted the need for healthcare organizations to address the unique challenges faced by nurses, including high workloads and inadequate support [78]. In the future, these findings may pave the way for further studies to explore the long-term effects of certain interventions on occupational safety.

Although much valuable information arose from our findings, several limitations had to be considered in interpreting our findings. One of the key limitations of this study is the assumption of possible confounding variables influencing the final outcomes, including organizational culture, levels of individual stress, experience, and specific job roles, which may be the confounding factors [89]. Those potential confounding variables may play a role in determining the study's outcomes. Without analyzing these factors, the results should be interpreted with caution. Also, sample size might be one of the limitations of our study. Although fifty articles have been included in the analysis, the sample sizes of each article were different, ranging from 95 to 61,309 participants. Some of the articles had small sample sizes. Of the studies, 37 had sample sizes of fewer than 500 participants, with two studies having sample sizes of less than 100 participants. Thus, the results may be biased. Furthermore, the research method of the articles that we included in our study may also be one of the limitations. Some of the studies depended on self-reported methods to identify work accidents, which might lead to response bias because of inaccurately reported information. Besides, the cross-sectional design in most of the articles included may become an issue regarding effects that could restrict causal inferences about risk factors associated with performance. Finally, the very high heterogeneity of data for some of the variables studied suggested that the results of this study may not apply directly to different contexts or populations.

Conclusion

This meta-analysis identified low safety performance among nurses compared to other healthcare professionals. Improved safety performance was observed among healthcare workers who had undergone work safety training and those in the housekeeping profession. The results of this study can be used to improve the work systems of healthcare workers to enhance safety performance. In the future, further studies should be conducted involving the examination of additional factors, such as organizational culture, as well as exploring the long-term effects of certain interventions.

Ethics approval

Not required.

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

The data from this study is available in an online repository on Figshare at the following link: https://doi.org/10.6084/m9.figshare.27159708.v2.

Declaration of artificial intelligence use

This study utilized artificial intelligence (AI) tools in the following capacities: ChatGPT and Quillbot were employed for language refinement, including improving grammar, sentence structure, and readability of the manuscript. We confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were made solely by the authors.

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