The Prevalence of Unsafe Behaviors in Iranian Workers: A Systematic Review and Meta-Analysis

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Abstract

Background: Unsafe behaviors are the cause of 80% of accidents. However, there has also been no worldwide review and meta-analysis of the prevalence of workers' unsafe behaviors. Therefore, the present study aimed to investigate and estimate the prevalence of unsafe behaviors among Iranian workers using a systematic review and meta-analysis study.

Methods: This systematic review and meta-analysis were conducted from Nov to Dec 2018. The researchers searched Medline/PubMed, Scopus, Embase, Science Direct, and Google Scholar for international articles and four Iranian databases (Scientific Information Database, MagIran, IranMedex, and IranDoc) for Persian articles. The method of reporting this study was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) checklist.

Results: Overall, 235 articles from databases were imported to EndNote library. Final screening of the included studies produced a total of 38 studies. Based on the random-effect model, the prevalence of total unsafe behaviors, non-use or inappropriate use of personal protective equipment, and inappropriate work posture was 40.37% (CI 95% = 35.8-44.9), 27.79% (CI 95% = 21.2-34.3), and 14.87% (CI 95% = 10.7-18.9). There was no statistically significant relationship between unsafe behaviors and mean age, mean of work experiences, and year of study.

Conclusion: The prevalence of unsafe behaviors among Iranian workers was relatively high and the most common behaviors were non-use or inappropriate use of PPE; one of the most important causes for this behavior is lack of training, inappropriate working conditions, and lack of positive attitude towards safety. Therefore, further studied are required to investigate the causes of these unsafe behaviors.

Keywords: Unsafe behaviors; Meta-analysis; Systematic reviews; Iran

Introduction

The industrial revolution and the expansion of industries have had many consequences. This development, along with its positive and valuable effects, has also been accompanied by adverse ef-

fects, such as the quantity and quality of contaminants in the workplace and in life, which have negative consequences for the development of industries. One of the most important of these is the occurrence of occupational accidents more pronounced in developing countries (1). According to International Labor Organization (2) statistics, 2.3 million people die because of occupational accidents each year (3). Moreover, more than 2.8 million serious and 3,806 fatalities occurred in Europe (4). According to the statistics of the Ministry of Cooperatives, Labor, and Social Welfare of Iran in 2017, the number of occupational accidents was about 10,000 (5).

Accidents occur for two main reasons: unsafe conditions and unsafe behaviors, with a higher share of unsafe behaviors. For the first time in the 1930s, Henrich identified three causes of unsafe behaviors, unsafe conditions, and unknown causes as the main causes of accidents after investigating about 75,000 accidents, and the share of unsafe behaviors in accidents was estimated to be 88% (6). Besides, human errors were reported as the cause of 70% to 90% of accidents (7). After these studies, the last few decades there have been catastrophic accidents such as Felix Borough (1974), Browns Ferry fire (Browns Ferry Nuclear Power Plant, 1975), Bantry Bay disaster (Bantry Bay Petrochemical Industries, 1978), Three Mile Island (1979), Bhopal disaster (1984) and Chernobyl in Russia (1986), and other accidents reported less frequently, but have been extremely fatal, so catastrophic events have triggered a serious wave of research on unsafe behaviors and human error (8). Unsafe behaviors are an important factor in the occurrence of accidents. Unsafe behaviors are defined as the deviation from an accepted safe procedure or rule that is capable of causing an accident (9). Investigating and identifying unsafe behaviors in industries is carried out using a variety of methods that fall into two general categories: objective and subjective methods (10). Questionnaires, interviews, accident reports and self-reporting tools are used in the subjective methods for investigating the people's knowledge and attitude about unsafe behaviors, investigating of culture, climate and safety performance or causes of

accidents in industry; these subjective methods make qualitative estimation of unsafe behaviors and only investigating the causes of such behaviors including lack of education, lack of awareness, etc. (11-13).

Safety behavior sampling is used in objective methods that is a sampling of behaviors of individuals during the task and identifying the prevalence of unsafe behaviors by the type of behaviors and high-risk task. This method is based on probability and random observation. First, a list of unsafe behaviors according to the rules and studied industry conditions is provided, and then to estimate the prevalence of unsafe behaviors randomly, each person's behavior is observed and the person's behavior is recorded as safe or unsafe. Finally, by dividing the number of unsafe behaviors by the total number of behaviors observed, the percentage of unsafe behaviors is calculated (14, 15).

Numerous studies have been conducted to identify the causes of unsafe behavior using different methods. Some studies used qualitative research to identification of the root causes of unsafe behavior, and some have examined the relationship between unsafe behaviors and other factors such as stress, safety training, safety signs, and the safety climate (16, 17). Besides that, numerous studies have investigated the prevalence of unsafe behaviors of workers in different industries in Iran by conducting safety behavior sampling method (18-26). All of these studies have been conducted separately, and since each study reported the prevalence of unsafe behaviors in a particular industry, cannot be indicated the total prevalence of such behaviors among Iranian workers and a final estimate of the prevalence of these behaviors cannot be reported. To authors' knowledge, there has also been no worldwide review and meta-analysis of the prevalence of workers' unsafe behavior. Therefore, the present study aimed to investigate and estimate the prevalence of unsafe behaviors among Iranian workers using a systematic review and meta-analysis study.

Materials and Methods

The present systematic review and meta-analysis on the prevalence of unsafe behaviors among Iranian workers; was designed and conducted from Nov to Dec 2018. The method of reporting this study was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) checklist.

Search strategy of systematic review

The researchers searched in five international databases Medline/PubMed, ProQuest, Scopus, Embase, Google Scholar (for international articles) and four Iranian databases (for Persian articles), namely Scientific Information Database (www.sid.ir), MagIran (www.magiran.com), IranMedex (www.iranmedex.com) and IranDoc (www.irandoc.ac.ir) in Dec 2018.

Keywords chosen for international databases include "at-risk behavior, at-risk act, risk-taking act, risk-taking behavior, unsafe act, unsafe behavior, prevalence, incidence, frequency, occurrence, epidemiology, observation, assessment, evaluation, safety behavior sampling, and Iran". The equivalent of the same keywords in Persian was also searched in Iranian databases. The collected data was imported into EndNote X7 software, and the duplicate articles were automatically removed. Two researchers (M.M and S.H) reviewed the articles separately. Screening studies, extraction of results, and evaluation of the quality control of articles were performed separately by two researchers (M.M and H.R). If there were no differences between the researchers, the team leader (M.J) would comment on the article.

Inclusion and exclusion criteria

The main purpose of this study was to investigate the prevalence of unsafe behaviors. To this end, studies that used safety behavior sampling and reported unsafe behaviors in terms of number and percentage were included. Studies that used a questionnaire to determine the prevalence of unsafe behaviors, identified only the factors affecting it, and did not report the prevalence of these behaviors were excluded.

Evaluating the quality of articles

A checklist from the Joanna Briggs Institute was used for studies reporting the prevalence to check and control the quality of articles. The tool consists of 9 questions classified as Yes, No, Uncertain and Unused. Based on the number of positive responses to the questionnaire, the articles were categorized into three categories: low quality (score 1 and 2 out of 9 questions), average quality (score 3 to 6) and high quality (score 7 to 9). The purpose of this tool is to evaluate the methodological quality of the studies, and ways to access and understand the errors in the studies, design, implementation and analysis of data. Egger test was used to evaluate the risk of publication bias.

Statistical analysis

The heterogeneity between studies was evaluated by Cochran's' Q statistic (with a significance level $P=0.1$) and combined with I^2 statistic (with a significance level $\geq 50\%$). In the case of heterogeneity ($P=0.1$, $I^2 \geq 50\%$), the random effects model was applied by the variance method, and in the absence of heterogeneity ($P>0.1$, $I^2<50\%$), the fixed effects model was used.

Meta-regression was used to investigate the relationship between quantitative variables and prevalence of unsafe behaviors. Moreover, to investigate the cause of heterogeneity in the studies, subgroups based on different occupations were studied. All analyses were performed using STATA version 12 software.

Results

Description of search

After searching all international and Iranian databases, 235 articles were found. After three phases of checking (a. duplicate checking, b. title and abstract checking, and c. full-text checking) 37 articles entered the final analysis. In addition, the references of the included articles were reviewed to

add related studies; one study was added, and finally, 38 studies were reviewed. During the screening stages of the studies, some studies were excluded for various reasons, including unrelated subject matter of 110 studies (40 studies in titles and abstracts and 70 studies in full text), lack of access to 17 full texts (The study was presented at conferences and were not published) and duplicate results were 5 articles. The flowchart of the studies is presented in Fig. 1.
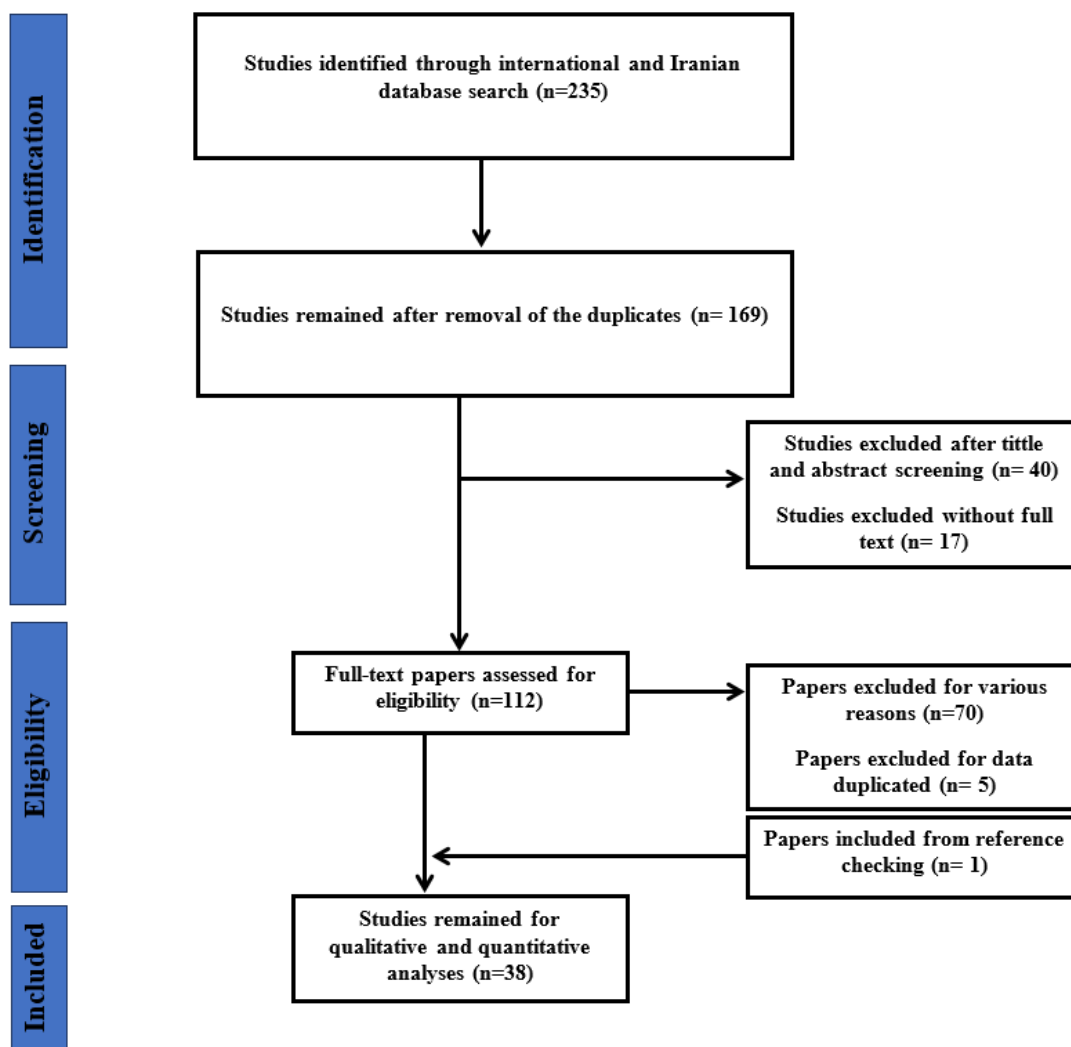

Fig. 1: Flowchart of the included studies in systematic review

The characteristics of the included studies are listed in Table 1. Of these, 17 were published in English and 21 in Persian. The occupations studied in these articles were, of 38 studies, 3 studies in the construction industry, 6 in automotive industry, 6 s in steel industry, 8 in petrochemical & refinery, 4 in drivers, 9 in other industries (such as harbor, livestock industries, defense industries, subway workers, turbines and power distribution, etc.), and 2 studies did not mention the industries (Table 1). The included studies were categorized by province. Of the 38 studies studied, most studies were conducted in Tehran and 13 articles did not mention the city (Table 2).

Table 1: Summery of the studies included in systematic review and meta-analysis

No.	Authors names/Year	Industries	City of study	Number of observations	Number of un-safe behaviors	SQA*
1	Mousavipour/2016 (18)	Petrochemical & Refinery	Khuzestan	2029	960	9/9
2	Mohammadfam/2010 (17)	———	Tehran	2317	1207	7/9
3	Oostakhan/2012 (19)	Construction	———	1496	663	5/9
4	Tajvar/2013 (20)	———	Bandar Abbas	2400	———	3/9
5	Darvishi/2015 (21)	Construction	Kurdistan	1120	860	6/9
6	Es-haghi/2008 (22)	Steel industry	———	2280	1049	8/9
7	Mohammadfam/2009 (23)	Automotive industry	Tehran	3456	1193	9/9
8	Abbasi/2015 (24)	———	Tabriz	3145	790	6/9
9	Arghami/2017 (16)	Livestock	Tehran	25000	8750	8/9
10	Khandan/2016 (25)	Printing	Qom	800	154	7/9
11	Shamsi/2016 (26)	Subway	Isfahan	———	———	2/9
12	Khandan/2013 (27)	Petrochemical & Refinery	———	2631	1147	8/9
13	Ghasemi/2017 (28)	Construction	———	1960	486	7/9
14	Azadeh/2010 (29)	Steel industry	———	387	128	6/9
15	Azadeh/2009 (30)	Steel industry	Isfahan	3248	1358	6/9
16	Nouri/2008 (31)	Petrochemical & Refinery	Qeshm Island	3248	868	5/9
17	Mohammadfam/2008 (32)	Petrochemical & Refinery	Bushehr	2121	868	7/9
18	Mohammadfam/2011 (17)	———	———	3456	1452	7/9
19	Mohammdfam/2009 (23)	Automotive industry	———	3376	1223	9/9
20	Arghami/2009 (9)	———	———	3478	1450	7/9
21	Negahdari/2011 (33)	———	———	1067	580	4/9
22	Mohammadfam/2008 (32)	Automotive industry	———	3456	1193	8/9
23	Hasheminejad/2012 (34)	Petrochemical & Refinery	Kermanshah	4014	938	8/9
24	Mohammadfam/2009	Petrochemical & Refinery	———	3362	2320	3/9
25	Barkhordari/2015 (35)	———	———	12340	4520	7/9
26	Adl/2014 (36)	Driver	Tehran	———	———	5/9
27	Golmohammadi/2014 (37)	Driver	Hamedan	———	———	5/9
28	Mohammadfam/2002 (38)	Steel industry	Hamedan	573	339	4/9
29	Asadi/2018 (39)	Steel industry	Isfahan	6230	2693	9/9
30	Khosravi/2008 (40)	Petrochemical & Refinery	Tehran	1200	283	3/9
31	Askaripoor/2015 (41)	Automotive industry	Isfahan	9200	1204	8/9
32	Mazaheri/2010 (42)	Steel industry	Isfahan	135	84	6/9
33	Mahmoudi/2013 (43)	Automotive industry	Tehran	3510	1113	4/9
34	Mohammadfam/2004 (44)	Driver	Hamedan	1069	453	7/9
35	Soori/2013 (45)	Automotive industry	Tehran	———	———	4/9
36	Garavand/2017 (8)	Petrochemical & Refinery	Ilam	1878	604	8/9
37	Mohammadfam/2013 (46)	———	———	702	343	6/9
38	Damyar/2012 (47)	Driver	Hamedan	2189	935	6/9

* Score of Quality Assessment

Table 2: Category of included studies by province

No.	Province	Number of articles	References
1	Tehran	7	(16, 17, 36, 40, 45, 48, 49)
2	Isfahan	5	(26, 30, 39, 41, 42)
3	Hamadan	4	(37, 38, 44, 47)
4	Bandar Abbas	1	(20)
5	Bushehr	1	(50)
6	Ilam	1	(51)
7	Kermanshah	1	(34)
8	Kurdistan	1	(21)
9	Khuzestan	1	(18)
10	Qeshm Island	1	(31)
11	Qom	1	(25)
12	Tabriz	1	(24)
	Total	25	

The highest and the lowest number of observations were 25000 and 135 observations, respectively. In addition, duration of each observation was about 3 to 6 seconds (17 studies reported the duration of each observation). The lowest and highest number of participants was 20 and 385, respectively (32 studies reported number of participants). The Mean±SD of age and work experience of the participants were 36.46±9.07 yr (29 studies) and 9.38 ±3.38 yr (22 studies), respectively. Of the studies reviewed, 6 investigated whether or not safety education was completed, with 80% of individuals receiving safety training.

Numerous unsafe behaviors were reported among the studies studied. Among the most unsafe behaviors reported are non-use or inappropriate use of personal protective equipment (PPE) (22 studies) and the least reported was non-compliance with safety principles (5 studies). The rest of the identified unsafe behaviors were reported as inappropriate posture studies (15 studies), inappropriate use of the tool or use of the wrong tool (10 studies), unsafe driving (10 studies), and inappropriate manual material handling (8 studies).

Quality checking of studies

The results of the quality of studies showed that only one study was of low quality, 18 had medium quality and 19 had high quality.

Heterogeneity of studies

A high level of heterogeneity was observed in the results of the studies. The heterogeneity in this study was based on two indices Q and I^2 for Unsafe behavior (Q = 9024.33, df = 32, I^2 =99.6%, P=0.000), non-use or inappropriate use of PPE (Q = 2339.87, df = 18, I^2 = 99.3%, P=0.000), and inappropriate work posture (Q=461.86, df =12, I^2 = 98.7%, P=0.000).

Meta-analysis results

Due to the high heterogeneity in the results, random-effects models were used. The results of the meta-analysis are shown by the type of unsafe behaviors (total unsafe behaviors, non-use or inappropriate use of PPE, and inappropriate work posture).

Total unsafe behaviors

Thirty-three studies reported a total prevalence of unsafe behaviors in Iranian industries. Based on the results of the random-effects model, the overall prevalence was 40.37% with a confidence interval (CI) of 35.8 to 44.9. The highest prevalence of unsafe behaviors was in steel industry (47.93%) and the lowest was in automobile industry (30.2%). The results of the prevalence of unsafe behavior based on different subgroups are shown in Fig. 2.
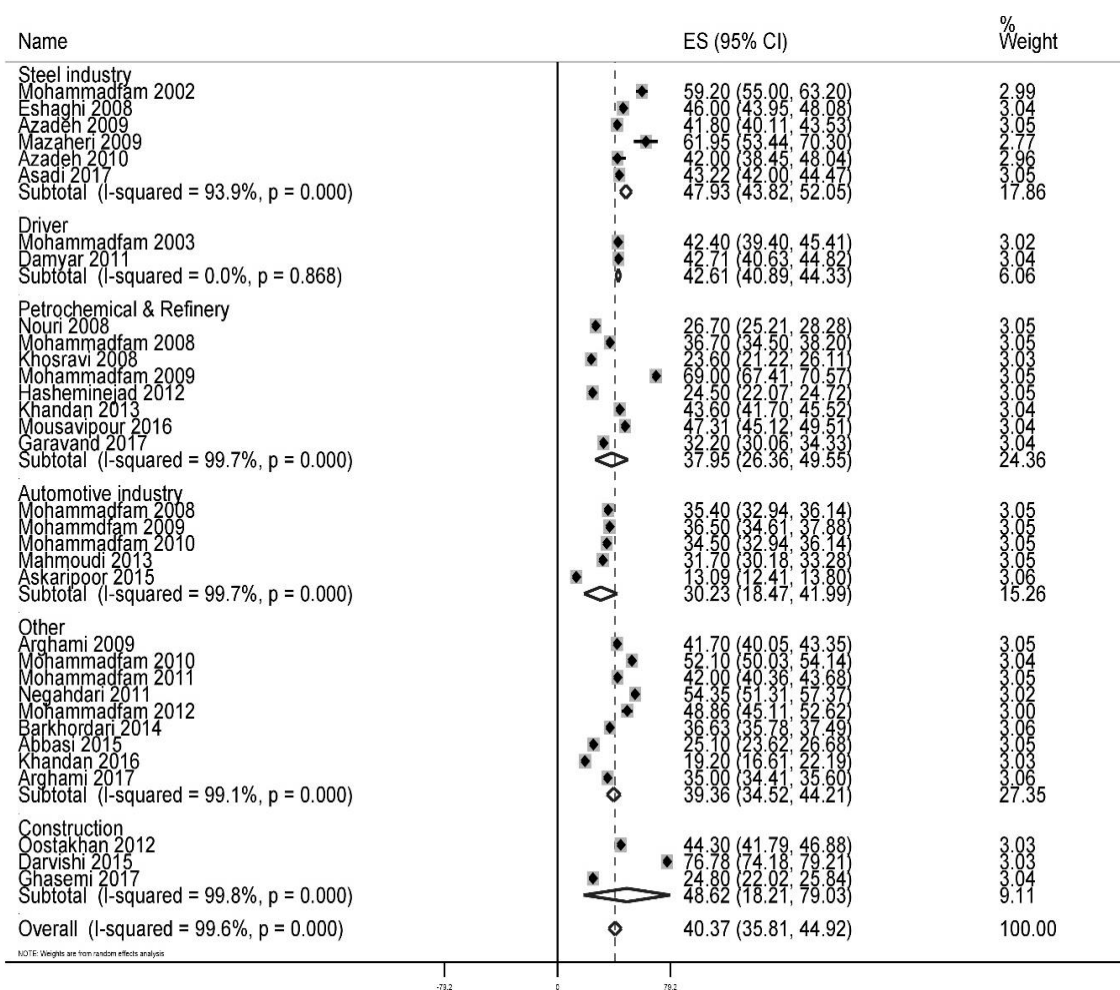
Fig. 2: Prevalence of unsafe behaviors amongst the studies included

Non-use or inappropriate use of PPE

Nineteen studies reported a total prevalence of non-use or inappropriate use of PPE. According to the results of the random-effects model, the overall prevalence was 27.79% (CI: 21.2-34.3%). The results of subgroup analysis showed that the highest prevalence of non-use or inappropriate use of PPE was in steel industry with 29.8%, and the lowest was in automobile industry with 23.8%. The results for the prevalence of non-use or inappropriate use of PPE by different subgroups are shown in Fig. 3.

Inappropriate work posture

Fifteen studies assessed the overall prevalence of inappropriate work posture. According to the results of the random-effects model, the overall prevalence was 14.87% (CI: 10.7-18.9%). The results of subgroup analysis showed that the highest prevalence of inappropriate work posture was 11.9% in petrochemical and refinery industry and the lowest in steel industry 5.2% (Fig. 4).
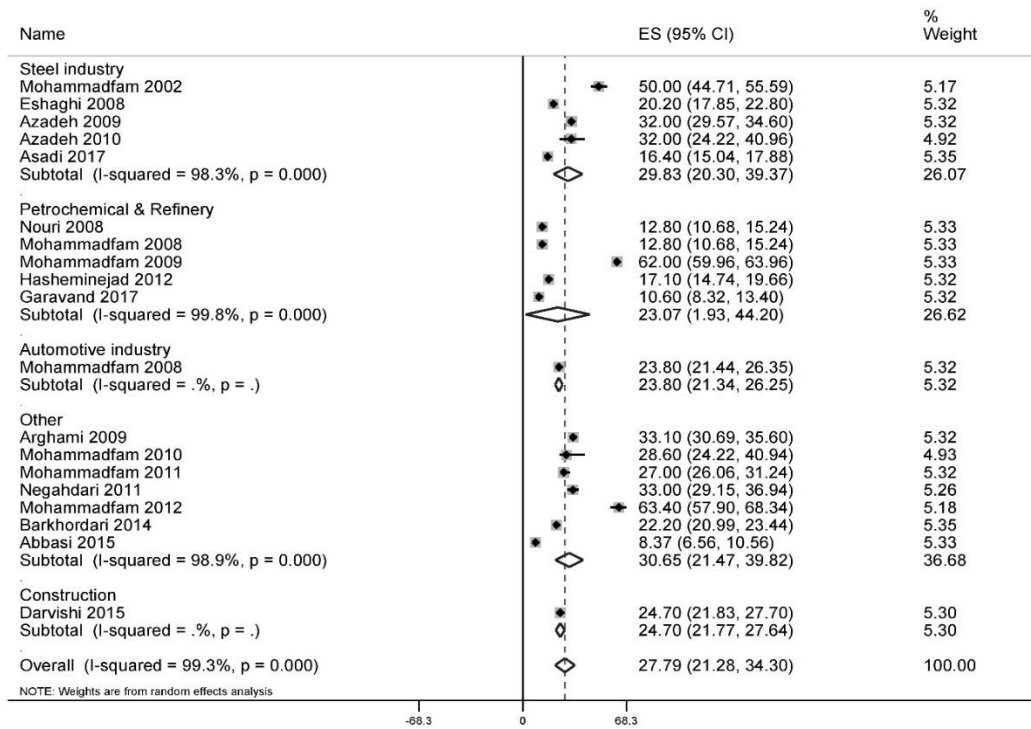
Fig. 3: Prevalence of non-use or inappropriate use of personal protective equipment amongst the studies included
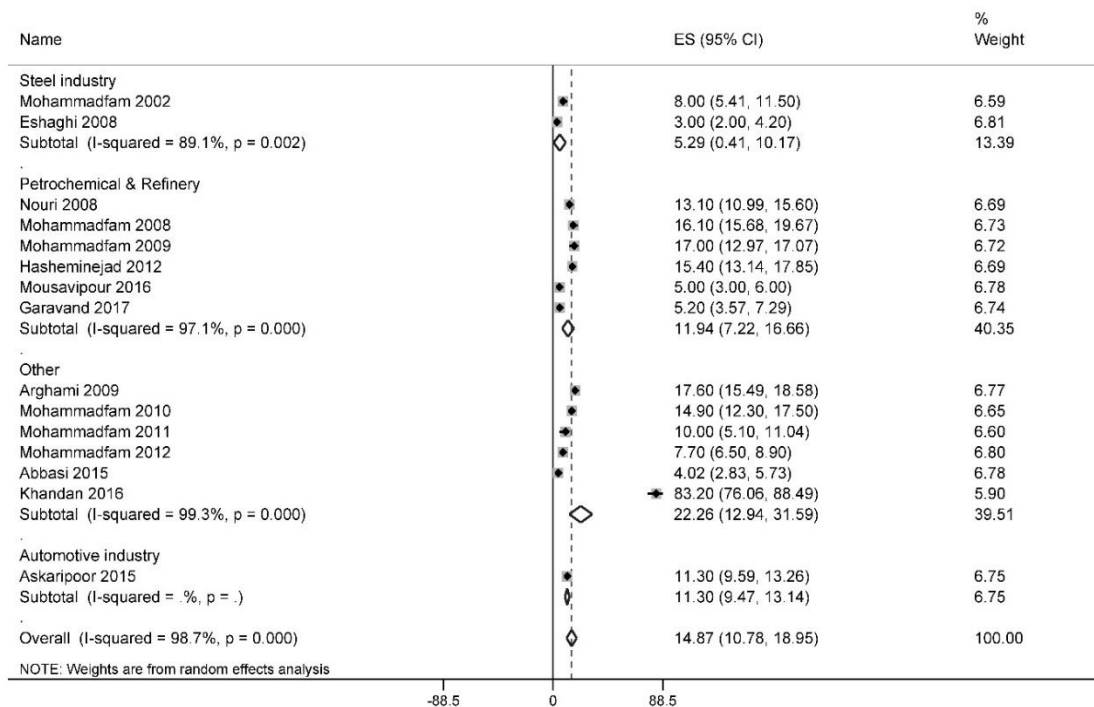

Fig. 4: Prevalence of inappropriate posture amongst the studies included

Meta-regression results

The meta-regression test was used to investigate the different factors on the prevalence of unsafe behaviors. The results of the relationship between the year of the study and the prevalence of unsafe behavior showed that, since 2003 (within 10 years), the prevalence of unsafe behaviors has decreased, but this decrease is not statistically significant (*P*=0.075). Another factor investigated was the mean age of the participants and the prevalence of unsafe behaviors. The results of the meta-regression showed that as the mean age of the participants increased, the prevalence of unsafe behaviors w decreased; however, this relationship was not statistically significant (*P*=0.445). Finally, the relationship between work experience and the prevalence of unsafe behavior was not statistically significant (*P*=0.985). The results of investigating various factors using meta-regression is shown in Fig. 5.
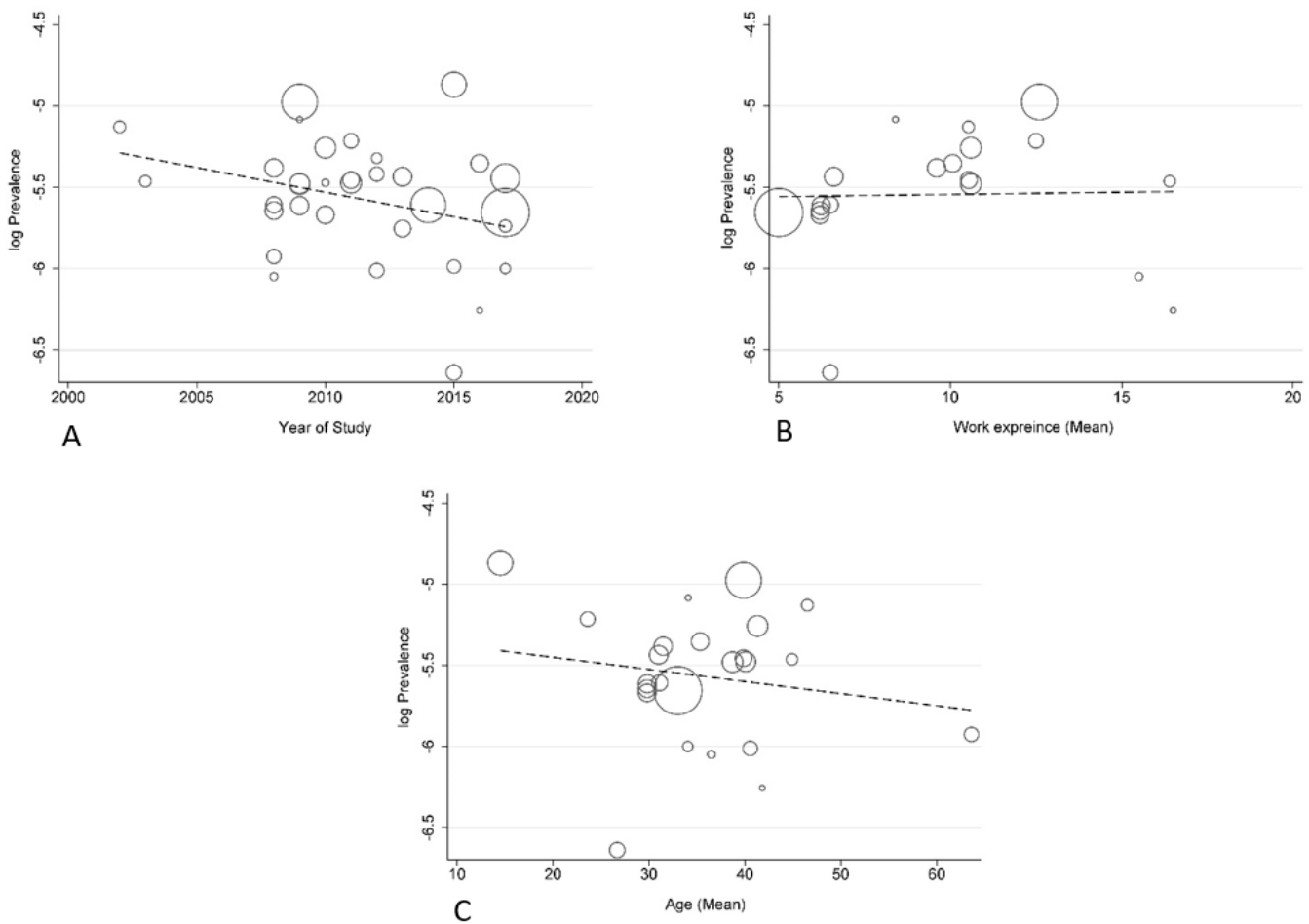

Fig. 5: Meta-regression analysis on the year of study (a), work experience (b), age of workers (c)

Publication bias analysis

Egger test and funnel plot were used to evaluate the publication bias in the results. The results of the publication bias indicated that this error was not present in the results of the studies (*P*=0.221) (Fig. 6).
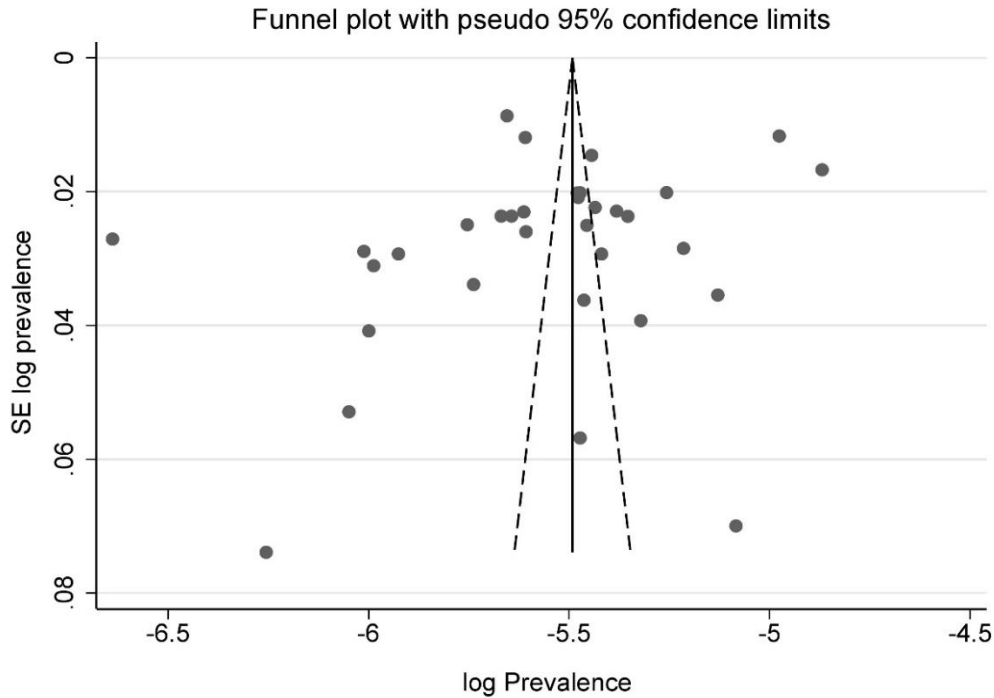
Fig. 6: Funnel plot for publication bias of included study with Egger test

Discussion

This study aimed to investigate the prevalence of unsafe behaviors among Iranian workers using a systematic review and meta-analysis. After reviewing the studies in terms of title and abstract, eventually, 38 studies that reported the prevalence of unsafe behaviors in Iran were included. The petrochemical, automotive, and steel industries were the most studied industries, respectively. About half of the observed behaviors in the studies were categorized as unsafe and the most prevalent was non-use or inappropriate use of PPE and inappropriate work posture.

Despite safety training, establishment of safety management system and numerous control strategies, the prevalence of unsafe behaviors among Iranian workers was high (48.62%). The most prevalent unsafe behaviors were in steel, petrochemical and refinery and automotive industries, respectively. The prevalence of unsafe behaviors in Iranian industries is due to inefficiency of safety training or low safety culture and insufficient supervision and inspection of the safety procedures

(52). Besides, other causes of unsafe behaviors among Iranian workers can be attributed to economic and social conditions, lack of risk awareness, work environment, and lack of proper inspection rules to record and report unsafe behaviors (53). However, to knowledge of authors, there has been no review and meta-analysis of the prevalence of unsafe behaviors in the world, only studies in some industries such as mining or steel industries have been conducted; therefore, the results of this study cannot be compared with other studies.

In addition, the results of the present study showed that most studies reporting the prevalence of unsafe behaviors were conducted in the petrochemical and refinery industry. This can be attributed to several factors. First, due to the establishment of HSE management, these industries have better acceptance of research and these industries have also been cited because of their high complexity, high risk process, and shift works with, and a high probability of accident (54), these occupational characteristics can contribute to the prevalence of unsafe behaviors (8, 18, 31). Other

studies in the automotive and steel industries, besides working conditions, indicated that causes of the prevalence of unsafe behavior in these industries are lack or insufficiency of safety training (42), organizational factors, workload, occupational stress (23), deficiency in the safety of equipment and tools, inadequate work experience, unsafe conditions, drowsiness, time pressure, and inappropriate work speed (41, 45, 55).

According to the results of the present study, the most common unsafe behaviors among Iranian workers were non-use or inappropriate use of PPE (27.79%). Non-use or inappropriate use of PPE has always been major contributors to accidents. Non-use of PPE has been reported as one of the six major causes of accidents in Iran from 1994 to 2003 (31). The study on 500 construction accidents in the UK in 2001 also found that 80.29% of these accidents were related to unsafe behaviors and a large percentage of these behaviors was due to non-use or inappropriate use of PPE (56). In China, the second most common unsafe behaviors among technical workers after non-compliance with safety rules was the non-use or inappropriate use of PPE by 24% (55). In the present study, the steel and petrochemical and refinery industries with 5 studies and the automotive and construction industries with 2 studies reported the highest prevalence of non-use or inappropriate use of PPE. Causes such as training, encouragement, follow-up, lack of a positive attitude towards safety and low safety culture (32), non-use or inappropriate use of safety panels and signs (9), ignorance of the employees' opinions in choosing and purchasing PPE (31), inappropriate PPE selected with the individual or occupation and harmful agent (30), possible interference with the working process or environmental conditions, a lack of comfort in using these devices (46), and failure to install warning panels can led to this unsafe behavior (51).

 The unsafe behaviors reported in the studies was related to inappropriate work posture with a prevalence of 14.87% and most studies were reported in petrochemical and refinery and steel industries. This behavior can reduce the concentration of people in sensitive and precise tasks, decrease productivity, increase the incidence of accidents, increase the risk of musculoskeletal disorders and thus increase work turnover and absenteeism (52). The most important causes of this unsafe behavior are untrained workers, inappropriate workstations, inappropriate material handling, inappropriate use of tools (55), and the nature of the job and task. The study conducted on unsafe behaviors of construction project workers indicated that inappropriate posture during transportation was the second unsafe behavior (11) which is consistent with the results of the present study.

In addition to the prevalence of unsafe behaviors and its causes among studies, the effect of the year of study, work experience and age on the prevalence of unsafe behaviors was investigated using meta-regression and there was not a significant relationship between the factors expressed and the prevalence of unsafe behaviors; however, the results of the meta-regression in the year of the study show that the prevalence of unsafe behaviors has declined since 2003. It seems to be attributed to the development of a safety culture over time and activities such as training, conducting a behavior-based safety program, the impact of safety panels, and information sharing. However, a closer investigation of this issue requires further studies.

Limitations

The present study had limitations. In most previous studies, depending on the type of industry and the events that occurred, there was a great deal of variation in the unsafe behaviors investigated and, therefore, it was not possible to investigate the prevalence of some unsafe behaviors such as inappropriate use of or use of wrong tools, inappropriate manual material handling and adherence to safety principles in the meta-analysis. It is also difficult to generalize the results to the entire country's industries as most studies have been conducted in several well-known industries. Another limitation of the present study was the lack of similar review and meta-analysis studies in other countries; therefore, it was not possible to compare the results of this study with other countries.

Conclusion

The prevalence of unsafe behaviors among Iranian workers was high and the petrochemical and refinery, automotive and steel industries were the most studied industries. The most common behaviors were non-use or inappropriate use of PPE and inappropriate work posture, and the most important causes for these behaviors are lack of training, inappropriate working conditions, and lack of positive attitude towards safety. Despite the decrease in the prevalence of unsafe behaviors in recent years, such behaviors are still prevalent among workers and are likely to influence other factors that require further studies to investigate these causes.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of interest

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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