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Comparing Risk Changes of Needlestick Injuries between Countries Adopted and Not Adopted the Needlestick Safety and Prevention Act: A Meta-Analysis

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ABSTRACT

Background: Needlestick injuries (NSIs) are a prevalent occupational hazard among healthcare workers (HCWs). They elevate the possibility of contracting bloodborne infections, including hepatitis C virus, hepatitis B virus, and human immunodeficiency virus. The prevention of needlestick injuries may be achieved through the utilization of needles with safety-engineered devices.

Aim: To compare the risk changes of needlestick injuries between countries adopted and not adopted the needlestick safety and prevention act.

Materials and methods: This meta-analysis has been carried out on 11 studies according to the guidelines by the Cochrane Collaboration reporting followed the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-analyses).

Main findings: Two studies reported (NSI incidence among nurses) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model has been utilized for analysis (I^2-value = 80%, P-value=0.03). The combined mean difference and 95 percent CIs was 1.13 (1.07 to 1.20). The combined result demonstrates highly statistically significant difference between groups regarding (NSI incidence among nurses) ($Z = 4.15$, $P \leq 0.001$). One study reported (NSI frequency among nurses in unlegislated countries) and all can be used. The result demonstrates highly statistically significant difference between groups regarding (NSI frequency among nurses in unlegislated countries) (Z-value = 3.30, P-value ≤ 0.001).

Conclusion: The frequency of NSIs among healthcare workers reduced significantly in countries with SEMD legislation in comparison to those without. Improved regulations may result from further investigation to ascertain if such reductions vary among occupational subgroups.

Keywords: NSIs, needlestick safety and prevention act, HCWs

INTRODUCTION

Needlestick injuries are a prevalent occupational hazard among healthcare workers. They elevate the possibility of contracting bloodborne infections, including hepatitis C virus, hepatitis B virus, & human immunodeficiency virus. Needlestick injuries may be effectively prevented by utilizing safety-engineered devices with needles (1).

Nevertheless, the Needlestick Safety and Prevention Act (NSPA), which has been initially passed by the Unites States Congress in 2000, has been implemented in only a handful of countries. This legislation mandated that the Occupational Safety and Health Administration revise its bloodborne pathogens standard to require that healthcare facilities provide safety-engineered medical devices (SEMDs) to healthcare workers (2). Australia, Austria, Belgium, Canada, Germany, France, Italy, the Netherlands, Portugal, Poland, Taiwan, UK,

and the United States are among the countries that have implemented legislation with regard to utilization of safety-engineered medical devices. The majority of the previous countries are located in Europe, North America, & East Asia (3).

The legislation has successfully raised the utilization of safety-engineered medical devices by healthcare workers, thus decreasing the possibility of infections and sharps injuries and exposure to infectious body and blood fluids. In contrast, the optional adoption of safety-engineered medical devices in healthcare facilities that lack a mandate may not achieve a significant level of utilization (4). Despite the fact that legislation successfully decreases sharps injuries, it imposes a cost burden on healthcare facilities to a certain degree (5).

To evaluate the alterations in needlestick injury risk among countries that have adopted and haven't adopted the needlestick safety and prevention act, this meta-analysis has been carried out.

MATERIALS AND METHODS

This meta-analysis has been carried out on 11 studies based on the guidelines by the Cochrane Collaboration reporting followed the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-analyses).

Search strategy

We conducted an investigation of the Embase, PubMed, MEDLINE, EBSCO, and Airiti Library databases for relevant articles. The search terms used were "sharps injury," "needlestick injury," "percutaneous injury," and "incidence," "epidemiology," or "prevalence," as indicated in the title or abstract. The inclusion criteria have been assessed against the resulting investigations following the removal of duplicate articles. The full texts of every investigation that has been potentially relevant has been acquired for evaluation against the specified inclusion criteria. The outcomes have been synthesized only after the investigations that met the criteria have been further evaluated. The reference list of the articles that have been involved has been evaluated to determine whether any investigations met the inclusion criteria.

Selection criteria

Inclusion criteria: Articles stating the numerators and denominators of a multiyear incidence rate of needlestick injuries, study population not limited to one department, needlestick injuries information obtained from the report system databases, & articles written in English

Exclusion criteria: legislation articles for which the investigation timeframe didn't involve the review articles & legislative year.

Quality assessment

Utilizing the Critical Appraisal Checklist for Prevalence Studies of the Joanna Briggs Institute (JBI), the articles' quality has been assessed. **Munn et al (6)** published the Joanna Briggs Institute checklist, which serves as an evaluation instrument for investigations that quantify occurrence or frequency. The checklist comprises nine questions that evaluate the validity, reliability, subgroup coverage, sample method, sample frame, and sample size of the measuring instrument. To assess the quality of the investigation, a statistical analysis has been conducted. The questions have been evaluated as "yes," "no," "unclear," or "not applicable." The checklist enabled the calculation of a quality score or grade; the total number of "yes" responses for every investigation denoted quality of investigation.

Statistical analysis

Review Manager version 5.4.1 has been utilized to conduct all data analyses. (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). The odds ratio for binary results has been determined using a ninety-five percent confidence interval (CI). For continuous results, we computed the mean difference with a ninety-five percent confidence interval. A fixed-effect model with the Mantel-Haenszel technique has been utilized to compute the total effect, which has been estimated with a ninety-five percent confidence interval, in the absence of heterogeneity among investigations. Alternatively, the random-effects model utilizing the method of DerSiomonian and Laird has been selected. The I^2 test and Q statistic have been utilized to assess the heterogeneity among investigations, which denotes the degree of variability in the effect estimates. A P-value of less than 0.05 was regarded as statistically significant.

RESULTS

A total of eleven studies have been selected for the current analysis, the publication year ranged from 2010to 2019. 2 studies were conducted in Canada, one investigation was carried out in each of the following: Italy, Poland and, US, England, Tiwan, Northern Thailand, Hong Kong, South Korea, and Saudi Arabia. Demographic

data of involved investigations are showed in Table 1.

Table 1

Author, year	year	country	Study period		Study design
			from	to	
Bianco et al(7)	2019	Italy	1995	2016	retrospective study
Champers et al (8)	2015	Canada	2004	2015	observational study
Garus et al (9)	2018	Poland	2010	2014	retrospective study
Lu et al (10)	2015	Canada	2003	2010	retrospective study
Perry et al (11)	2012	U. S	1987	2007	
Phillips et al (12)	2013	England	1995	2005	prospective design
Wu et al (13)	2019	Tiwan			
Chaiwarith et al (14)	2013	Northern Thailand	2005	2010	retrospective study
Cheuge et al (15)	2010	Hong Kong	2002	2006	
Lee et al (16)	2017	South Korea	2011	2015	retrospective cohort study
Memish et al (17)	2013	Saudi Arabia	2007	2011	Retrospective study

Table 2. Patient's characteristics

The mean participants' age in studied groups was 29.65 ranging from 20to 52 years, and gender was reported in all studies with 1524 male and 2646 female as shown in table 2.

Author, year	Age (year)		Sex		
	Mean	SD	Male	Female	total
Bianco et al (7)	39.4	10.1	806	667	1473
Chaiwarith et al (14)	27.6	7.2	525	1,086	1611
Cheuge et al (15)	21.14	1.36	9	42	51
Lee et al (16)	34.6	11.5	184	851	1076

NSI incidence among workers in legislated countries

Seven studies reported (NSI incidence among workers) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model has been utilized for analysis (I^2-value equals 98%, P-value not more than 0.001). The combined mean difference and ninety-five percent confidence intervals was 1 36.(1.33to 1.39). The combined result demonstrates highly statistically significant distinction among groups regarding (NSI incidence) (Z-value equals 30.96, P-value not more than 0.001).

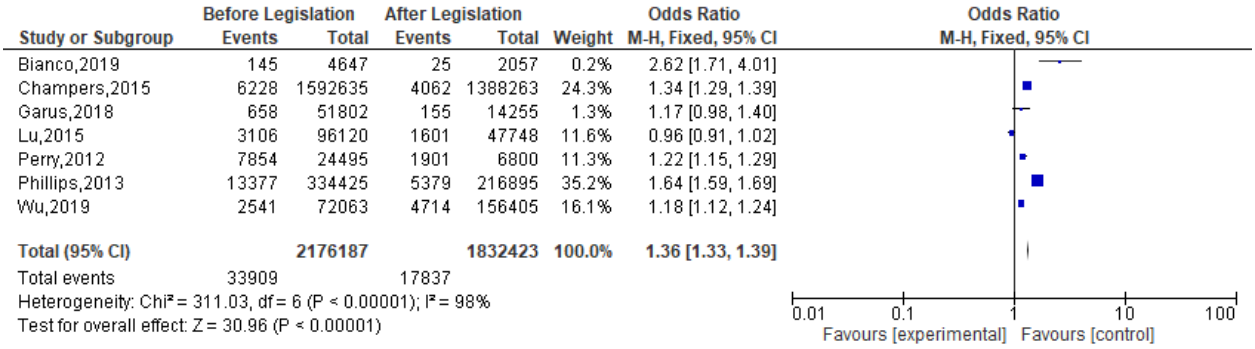

Figure 1. Forest plot of NSI incidence among workers in legislated countries demonstrates slight statistically significant difference between Before Legislation & after Legislation groups**.**

NSI incidence among nurses in legislated countries

Two studies reported (NSI incidence among nurses) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model has been utilized for analysis (I^2-value equals 80%, P-value equals 0.03). The combined mean difference and ninety-five percent confidence intervals was 1.13 (1.07to 1.20). The combined result demonstrates highly statistically significant difference between groups regarding (NSI incidence among nurses) (Z-value equals 4.15, P-value not more than 0.001).

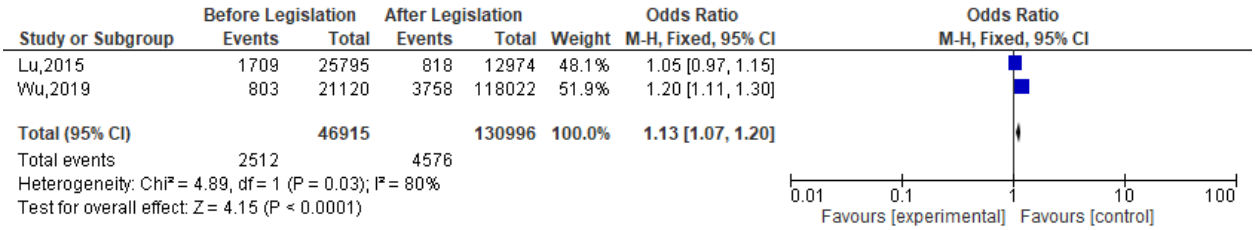

Figure 2. Forest plot of NSI incidence among nurses in legislated countries demonstrates slight statistically significant difference between Before Legislation & after Legislation groups**.**

NSI incidence among physiciansin legislated countries

one study reported (NSI incidence among physiciansin legislated countries) and all can be used. The result demonstrates slight statistically significant difference between groups regarding (NSI incidence among physiciansin legislated countries) (Z-value equals 1.96, P-value equals 0.05).

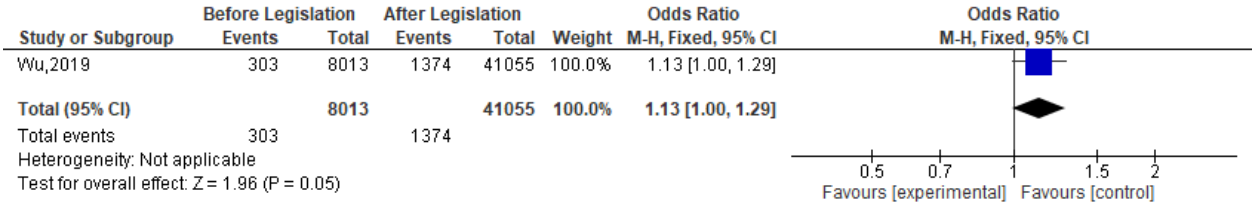

Figure 3. Forest plot of NSI incidence among physicians in legislated countries demonstrates slight statistically significant difference between Before Legislation & after Legislation groups**.**

NSI incidence among workers in unlegislated countries

four studies reported (NSI incidence among workers in unlegislated countries) and all can be used. A significant heterogeneity was detected. Therefore, a random-effect model has been utilized for analysis (I^2-value equals 64%, P-value equals 0.04). The combined mean difference and ninety-five percent confidence intervals was 1.01(0.94to 1.10). The combined result shows statistically insignificant distinction among groups regarding (NSI incidence among workers in unlegislated countries) (Z-value equals 0.33, P-value equals 0.74).

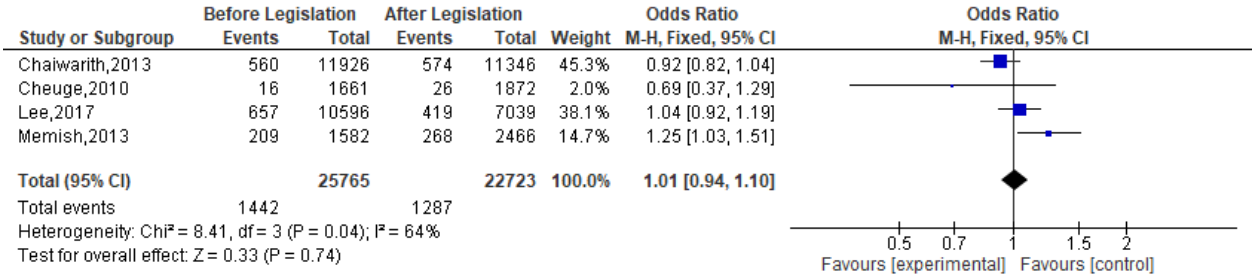

Figure 4. Forest plot of NSI frequency among workers in unlegislated countries shows statistically insignificant distinction among Before Legislation & after Legislation groups**.**

NSI incidence among nurses in unlegislated countries

one study reported (needlestick injuries frequency among nurses in unlegislated countries) and all can be used. The result demonstrates highly statistically significant difference between groups regarding (needlestick injuries frequency among nurses in unlegislated countries) (Z-value equals 3.30, P-value not more than 0.001).

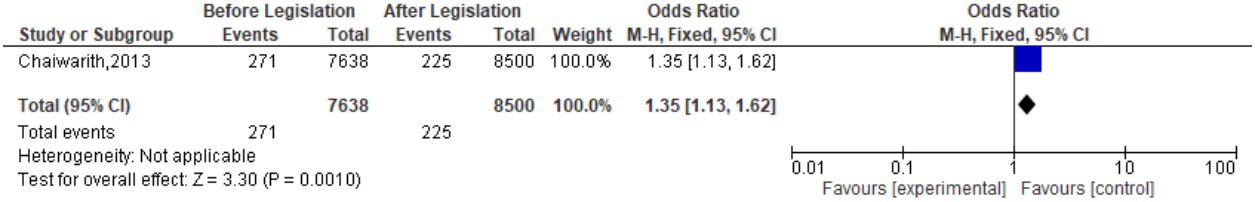

Figure 5. Forest plot of needlestick injuries frequency among nurses in unlegislated countries demonstrates highly statistically significant difference between Before Legislation & after Legislation groups**.**

NSI incidence among physiciansin unlegislated countries

one study reported (NSI frequency among physiciansin unlegislated countries) and all can be used. The result shows statistically insignificant distinction among groups regarding (NSI frequency among physiciansin unlegislated countries) (Z-value equals 1.10, P-value equals 0.27).

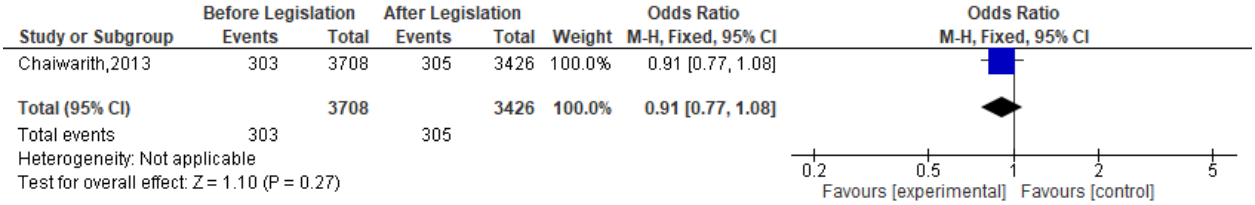

Figure 6. Forest plot of NSI incidence among physicians in unlegislated countries shows statistically insignificant distinction among Before Legislation & after Legislation groups**.**

DISCUSSION

The combined result demonstrated that there was a significant decrease in NSI incidenceamong workers, NSI incidence among nurses after Legislation. There was slight significant difference between groups regarding NSI incidence among physiciansin legislated countries. Also, the combined results showed highly significant difference between groups regarding needlestick injuries frequency among nurses in unlegislated countries. While articles from unlegislated countries demonstrated insignificant alteration in the needlestick injuries frequency amongworkers and among physicians.

The possibility of needlestick injuries to healthcare workers in a tertiary university hospital in southern Italy has been assessed in an investigation carried out by **Bianco et al. (7).** They stated that the frequency proportion for these highest-risk categories has been determined at three distinct time periods during the investigation duration: 104/2149 (4.86 percent) in 1995, 41/2498 (1.64 percent) in 2005, and 25/2057 (1.22 percent) in 2015. The most injuries have been reported in General Surgery (14.21 percent), Gynecology and Obstetrics (9 percent), and Pediatrics (6.49 percent). Healthcare workers had been exposed to hepatitis C virus-infected fluids in approximately thirty-four percent of cases. The rate of accidental exposure for physicians (p-value equals 0.019), nurses (p-value less than 0.0001), and HCAs (p-value less than 0.0001) decreased significantly over time.

Additionally, the frequency of needlestick injuries reduced by 43.3 percent (from 9.44 to 5.35 per 10,000 FTE) from 2006 to 2011, as a result of the enactment of safety-engineered medical device legislation by **Chambers et al. (8)** in 2009. The rates of workers' compensation claims correlated with needlestick injuries decreased by thirty-one percent in the hospital sector, by sixty-seven percent in the long-term care sector, and have elevated by about one percent in nursing services between 2004 and 2012. They observed a significant decrease in needlestick injuries in the province of Ontario as a result of a regulatory requirement to use safety-engineered needles; nevertheless, a substantial amount of occupational needlestick injuries continue to occur in their setting.

The needlestick injuries frequency in Poland, which implemented safety-engineered medical device legislation in 2014, didn't vary significantly between 2010 and 2013 (from 11.55 to 13.82 per 1,000 healthcare workers). However, it decreased by 14.5 percent from 2013 to 2014 **(9).** In the US, the frequency rate reduced by thirty-eight percent from 1995 to 2005 (from 4.00 to 2.48 per 100 FTE) after the NSPA has been passed in 2000 **(11), (12).** The needlestick injuries frequency rate in Taiwan reduced by thirty-one percent (from 3.6 to 2.48 per 100 healthcare personnel) after the government implemented safety-engineered medical device legislation in 2012. In Thailand and Korea, the frequency rate of needlestick injuries reduced by 8.3 percent from 2005 to 2010 **(14)** and by 16.2 percent from 2011 to 2015 (from 6.8 to 5.7 per 100-person year) **(16),** correspondingly, in the absence of safety-engineered medical device legislation. Therefore, their frequency rates of needlestick injuries hadn't undergone a significant alteration as those in Taiwan. The cause for a reduction in unlegislated countries could be that certain unlegislated countries started utilizing safety-engineered medical devices. Nevertheless, the widespread utilization of safety-engineered medical devices might not be a significant factor because of a lack of legal enforcement. Additionally, research indicates that significant reductions in needlestick injuries don't typically occur within the first two years following the act's passage**(10).** A different Canadian investigation discovered that the efficacy of safety-engineered medical devices wasn't realized until four years following the legislation has been enacted **(8).**

CONCLUSION

In conclusion, our analysis suggests that the frequency of needlestick injuries among healthcare workers reduced considerably in countries with safety-engineered medical device legislation when compared with healthcare workers in countries without such policy. Additional research to ascertain if these decreases are distinct among occupational subgroups may result in enhanced regulations.

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