Global, regional and national incidence and causes of needlestick injuries: a systematic review and meta-analysis

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Abstract

Background: Needlestick injuries (NSIs) are one of the most serious occupational hazards for healthcare workers (HCWs).

Aims: The aim of this study was to evaluate the incidence and causes of NSIs globally.

Methods: A systematic review and meta-analysis of data from January 2000 to May 2020 collected from Scopus, PubMed, Embase, Web of Science, and Google Scholar. The Newcastle–Ottawa Scale was used to assess the quality of the included articles. The data obtained were analysed by R version 3/5/0, and 113 articles were retrieved.

Results: There were 113 studies with a total of 525,798 HCWs. The incidence of NSIs was 43%. Africa had the highest rate of these injuries in 51%, and the World Health Organization (WHO) African Region had the highest incidence among WHO regions of 52%. Women were more frequently affected by NSIs than men. Hepatitis C virus infection was the disease most commonly transmitted via NSIs (21%). The highest rates of NSIs according to causes, devices, hospital locations, occupations and procedures were for recapping of needles, needles, general wards, nurses and waste disposal, respectively.

Conclusion: The incidence of NSIs is gradually decreasing. The findings of this study can contribute to improving the decision-making process for reducing NSIs in HCWs.

Keywords: needle-stick injuries, healthcare providers, healthcare workers, hospitals, occupational hazard

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Introduction

Physicians, nurses and other members of the healthcare professions are increasingly exposed to a wide range of occupational risks, such as needlestick injuries (NSIs) (1). Globally, NSIs are one of the most serious occupational hazards among healthcare workers (HCWs), with > 2 million occupational exposures occurring among 35 million HCWs annually, according to the World Health Organization (WHO) (2).

NSI refers to a penetrating wound with an instrument potentially contaminated with another person’s body fluid. According to the United States National Institute of Occupational Safety and Health (NIOSH), NSIs are caused by hypodermic needles, blood collection needles, intravenous (IV) styles, and needles used to connect parts of IV delivery systems (3). HCWs at risk of NSIs, if injured, are at high risk of serious infections by blood-borne pathogens such as HIV/AIDS, hepatitis B virus (HBV) and hepatitis C virus (HCV). According to WHO, NSIs are responsible for the global incidence of HBV (36.7%), HCV (39%) and HIV/AIDS (4.4%) among HCWs for various reasons such as fatigue, carelessness, stress, haste, and sudden movement of patients (4).

The incidence of NSIs varies depending on working conditions, area of specialization and workplace environment. Kebede and Gerensea reported that the incidence of NSIs in Ethiopia was 48.8% among 252 nurses, and most NSIs occurred in the medical and surgical departments (5). Makary et al. estimated that the incidence of NSIs in the United States of America was 83% among 699 surgical residents, with most injuries related to the operating room (6). Despite the high incidence of NSIs among HCWs, evidence suggests that HCWs often do not report their injuries or are not followed up for treatment and testing; possibly due to lack of time, lack of belief in NSI-transmitted infection, and other reasons (7).

Given the importance of NSIs among HCWs, and lack of knowledge, HCWs need to receive accurate and comprehensive information on incidence, control and prevention of NSIs. Although many preliminary studies

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have been conducted on the incidence of NSIs, there is no systematic review of all dimensions and factors (cause, procedure, device and location) related to the global incidence of NSIs. The results of this study provide valuable information for HCWs, hospitals and other medical centres to reduce the incidence of NSIs, as well as provide a safer atmosphere for HCWs to perform clinical tasks, and ultimately improve the quality of services.

Methods
The preregistration of this study took place on PROSPERO (International Database of Prospectively Registered Systematic Reviews in Health and Social Care) at the University of York (https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020198842).

Search strategy
Two of the authors separately searched Web of Science, PubMed, Scopus and Embase for article published from January 2000 to May 2020, using the following keywords: Injury, Needle-stick OR Needle-stick Injury OR Needle-sticks OR Needle-stick OR Needle-Sticks OR Needle Stick OR Needle-Stick Injuries, Needle-stick OR Needle-Stick Injuries OR Injuries, Needle-Stick[Title] OR Injury, Needle-Stick OR NSIs OR Needle-Stick Injury OR Sharp Injuries OR Injuries, Sharps OR Injury, Sharps OR Sharps Injury. The initial search resulted in 4981 relevant articles. In addition, we searched Google Scholar (additional sources) resulting in 41 studies. The duplicates were omitted using EndNote software, and 1624 articles remained for review.

Study selection process
The selection process was accomplished in 2 steps. First, the title and abstract of searched articles were checked by 2 individual reviewers to select the relevant studies based on the exclusion and inclusion criteria of this study, which resulted in 348 articles. Subsequently, full-text analysis led to 113 eligible articles (Figure 1).

Inclusion criteria
Inclusion criteria were original English-language articles published between January 2000 and May 2020 with full text, having cross-sectional, descriptive, prospective, case study or cohort designs.

Exclusion criteria
Exclusion criteria were articles in languages other than English, published after May 2020 or before January 2000, in addition to randomized controlled trials, theses, case-control studies, commentaries, book chapters, books, editorials, expert opinions, letters to the editor, brief reports and reviews, assessments of treatment approaches, follow-up studies, interventional studies, clin-
ich decision-making, studies with invalid tables or figures, or difficulty in calculating quality of life.

### Quality assessment of included articles

The Newcastle–Ottawa Scale (NOS) was used to assess the quality of included articles in this systematic review by 2 separate reviewers to mitigate bias, and any disagreements were resolved by a third reviewer. The articles were assessed by NOS in terms of the domains and related subdomains: (A) selection process (1 – definition of case; 2 – representativeness of cases; 3 – selection of controls; and 4 – definition of controls); (B) comparability (comparability of cases and controls on the basis of design or analysis); and (C) exposure (1 – ascertainment of exposure; 2 – same method of ascertainment for cases and controls; and 3 – non response rate). Scores were displayed as 0 and 1 points for unreported and referenced items, respectively. The total quality score was calculated through the sum of the points calculated for the reported items, indicating a score of 10 as the best quality and a score of 0 as the lowest quality. Low quality was considered for articles with a score less than the mean score (< 4) (8).

### Process of data extraction

The required data were extracted by 3 of the authors in a predesigned form containing name of author, place of research, date of publication, quality of research, WHO region, sample size, number of participating men and women, number of NSIs, number of men and women with NSIs, infection, job status, causes of NSIs, NSI site, instruments and procedures that caused NSIs (Supplementary File 1).

### Data analysis by statistical methods

A random-effects model meta-analysis, the conventional DerSimonian–Laird estimator, was used to calculate the means by 4 authors who were experienced in this area. The results were presented in a forest plot at 95% confidence interval (CI). Publication date and sample size were selected as criteria for measuring heterogeneity (I²) of included articles and meta-regression analysis. Sensitivity analysis was performed to verify stability of the results. Sample size, place of research, date of publication, sex, procedures and instruments that caused NSIs, NSI site, causes of NSIs and job status were parameters for subgroup analysis. Cumulative meta-analysis was performed on the basis of date of publication and sample size. Publication bias was evaluated by Egger test. R version 3/5/0 was used for data analysis.

### Results

The findings of this study were based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement, and using the meta-regression analysis of data from 113 articles published from January 2000 to May 2020. Total incidence of NSIs was 43% (95% CI = 37–49%; n = 226 093) among 525 798 HCWs (Figure 2).

### Meta-regression based on WHO regions

Analysis of WHO regions showed that the incidence of NSIs in the African Region was higher than in other regions (51%, 95% CI = 40–61%) (Table 1). The lowest incidence of NSIs (31%, 95% CI = 19–46%) was in the Western Pacific Region.

### Meta-regression based on continent

The incidence of NSIs in Africa was higher than in other continents (52%, 95% CI = 41–62%) (Table 1). The lowest incidence of NSIs (21%, 95% CI = 9–41%) was in Oceania.

### Meta-regression based on gender

The incidence of NSIs was higher in female than in male HCWs. A total of 93 959 women had a 39% incidence of NSIs (95% CI = 26–54%) compared with 27% (95% CI = 18–38%) among 76 504 men.

### Meta-regression based on transmitted diseases

The 6 most frequent NSI-transmitted diseases are shown in Table 1, including HCV (21%, 95% CI = 7–38%), HBV (18%, 95% CI = 14–25%) and HIV (17%, 95% CI = 14–32%) in the first to third places, respectively.

### Meta-regression based on causes

Recapping of needles was the most frequent cause of NSIs among HCWs (n = 6070, 30.5% of the total) (Figure 3), followed by mental distraction (n = 3566, 17.96%). Carelessness had the lowest rate (n = 170, 0.2%).

### Meta-regression based on devices

Needles were the most common cause of NSIs (n = 32 325, 68.46% of the total), followed by scalpels (n = 9189, 19.46%) (Figure 3) while 0.12% of NSIs were related to scissors, which was the lowest rate.

### Meta-regression based on hospital wards

Most NSIs occurred in general wards (n = 16 592, 34.67% of the total), followed by operating rooms (n = 11 508, 24.04%) (Figure 3). The radiology ward had the lowest number of NSIs (0.03%).

### Meta-regression based on occupation

Nurses had the highest number of NSIs (n = 26 840, 56.28% of the total), followed by physicians (n = 9874, 20.28%), and operating room technicians (n = 45, 0.9%) had the lowest number (Figure 3).

### Meta-regression based on type of procedures

Disposing of waste accounted for most NSIs (n = 9405, 37.17% of the total), followed by injections (n = 8583, 33.92%) and suturing (n = 1828, 7.22%) (Figure 3).

### Meta-regression based on publication year

The results of meta-regression, based on the year of study, showed that an increase of 1 year of study publication date caused a lower incidence of NSIs by 0.84 units (β = 0.84, 95% CI = 0.837–0.842, P < 0.001) (Figure 4).
Figure 2 Total prevalence of needlestick injuries.
Figure 3: Meta-regression of needlestick injuries according to causes, devices, hospital wards, occupations and procedures.
Discussion

The present systematic review and meta-analysis was conducted to estimate the overall prevalence of NSIs among HCWs. Based on the results of our study, the global incidence of NSIs in HCWs was 43%, which is a significant rate in terms of WHO policies. WHO reported in 2002 that about 6.5% of all HCWs had experienced such events. In the systematic review by Bouya et al. (2020) of 87 articles with a total of 50,916 participants, the incidence was 44.5%, which is in line with our study (9). Comparison of the incidence in our study and the 2020 study with that of the WHO report in 2002 shows that the incidence of NSIs has increased, and that presently about half of all HCWs experience these events at least once (10). Considering the annual trend identified in our study, the incidence of NSIs is decreasing based on publication year. This could be an appropriate subject for future studies. We think that increases in the ratio of patient to medical staff numbers and workload could be the main reason for the incremental incidence of NSIs.

Our study showed that Africa and the WHO African Region had the highest incidence of NSIs among other continents and regions. For example, in a study of 72 people in Nigeria in 2009, 86.6% (n = 65) had experienced NSIs (11). In studies conducted in Cameroon, Uganda and Ethiopia, this rate was reported to be > 55%, which is significantly different from other regions, and is in line with our study. We believe that the large workload of medical centres imposes a high risk of experiencing NSIs by the medical staff, and inadequate, unsafe facilities in African countries should be taken into consideration (12).

We found a significant difference in incidence between women and men. Zhang et al. (13) reported that the incidence of NSIs was higher in women, which is consistent with our findings. In contrast, a study by Lee and Hassim found that the incidence of NSIs was higher in men (14). Unfortunately, no specific study has been conducted on this topic, and there is no information on why the incidence of such NSIs is low or high in men and women. However, we believe that one of the main
Incidence et causes des blessures par piqûre d’aiguille aux niveaux mondial, régional et national : revue systématique et méta-analyse

Résumé

Contexte : Les blessures par piqûre d’aiguille constituent l’un des risques professionnels les plus graves pour les agents de santé.

Objectifs : L’objectif de la présente étude était d’évaluer l’incidence et les causes des blessures par piqûre d’aiguille à l’échelle mondiale.

Méthodes : Nous avons réalisé une analyse systématique et une méta-analyse des données recueillies dans Scopus, PubMed, Embase, Web of Science et Google Scholar de janvier 2000 à mai 2020. L’échelle de Newcastle-Ottawa a été utilisée pour évaluer la qualité des articles inclus. Les données obtenues ont été analysées au moyen du logiciel R version 3/5/0 et 113 articles ont été récupérés.

Résultats : Il y avait 113 études incluant un total de 525 798 agents de santé. L’incidence des blessures par piqûre d’aiguille était de 43 %. Le continent africain affichait le taux le plus élevé de ces traumasmes, soit 51 %, tandis que la Région africaine de l’Organisation mondiale de la Santé (OMS) présentait l’incidence la plus élevée parmi les régions de l’OMS, soit 52 %. Les femmes étaient plus souvent touchées par les blessures par piqûre d’aiguille que les hommes. L’infection par le virus de l’hépatite C était la maladie la plus souvent transmise par les blessures par piqûre d’aiguille (21 %). Les taux les plus élevés de blessures par piqûre d’aiguille selon les causes, les dispositifs, les
Conclusion: The incidence of needlestick injuries has been declining progressively. The results of the present study can contribute to improving the process of decision-making for reducing needlestick injuries in health care workers.

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