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Needlestick and sharp injuries among healthcare workers in hospitals: A mini-systematic review

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Abstract
Background: Needlestick and sharp injuries (NSSIs) are defined as percutaneous injuries with needles or sharp objects contaminated with blood or other body fluids. NSSIs are considered as a major occupational hazard among healthcare workers (HCWs) since needles and sharp objects are commonly used in hospitals. *Objectives:* The objective of this study is to conduct a systematic review on the published scientific literature to provide accurate assessment of needlestick and sharp injuries among healthcare workers including prevalence, risk factors, predictors, reporting, and interventions. *Methods:* The following selection criteria were used to perform a systematic search of the literature: research studies published in English language between 2011 and 2014, targeted population is the healthcare workers providing direct care to the patients in the hospitals. The outcome of the study is the needlestick and sharp injuries. The following databases were searched: ScienceDirect, Scopus, and EBSCO. The included search terms were: needlestick injury, sharp injury, NSI or NSSI and healthworkers. The search was limited to cross-sectional studies, retrospective studies, and randomized controlled trials conducted in the hospital. The criteria to select articles were limited to peer-reviewed scientific publications and review articles were excluded. *Result:* Based on the inclusion and exclusion criteria, screening was done to the 35 articles. 18 articles were found eligible to be included while 17 studies were excluded. The included studies consisted of 10 cross-sectional, 7 retrospective, and 1 intervention study. In general, higher NSSI rates were found in nurses (average reported between 64.1% - 44.3%) compared to other occupational groups (average NSSI rate reported were first year resident physician 45%, interns 26% and housekeeper 12.3%). *Conclusion:* NSSIs is an important occupational hazard among health workers in their daily working. More emphasis must be put on investigating methods and strategies to reduce NSSIs. Safety devices must be used more by HCWs to reduce NSSIs along with planning educational and training programs with close monitoring to practices.

1. Introduction

Waqaret al.,(2011) defined needle stick injuries as: “introduction into the body of health care providers during the routine performance of their duties, of blood or other potentially hazardous material by a hollow bore needle or sharp instruments e.g. needles, lancets and contaminated broken glass”. According to Khushdilet al., (2013) needlestick and sharp injuries were considered as the single greatest serious occupational hazards

threatening healthcare workers.

Needlestick and sharp injuries are very common to happen among healthcare providers, and it puts them under the risk of obtaining blood-borne pathogens like HIV, Hepatitis B Virus (HBV), or Hepatitis C Virus (HCV), which are serious threats to their well being or even to their lives. Epidemiological data on needlestick and sharp injuries, including factors associated with occupational transmission of blood-borne pathogens, are essential for targeting, implementing, and evaluating interventions at the local and national levels. More than 80% of needlestick injuries are avoidable with the use of correct precautions measures (Zaidiet al., 2010). There are numerous serious pathogens that can be transmitted by needlestick and sharp injuries, according to Kebede et al., (2012) there are more than 30 known dangerous blood-borne pathogens that can be transmitted to healthcare workers through the incidence of a needlestick injury.

Hospitals are dynamic places where a lot of processes are continuously going on non-stop at all levels of structure, processes, and outcomes (Elverson & Samra., 2012). According to Cho et al., (2012) there are some factors that increase the risk of needlestick injuries inside hospitals, factors like re-capping needles after use, ignoring the use of needle-disposing containers, job stress, lack of experience, and emotional distress, but according to Zafar et al., (2009) the most common reasons for needlestick injuries are recapping and the unsafe collection and disposal of sharp wastes. Thus, it is of high importance to explore what has been done to understand and prevent this problem. Hospitals can monitor NSIs by using appropriate surveillance methods, like for example EPINet; which is a software tool that was developed in 1992 by the International Healthcare Worker Safety Center at the University of Virginia (Jagger et al., 1999). EPINet is widely used in the United States and some other countries like Japan to monitor NSSIs for the purpose of developing strategies to minimize it. The aim of this paper is to systemically review the scientifically published evidence that assesses the incidence, risk factors, complications, and prevention of needlestick and sharp injuries among healthcare workers inside hospitals.

2. Materials and Methods

The electronic databases searched were ScienceDirect, Scopus, and EBSCO. A comprehensive strategy was used in order to include all possible articles that fit the criteria of this systematic review. Search terms included “needlestick injury”, “NSI”, “sharp injury”, or “NSSI” in title, abstract, or key words.

Studies were included if they were scientific articles published between 2011-2013 with full text provided, written in English language, and followed appropriate arms of Randomized Controlled Trials (RCT) design, cross-sectional design, or retrospective design for data collection. Studies must be conducted inside hospitals on the population of healthcare workers who provide direct care to the patients. In addition, studies were included if they assess any of the following: needlestick or sharp injury prevalence, risk factors, complications, predictors, or interventions to reduce needlestick injuries. Studies were excluded if they took place in nursing schools, medicine schools, primary health centers, home care, or any place outside hospitals. Studies were excluded too if the population was not practicing inside hospitals, like undergraduate students. Table 1 provides the articles that were eligible and included in this systematic review were the study design, population, and variables of each article.

3. Results

In total, 35 published articles were identified and extracted through the included databases in this review after the removal of duplicates, these 35 articles were screened based on the inclusion and exclusion criteria, 18 articles were found eligible to be included while 17 articles were excluded. Of the included 18 articles 10 were cross-sectional, 7 retrospective, and only 1 intervention study but without randomization. Table 1 also provides the results of all articles included in this systematic review.

Table 1. *Included studies investigating NSSIs, population, and variables.*

Authors	Study design	Study population	Exposure measures and variables	Results
Lee et al., (2014)	Retrospective study	All reported NSIs between 2009-2011 was reviewed in the Department of Dentistry at the National Taiwan University Hospital. HCW included 79 dentists (39 attending doctors and 40 residents), 85 dental students (45 interns and 40 clerks), and 64 members of nursing staff.	Age, sex, profession group, NSI prevalence, the use of gloves, injury type, injury site, injury degree, injury date and time, location of the accident, procedure and instrument involved in the accident, and the cause of accident.	In the three years period, 56 incidents of needlestick and sharp injuries from contaminated sources were reported by the Department of Dentistry at the National Taiwan University Hospital. 31 of these injuries occurred during surgical procedures while the other 25 injuries occurred during cleaning up. 54 injuries occurred to hands. Interns were the most occupational group acquiring NSIs followed by nurses. Analysis showed high incidence of NSI from July to September due to a significantly higher occurrence of NSI among interns in this period (P=0.027 by Chi-square analysis). Injection needles were responsible for 19 injuries out of 40 cases where the instruments where penetrating in nature.

Authors	Study design	Study population	Exposure measures and variables	Results
Memish et al., (2013)	Retrospective study involving all reported cases.	Healthcare workers inside a tertiary hospital in Saudi Arabia	Distribution of NSIs by location, job category, type of activity, type of needle, affected body part, and use of gloves.	31.1% of NSIs occurred in patient room/ward, followed by 17% in emergency department and 14.7% in intensive care units. Most of the incidences were caused by syringes with disposable needles (64.1%). Nurses were found to be the most frequent occupational category suffered from NSIs by 64% of all categories of healthcare workers, followed by consultants/registrars of all grades with 5.5% only. Almost half of the NSIs (46.4%) occurred during the use of item, followed by 7.4% occurred while recapping a used needle. 95.5% of NSI occurred in the hands.
Cho et al., (2013)	Cross-sectional study	Data were collected from 3079 staff nurses working in 60 different hospitals in South Korea. Nurses were chosen using a stratified random sampling based on number of beds and region.	NSI prevalence, risk factors, protective equipment, nursing characteristics, and hospital characteristics.	51.9% of the registered nurses participated in the study had a diploma in nursing as their highest level of education while only 3.9% had masters degree. Cho found that 70.4% of nurses had suffered at least one NSI during the past year of the study. NSIs were significantly associated with a number of risk factors, which are: NSIs decreased as the years of experience increased (OR = 0.990, CI = 0.988–0.991). Emotional exhaustion was found positively associated with NSIs (OR = 1.486, CI = 1.195–1.850). Regarding work environment, the NSIs decreased by increasing the adequacy of staffing and resources (OR = 0.794, CI = 0.671–0.940). Safety containers for sharps disposal significantly decreased the risk of NSI (OR = 0.727, CI = 0.580–0.913). Nurses working in perioperative units were found to have greater risk of having a NSI (OR = 1.555, CI = 1.193–2.026). Approximately 92% agreed that it is important to report all body fluid exposure, but only 58% actually reported any incident they had.
Winchester et al., (2012)	Cross-sectional study	120 healthcare worker inside a dental institute inside King's college hospital completed anonymous questionnaire.	HCWs perceptions of blood-borne pathogens, knowledge of blood-born pathogens, reporting attitudes and perceptions, and experience.	About 86% of participants reported that they worry of getting a BBV at work and develop infection, the majority of them (69%) feared HCV the most ($P < 0.001$). 75% of participants with more than 21 years of experience knew the risks of HIV transmission vs. 13% only of participants with less than 5 years of experience ($P = 0.002$). all participants with 21 years of experience or more knew of HIV PEPVs. 20% only of participants with experience less than 21 years.
Martins et al., (2012)	Cross-sectional study	363 healthcare professionals participated in this study in Portugal. Logistic regression was used to identify risk factors associated with needlestick and sharp injuries.	The relationship between NSIs and age, gender, job category, years of experience, device involved in the accident, procedures involved in the accident.	65% of health workers reported having at least on NSI in the past five years of the study, 71% of those who have had a NSI reported having it more than once. 61% reported their injuries to the responsible departments. Syringe needles were the most common devices causing the injuries (45.8%) followed by when breaking ampoules (22.2%). Martines et al., (2012) reported that recapping was a major problem causing NSIs contributing to 26.1% of all injuries. 4.3% of injuries were inflicted by another HCW. Univariate statistical analysis was conducted, four variables were found to be statistically significant risk factors of NSSIs: having 10 or more years of experience compared with less than 10 years (OR 3.37, 95% CI 1.82, 6.24). NSSIs were higher in HCWs over 39 years old when compared with workers under 39 (OR 1.94, 95% CI 1.03, 3.63). HCWs who tend to dispose needles and sharp objects in safety containers had less probability of having an injury (OR 0.18, 95% CI 0.08, 0.40). Surprisingly, HCWs

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				who reported not knowing how to proceed in case of a NSSI had a lower risk of acquiring an injury (OR 0.33, 95% CI 0.16, 0.67).
Kebede et al., (2012)	Cross-sectional study	344 HCW selected using simple random sampling techniques in a governmental hospital, Ethiopia. Data was collected based on interviews using structured questionnaire.	NSIs prevalence, risk factors knowledge of diseases transmitted via NSSIs, devices causing NSSIs, activities causing NSSIs, reporting attitude.	30.8% of respondents reported at least NSSI in the past 12 months of the study. The majority of these injuries (44.3%) were reported by nurses, followed by housekeepers (only 12.3%). The most common pieces of equipment involved in NSSIs were syringe needles (47.2%), followed by intravenous cannula (12.3%). The majority of NSSIs occurred during injection of needles (23.6%), followed by assembling sharps after use (12%) and recapping (11.3%). Kebede et al., (2012) measured time of occurrence by days and shifts, he found that Monday was the most frequent day for NSSIs to occur (40.6%), especially on morning shifts (46%). Kebede et al., (2012) reported that 60% only of HCW who suffered a NSSI have reported it. Healthcare workers with >10 years of experience were more than two times more likely to acquire a NSSI in the previous 12 months of the study compared to those with less experience (<5 years) (OR = 2.24, 95% CI: 1.13, 4.43). Healthcare workers who never received any training on occupational health safety were 4.89 times more likely to report a NSSI compared to those who received such training (OR: 4.89, 95% CI: 2.21, 10.84). Healthcare workers who worked more than 48 hour per week reported more NSSIs than those who had worked ≤ 48 hour per week (OR: 3.44, 95% CI: 1.76, 6.74). Finally, healthcare workers who are not satisfied with their work environment reported NSSIs 3.76 times more than with the satisfied ones (OR = 3.76, 95% CI: 2.12, 6.69).
Mohammad (2014)	Retrospective review study	All reported incidences of percutaneous injuries among resident physicians to the employee occupational health clinic (EOHC) were investigated between January 2000 and January 2008.	NSSIs predictors; devices causing NSSIs, location of the accident.	A total of 378 percutaneous injuries were reported, of which 285 were needlestick injuries and 93 were sharp injuries. 49% of the percutaneous injuries were reported by residents in general surgery and surgical specialties, and 45%of injuries caused by hollow-bore needles, followed by suture needles with 30%. Mohammad (2014) found that 45% of percutaneous injuries were reported by resident physicians in their first year of postgraduate training.
Mehrdad et al., (2014)	Cross-sectional study	The study took place in a public hospital in Iran among nurses. 339 nurses completed a questionnaire; the nurses were selected using simple random sampling from the list of all nurses.	Demographics of nurses, the nurses' exposure history to blood-borne pathogens at work, including NSSIs, and psychosocial factors at work.	The results showed that more than half of the nurses (58%) have had at least one NSSI in the previous year, and more than half of those injured (52%) did not report it. Univariate statistical analysis showed no significant differences between exposure group and non-exposure group in terms of age, gender, education and marital status. No association found between history of training and the exposure to blood-born pathogens. Mehrdad et al., (2014) reported that longer duration of employment as a nurse was associated with a lower risk of exposure (P = 0.02), and permanent nurses have lower risk for exposure than temporary nurses (P = 0.04), and groups with higher levels of stress have higher risk for exposure (P = 0.01).
Yoshikawa et al., (2013)	Retrospective study	Data was collected between April 2009 and March 2012 from 67 referral hospitals for HIV/AIDS in	NSI prevalence, demographic characteristics of the injured health worker, place, device,	Included hospitals were asked to report their bed numbers and the mean annual bed occupation rate in order to calculate the actual number of occupied

Authors	Study design	Study population	Exposure measures and variables	Results
		Japan that are using EPINet-Japan. The prevalence of NSI was calculated based on annual incidences per 100 occupied beds.	time of incidence, and the patients' infectious status.	beds. The number of needlestick injury per year was divided by the corresponding number of occupied beds at each hospital, and the mean needlestick injury incidence rate per 100 occupied beds and 95% confidence interval (CI) were calculated. The included hospitals were then categorized into three different groups according to the number of occupied beds: hospitals with 399 or fewer beds, hospitals with 400–799 beds, and hospitals with 800 or more beds. The number of NSI reported between April 2009 and March 2012 was 5463 cases in which the majority of them were between 20-29 years old. 51% of the injured workers were nurses (3.2 [3.0–3.5]). The mean annual needlestick injury incidence rate per 100 occupied beds with 95% CI was 6.2 (5.7–6.7) which is lower than corresponding rates USA, Taiwan, and South Korea. Most of the NSIs took place inside patient rooms in the wards (2.0 [1.8–2.2]) followed by operating rooms (1.7 [1.5–1.9]). The NSI incidences tend to increase as the hospital size increased among injured workers less than 40 years old ($P < 0.001$), but for workers above 40 years old this trend was not significant to suggest a relative increase in NSI incidence rate in larger hospitals.
Hoffmann et al., (2013)	Interventi on study	The study took place in the University Hospital Heidelberg in Germany, which is a tertiary hospital with 2000 bed capacity. In 2007, serological data was extracted for from the laboratory information system and data on NSSIs from the mandatory NSI report forms, all medical disciplines were investigated. In 2008, safety devices were introduced to the HCWs, and the investigations continued to measure the differences before and after using chi-square statistics.	Frequency of NSSIs, devices, and the introduction of safety devices. Outcome: the effectiveness of safety devices on reducing NSIs.	448 NSSIs were reported in 2007 before any interventions were introduced. In 2009, after one year of the introduction of the safety devices, a 21.9% decline of NSIs was measured. The annual rate of NSSIs in 2007 was 69.0 per 1000 full-time HCW, but in 2009 it dropped to an annual rate of 52.4 per 1 000 full-time HCW. In 2007 nurses were the occupational group with the highest risk of having NSSIs (36.2%), followed by medical doctors (33.7%), and it remained the same even after the introduction of the safety devices although a significant decrease happened in the NSSIs incidences. After the introduction of safety devices, a clear decrease in the number of NSSIs was detected for stapling systems used for wound sealing, hypodermic needles, peripheral venous catheter, and blood withdrawal.
Irmak et al., (2012)	Cross-sectional study	The study included 143 nurses working in a state hospital in Turkey. Only nurses providing direct care to the patients were included. The study excluded nurse managers, nurses on leave due to health reasons, nurses on annual leave and those participating in any committees.	Prevalence of needle stick and sharps injuries among nurses, risk factors, Socio-demographic factors (age, gender, marital and education status, & total years in profession), length of time working at current clinic, work hours, immunization against Hepatitis B, and the use of gloves.	The study showed that 30% of nurses have had at least one needle stick injury within the past year of the survey, which is considered lower than other similar studies took place in different countries. The study found no significant association between needle stick injury and any socio-demographic variable. The study found that the most common causes for NSIs were syringe needles and suture needles. 16% of nurses were not using gloves when injured and recapping was reported to be the most frequent cause of NSIs. The most frequent cause of NSIs was Intravenous/intramuscular injections (55.8%) followed by suturing (30.2%) and recapping (9.3%). 65.1% of NSIs were caused by Syringe needles, 18.6% by suture needles, and 11.6% by lancet. Unlike the results of other studies, most of the NSIs (55%) happened in medical wards and not in the surgical wards. About 40% of nurses who suffered from a NSI admitted not reporting it because they were too busy or the item was not contaminated.

Authors	Study design	Study population	Exposure measures and variables	Results
Kable et al., (2011)	Cross-sectional study	The study population was the practicing nurses who were members of the New South Wales Nurses' Association (NSWNA). The nurses were randomly selected from the membership databases. 7423 nurses were eligible and invited to participate, only 1373 nurses replied and participated. Data was collected using a questionnaire and Pearson's chi-square test was used for comparison.	NSSI prevalence, risk management, nurses' perceptions of work place risk, and NSI reporting	A total of 71 nurses reported the occurrence of NSSIs, and these nurses reported three main reasons to report the incident, which are: 1. To identify and register the hazard (66%). 2. To assess the injury (58%). 3. Fear of acquiring HIV, HBV, or HCV (54%). After having a NSSI, tow-thirds of the nurses had the perception that they were not under any risk of acquiring a blood-borne disease, and three-quarters of them reported that they were provided with adequate information, support, and follow up after the injury.
Fourie and Keogh (2011)	Cross-sectional study	The sample of this study was taken from all practice nurses in Auckland-New Zealand registered on the database of the New Zealand College of Practice Nurses. 749 questionnaires were distributed, and 258 of them were completed (34.7%). Content analysis was performed on the open-ended questions and all the answers were categorized under similar themes. Descriptive statistics was performed on quantitative data.	Demographic data, continuous education programs, own experience with NSI, reporting or non-reporting of NSI, and the management aspects following a NSI	They found that 93.8% of the registered nurses knew how to report NSIs when they occur, while 92.2% reported they have the knowledge and ability to manage NSIs if happen in practice. Regarding the barriers of reporting NSIs, 24% identified inexperience as the number one barrier to report injuries, and 19.8% identified inadequate communication as the second barrier ($P < 0.05$). The researchers reported that 98.8% of the nurses used sharp containers as the system of handling sharps and needles, while only 10% reported using needle free systems. 12.8 % of nurses who reported having a NSI did not undergo blood tests for HIV, Hepatitis, or any other blood-borne diseases; this maybe referred to them for not reporting the injury. 60% of the nurses perceived the risk of NSI as minimal, only 9.3% perceived the risk as significant. 31.8% of the injuries occurred while administering injections and 20.2% occurred while recapping needles.
Azadi et al., (2011)	Cross-sectional study	The study was undertaken in five major teaching hospitals in Tehran/ Iran during 2007–2008 amongst 111 working registered nurses who were randomly selected using randomized allocation sampling method. A self-reporting questionnaire was distributed to participating nurses. Statistical analysis was performed using SPSS, and Chi-square and Fisher Exact tests were used for all the analyses.	NSSI prevalence, reporting barriers, and demographic characteristics including sex, age, characteristics, clinical job experiences, shifting status (day, night or rotation), and HBV vaccination.	45.9% of the nurses have had at least one NSI during their working experience, and 34% of the nurses have had at least one NSI in the past 12 months of the study. The results of the study showed that the main reasons for not reporting NSIs were dissatisfaction with follow-up investigations by officials after reporting the injury (33,3%), considering the source patients safe or low risk (29,2%), and not being familiar with NSI reporting process (16,7%). Azadi et al., (2011) reported that 68% of the nurses who encountered a NSI in the past year had had experience less than five years. There was a significant difference between experience and NSIs ($P = 0,02$). Overall, 37,3% of nurses ($n = 42$) aged between 25–30 years, and 46,8% of NSIs had occurred in this group. Regarding procedures and activities that caused NSIs, 31.4% of the injuries occurred while recapping, followed by 25.5% occurred during intravenous line administration, and 13.7% occurred during blood collection.
O'Sullivan et al., (2011)	Cross-sectional study	The study was conducted among Irish intern doctors. A self-reporting questionnaire was distributed among intern doctors at two Dublin-based teaching hospitals. The number of inters who completed the questionnaire was 31. The interns were not	NSSI prevalence, reporting NSIs, standards precautions compliance, and factors to reduce NSIs.	26% of the interns had sustained a NSI within the first 8 months of commencing their internship. Only 26% interns reported that they always wear gloves while performing intravenous cannulation, but this percentage rose to 94% if the patient was considered high risk. For the interns, the main reason for not wearing gloves while routine phlebotomy or

Authors	Study design	Study population	Exposure measures and variables	Results
		selected randomly, but selected at interns teaching sessions.		cannulation is that it makes it harder to palpate the vein of the patient. Only 35% of the interns felt that they had received adequate training and education regarding phlebotomy and cannulation prior to commencing internship, which is considered low. The interns offered potential factors to prevent NSIs, which are avoidance of unfamiliar equipment, the use of a safety needle, and getting adequate hours of sleep, and 75% reported the NSI.
Patrician et al., (2011)	Retrospective study	Data were collected every 3 months between 2003 and 2006 for military staff nurses in the USA. Data was collected from 57 units in 13 different military hospitals. A total of 108,000 shifts from 54 units had useable and valid data for this study; the number of nurses worked in the study units was 4,553. Data were collected using self-reporting questionnaire. The probability of needle stick injury was modeled using hierarchical logistic regression to facilitate the analysis of multi-level outcome variations. The possibility of underreporting is a limitation in this study.	Staffing level was measured using 3 measures: skill mix, category mix, and total nursing care hours per patient per shift	The findings showed clearly that staffing and experience are associated with needle stick injuries. Overall rate of 0.07% of nursing staff experienced needle stick injuries every 3 months based on the data retrieved from occupational health clinic or the management office, this very low NSI prevalence rate is attributed to under-reporting, and 79% of needle stick injuries were contaminated with patients' blood.
Voide et al., (2012)	Retrospective study	The study took place in the University Hospital of Lausanne, Switzerland; a teaching hospital with 10000 employees. All workers providing direct care to the patients received a copy of 20-item questionnaire. All doctors and nurses received the questionnaire by email (n = 1,985); the other employees received a paper copy by post (n = 4,382).	Age, sex, occupation, years spent in occupation, history of NSSI during the preceding twelve months, NSSI reporting, barriers to reporting and knowledge of reporting procedures.	2,691 employees completed the questionnaire properly out of 6,367 who received it (response rate is 43.3%). Only 9.7% reported having a NSSI in the past 12 months of the study. Among all healthcare workers, the highest rate was observed in nurses (49.2%) followed by doctors routinely performing IPs (36.9%). About 73.1% of injured healthcare workers had reported all NSSIs to the responsible department, which is occupational health service. Multivariate analysis revealed a significant difference in underreporting between nurses and doctors (67.1% underreporting in doctors versus 30% in nurses, OR 3.29, CI (95%) 1.59–6.79, P = 0.001). Underreporting was significantly higher among healthcare workers who had experience for 10 years or more (57.1% versus 42.9%, OR 0.35, CI (95%), P = 0.014). Two reasons for not reporting NSSIs were obtained: considering blood as low risk (87%) followed by not having time to report (34.3%).
Wang et al., (2014)	Retrospective study	This study used data from 2004 to 2010 provided by The National Health Insurance Research Database (NHIRD). NHIRD provides data containing information on the sex, birth date of patients, classification code of diagnosed diseases, health services received by patients, and clinic or hospital code. The study population consisted of 4443 nurse healthcare workers (NHCWs), 1466 physicians, 459 medical technologists, and 1213 other healthcare workers, such as radiologists and pharmacists, who	Annual visits for ambulatory care after NSIs & cumulative incidence rate of NSI.	The subjects were grouped into two cohorts: 4443 nurses healthcare workers (NHCWs) and 3138 non-nurses healthcare workers (NNHCWs). The results showed that the annual visits for ambulatory care after NSIs was significantly higher for the NHCWs than NNHCWs in the period between 2004 (0.7) and 2010 (1.9) (all P < 0.05). The results showed also that cumulative incidence rate of ambulatory care visits after needlestick injuries was higher in NHCWs than in NNHCWs after adjustment for sex (OR = 3.23; 95% CI = 1.23-8.45, P< 0.030 for males and OR = 3.92; 95% CI = 2.70-5.69, P < 0.0005 for females). Similar results obtained after adjusting for age (OR, 2.74; 95% CI = 1.99-3.77, P< 0.000 for _30 years old and OR = 2.14; 95% CI = 1.49-3.07, P< 0.0005 for _31 years old) and for the

Authors	Study design	Study population	Exposure measures and variables	Results
		reportedly suffered from occupational NSIs. The cumulative and annual incidence of ambulatory care visits after NSSIs, odds ratios (ORs) and 95% confidence intervals (CIs) were calculated.		type of affiliation (OR = 1.89; 95% CI = 1.21-2.94, P< 0.006 for medical centers and OR = 3.33; 95% CI = 2.51-4.41, P< 0.0005 for nonmedical centers).

4. Discussion

This systematic review comprehended and presented 18 studies that explored NSSIs, their prevalence and its association with risk factors, predictors, and interventions to reduce it among HCWs who provide direct care to the patients inside hospitals. One possible limitation of this systematic review is the presence of possible bias based on the strategy of research.

Based on this systematic review, it does not seem there is a definite agreement in the literature on the definition of some variables associated with NSSIs, like risk factors. Different studies examined risk factors of NSSIs but different exposures were actually measured, so the meaning of (risk factors) differs from researcher to another. Cho et al., (2013) measured risk factors based on experience, emotional exhaustion, work environment, the use of safety containers, and work place. While Martins et al., (2012) measured risk factors as age, years in practice, total of years in the actual service, removing syringe needles after use, disposing needles in a container, self-assessment overrating of biosafety knowledge training in biosafety, knowing how to act in case of NSSIs and accidental exposure to body fluids. Kebede et al., (2012) considered the following factors representing NSSIs risk factors: experience, occupational health safety training, workload, risk perception, work environment, and work culture satisfaction. Irmak et al., (2012) had other thoughts of what risk factors are, he measured risk factors by age, marital status, educational status, total years in profession, working hours, use of gloves, and immunization against HBV. Similar goes for time of injury, some researchers measure by shifts (morning, evening, night), some measured by which day of the week, or which month of the year.

Different studies showed wide variations in the NSI prevalence among HCWs. Table 2 summarize the reported NSSI prevalence in this systematic review.

Table 2.*Summary of NSSI prevalence reported by reviewed studies.*

Study	NSSI prevalence	Occupational group	Place	Duration
Kebede et al., (2012)	30.8%	HCWs	Ethiopia	1 year
Martins et al., (2012)	65%	HCWs	Portugal	5 years
Voideet al., (2012)	9.7%	HCWs	Switzerland	1 year
Mehrdadet al., (2014)	58%	Nurses	Iran	1 year
Azadiet al., (2011)	49%	Nurses	Iran	All working experience
Azadiet al,. (2011)	34%	Nurses	Iran	1 year
O'Sullivanet al., (2011)	26%	Intern doctors	Ireland	8 months

These variations in the NSSI prevalence in different places can be explained by different numbers of HCWs in different hospitals, different work cultures, different work environments, variations of availability of resources, variations in methods of measurements and study designs.

Different strategies of variables measurements can provide information that can be easily interpreted in a wrong way, like in some studies; they found that intensive care units have higher rates of NSSIs as compared to medical wards and surgical ward [(Mernish et al., (2013) and Mohamma et al., (2014)]. But Memish et al., (2013) found that medical/surgical wards were the places with the most frequency of NSIs, but unlike most of other studies she did not separate medical wards from surgical wards, which could have given different results.

Nurses were found to be the most occupational health group to have NSSIs [Memish et al., (2013), Kebede et al., (2012), Yoshikawa et al., (2013), Hoffmann et al., (2013) and Voide et al., (2012)].This can be explained by the facts that the nurses administer most of the injections and intravenous fluid administration, basically nurses are the most healthcare group dealing with injections and sharp objects, plus the numbers of nurses are usually higher than any other occupational group inside hospitals, not forgetting that shortage of nurses inside hospitals is also an issue.

Martins et al., (2012) reported a very interesting finding, which is some of the NSIs were actually caused by a HCW colleague; she reported that 4.3% of her sample reported their injury inflicted by another healthcare worker. Martins were the only researcher brought this finding into the surface. Mehrdad et al. (2014) reported another interesting finding, that he did not find any statistical significant association between history of training on NSSI prevention and the exposure to blood-borne pathogens. This finding contradicts with the findings and recommendations of other studies, and it can be explained by the presence of response bias where people tend to present themselves in a favorable way.

Kebede et al., (2012) reported three major reasons for the NSSIs problem, which are absence of safety instructions and work guidelines at work, the respondents had never received

any occupational health and safety training, and written protocols on how to report NSSIs had never been provided (only 60% reported). He suggested that management should address issues like long working hours and the availability of safety devices.

Kable et al., (2011) investigated what happens after the NSSIwhichis lacking in the literature. He investigated if the health workers had a good follow up after the incidence. It seems that most of the researchers ignore this aspect and go only for investigations regarding how the injury happened, where, and when, but they usually do not go as far as what happens after that, if the health workers receive a good medical treatment; follow up, support, and proper information.

Yoshikawa et al., (2013) reported lower mean NSI incidences in Japan than few other countries like USA and South Korea. The methodology Yoshikawa used to calculate the mean NSI incidences based on annual incidences per 100 occupied beds allowed him to make accurate comparisons with the corresponding data from other countries. This enabled him to understand better why the mean NSI incidences was lower in Japan, and he explained it by the fact that fewer needles and sharp are handled per unit bed, because the mean hospital stay of patients is longer in Japan. Yoshikawa stated that the mean hospital stay of patients in 2009 was 18.8 days in Japan, which is much longer than 4.9 days in the USA, thus, the total number of devices used per bed on a daily basis in Japan may also be lower, and this could have possibly reduced the overall needlestick injury incidence rates per hospital bed. This conclusion could not be reached if it was not for the methodology Yoshikawa followed to investigate NSIs on a national level.

The importance of engineered safety devices in reducing NSIs is very clear and explicit in the literature. Hoffmann et al. (2013) stated that the best way to reduce NSSIs and protect against its risks is to use safety devices. The intervention of safety devices use has proven better effect than traditional educational workshops to healthcare providers, not ignoring that education is an effective tool as well in reducing NSSIs, just not as much as safety devices. Fourie and Keogh (2011) referred to a very important point that is the use of engineered devices is still low, although literature indicated its high effectiveness in reducing NSIs. Adams (2012) demonstrated that the use of engineering controls is more effective in reducing NSSIs than developing policies, consistent training, and the use of personal protective equipment. The little use of engineering devices can be referred to its higher costs than regular devices and any other intervention, hospitals may not be able to afford it or it is not a priority to top management in the hospitals.

No randomized control trials (RCT) trying to reduce NSSIs were found based on this systematic review, meaning that most of the studies were cross-sectional or retrospective designs. The scarcity of RCT designs results in less reliable scientific evidence based on present scientific studies, thus more emphasis must be put on investing more in randomized controlled trials.

A lot of the studies investigated reporting attitudes among healthcare workers, but mostly they investigate percentages of reporting, the percentages of under-reporting, why the health workers do not report, and if the health worker perceives reporting as a positive tribute. But it is very rare to investigate the reasons on why the health workers take the action of reporting, although it is very important to understand the underlying perceived benefits of reporting from the health workers point of view because it can relate into some theories like Health Belief Model (HBM). Kable et al., (2011) was one of the few researchers who investigated why nurses report NSSIs, and he found three main reasons for that, which are to identify and register the hazard, to assess the injury, and fear of acquiring a blood-born pathogen like HIV, HBV, or HCV. Voide et al., (2012) reported that the main reason for under-reporting was “perceiving blood as low risk” which confirms the importance of understanding and applying available theories in the subject of NSSIs. An interesting findings regarding underreporting issue presented by Voide et al., (2012) that doctors significantly reported less NSSIs than nurses, and workers with experience more than 10 years significantly reported less NSSIs than workers with experience less than 10 years. Voideet al., (2012) suggested an interesting explanation for the underreporting problem, which is a phenomenon called desensitization: “the more a healthcare worker is exposed to NSSI-prone activities and the more NSSIs are sustained, the more relaxed the healthcare worker becomes with respect to reporting”. O’Sullivan (2011) reported in his study in two teaching hospitals among Irish intern doctors that only 26% interns reported wearing gloves while performing intravenous cannulation, but this percentage rose to 94% if the patient was considered high risk. This emphasis the importance of taking perceived benefits and threats into consideration when planning to reduce NSSIs among HCWs, as it is suggested in some theories like the Health Belief Model. When the interns perceived higher risk of acquiring a disease, and potential benefit of wearing gloves, they complied more with the standard precautions.

5. Conclusion and Recommendation

More emphasis must be put on investigating methods and strategies to reduce NSSIs rather than just describe the problem. Future research must build up on the previous research and try to solve the problem; more RCTs with appropriate arms are required to be implemented. The use of safety devices must be more common among HCWs, and educational programs with close monitoring for practices to reduce the NSIs must be planned and implemented. Hospitals can reduce NSIs by establishing better work environment in terms of staff numbers and resources adequacy, retaining the more experienced nurses, and minimize emotional exhaustion at work, in addition to provide safety-engineered devices and equipment. HCWs must receive periodic training on proper and safe work procedures to avoid injuries.

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