

# Safety and Health Management System, Safety Climate, and Accident Occurrences in Hospitals: The Study of Needlestick, Sharp Injuries and Recidivism Rates

## Abstract

**Background:** Hospital Safety and Health Management System (HSH-MS) and Hospital Safety Climate (HSC) are the significant elements to develop safe work practices. The current study aimed to examine the dimensions of HSH-MS and HSC and the association with the prevalence of Needlestick and Sharp Injury (NSI) and NSI recidivism. **Materials and Methods:** A cross-sectional study was conducted among 1070 nurses in Iranian hospitals (89% response rate). **Results:** More than 54% ( $n = 579$ ) had sustained at least 1 NSI in the previous year. The NSI recidivism rate was 8.6% and recidivists were more likely to be younger, female, married, with higher Body Mass Index (BMI), and on night shift. Two aspects of HSH-MS including management leadership and employee participation were associated with the incidence of NSIs Odds Ratio (OR): 1.91 and 95% Confidence Interval (CI): 0.69–1.21; OR: 1.29 and 95% CI: 0.92–1.82) and NSI recidivism rate (OR: 1.98 and 95% CI: 0.55–1.74; OR: 1.12 and 95% CI: 0.83–1.49). Furthermore, three dimensions of HSC comprising management support (OR: 1.02 and 95% CI: 0.93–1.11 for NSIs; OR: 1.21 and 95% CI: 0.77–1.22 for NSI recidivism), absence of job hindrances (OR: 1.06 and 95% CI: 0.98–1.16 for NSIs; OR: 1.11 and 95% CI: 0.96–1.30 for NSI recidivism) and cleanliness/orderliness (OR: 1.07 and 95% CI: 0.98–1.08 for NSIs; OR: 0.84 and 95% CI: 0.87–0.97 for NSI recidivism) were correlated with reduced NSIs risk. **Conclusions:** This study suggests that HSH-MSs and employees' safety climate are significant factors, which are correlated with not only the prevalence of recurrent NSIs but also the single NSI in hospitals.

**Keywords:** Hospital safety climate, hospital safety and health management system, needlestick and sharp injuries, recidivism rate

## Introduction

Needlestick and Sharp Injuries (NSIs), as preventable common occupational accidents, expose health care workers, especially nurses and physicians, to different blood-borne pathogens including Human Immunodeficiency Virus (HIV) and Hepatitis B and C. Accidental exposure of health care professionals to blood-borne infections due to NSIs often occurs by pricking needles into the hands of professionals, sharp injuries via blood-contaminated apparatus, or splashing of infected blood/body fluids onto the mucosa.<sup>[1]</sup> The World Health Organization (WHO) reported that 37.6% of Hepatitis B, 39% of Hepatitis C, and 4.4% of HIV/AIDS in health care workers around the world are due to needlestick

injuries.<sup>[2]</sup> Needlestick and sharp injury also cause approximately 66,000 HBV infections, 16,000 HCV infections, and 200–5000 HIV infections among health care workers annually.<sup>[3]</sup> More than 20 other infections can be transmitted through needle sticks, including syphilis, malaria, and herpes.<sup>[4]</sup> In addition to the adverse consequences of infectious diseases, NSIs impose the costs associated with laboratory tests, required treatment as well as post-exposure prophylaxis along with the economic loss of hospitals brought on by absences from work.<sup>[5]</sup>

Because of the lack of sSafety-Engineered Devices (SEDs), organizational factors, and behavioral factors,<sup>[6]</sup> many injured nurses remain at risk of repeated NSIs. Repeated

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injury or injury recidivism, defined as the incidence of new and recurrent injuries requiring injured people evaluation and treatment. Injury recidivism accounts for thousands of high-risk trauma admissions annually all over the world.<sup>[7]</sup> Additionally, injury recidivism poses a significant burden on population health and health care settings.<sup>[8]</sup> There is no research on the prevalence and factors associated with needlestick and sharp injury recidivism and potential targets for intervention are not well understood all over the world. Therefore, identifying those at risk of NSIs and NS recidivism can highlight targeted populations for prevention to improve health and safety as well as reduce expenditures.

To prevent the occurrence of NSIs among nurses, we need to focus on organizational characteristics, protective equipment, and nurse characteristics.<sup>[6]</sup> Hospitals and health care centers can prevent or reduce such injuries by using SEDs. The studies showed that the use of SEDs was associated with a significantly lower NSIs rate and was probably the most important preventive factor.<sup>[9,10]</sup> Additionally, Tosini *et al.*<sup>[11]</sup> reported that among SEDs including automatic, semiautomatic, and manually activated safety in health care settings, passive (fully automatic) devices are most effective for NSIs prevention. On the contrary, a recent study claimed that the application of SEDs has not led to a reduction in NSIs. It was reported that the most common causes reported for NSIs were unsafe disposal of the needles and problems with the safety feature.<sup>[12]</sup> So, whether different models of the SEDs are used or not, hospitals must implement the key activities of an effective safety and health management system and take some preventive measures to improve the safety climate and consequently, to increase safety behaviors among nurses. Health policymakers and hospital administrators should formulate strategies to improve the working conditions of health care workers, discourage excessive use of injections, and increase their adherence to universal precautions. Reducing the risk of NSIs through strengthened occupational health standards and safety management systems would finally decrease the burden of disease on society from infections with blood-borne pathogens.<sup>[13]</sup>

Safety climate refers to workers' safety perceptions of an organization's practices, policies, procedures, and routines.<sup>[14]</sup> Safety climate is defined as employee perceptions about the importance of safety depending on managerial behaviors that convey a commitment to safety and actively promote employee involvement in safety issues.<sup>[15]</sup> Some studies confirmed the importance of hospital safety climate on NSIs reduction rates and reporting behavior.<sup>[16-18]</sup> No doubt that the provision of safer devices remains critical in preventing injuries; however, ensuring effective health and safety measures including efficient training programs, raising the awareness of health care workers about occupational health hazards and safety issues,<sup>[19]</sup> and ultimately, positive safety climate<sup>[16]</sup> will also be essential to reduce unsafe behaviors and to prevent NSIs.

So, it is firstly the imperative role of hospital management to consider improving the safety climate via strengthening management commitments and developing practical safety and health management systems to prevent exposure to blood-borne pathogens.

While the relationship between hospital safety components (managerial and personal) and NSIs reduction rates is emphasized by policy and regulatory organizations, such as National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), and WHO, evidence of this relationship is limited in the literature. In particular, no evidence thus far has linked a supportive hospital safety and health management system (HSH-MS) with the prevalence of hazardous outcomes such as NSIs. This relationship could be significant given the increasing belief that the occurrence of NSIs is affected by the quality of HSH-MSs. In this population-based study, we surveyed the occurrence of NSIs and its relationship with the role of HSH-MSs and safety climate to reduce the NSIs rates in hospitals.

## Materials and Methods

A sample of 1220 nurses who were considered with the highest risk for blood and body fluid exposure were selected. These subjects worked in hospital departments considered at risk for blood and body fluid exposures (such as oncology, urology, pathology, surgical services, nephrology, infection unit, and obstetrics and gynecology). The questionnaires were distributed and 1085 were returned, giving a response rate of 89.0% roughly. Because of incomplete or missing responses, 15 questionnaires were then deleted, leaving a final group of 1070 for analysis. The survey packet consisted of a cover letter, consent form, and the questionnaire which was separated into 3 main parts; firstly, 10 questions including age, sex, weight, education, work schedule, etc., were used to obtain information on employees' demographic and work characteristics as a nurse. The second section assessed the prevalence of NSIs experienced in the previous 12-month period. And the third involved a translated, validated, and reliable Persian version of the Hospital Safety Climate Scale (HSCS).

First of all, the subjects were asked about the prevalence of NSIs and then the other characteristics comprising the number of NSIs, the prevalence time, the main cause, etc., were assessed. Also, the nurses were asked about five types of devices exposing them to blood and body fluid incidents, including needles, suture needles, blades, angiocath, knives, and other devices (such as exposure to sharp surfaces). The employees were asked to report the number of each type of exposure incident they had experienced in the previous year; at least one exposure would place them in the "exposed" group.

Secondly, the possible recorded evidence about the prevalence of NSIs was surveyed for both injured and

non-injured nurses. The documented forms and reports in the hospitals' infection control units for the 1070 nurses were followed for 1 year. The data were population-based and provided information on a broad range of work and personal factors, as well as injury occurrence. The injured population was divided into three categories: without NSIs or Non-Injured Nurses (NINs), with one reported NSI or Injured Nurses (INs), and those who were with two or more reported NSIs or Recidivists (RCs). An injury RC was defined as a nurse who reported the prevalence of two or more NSIs during the one-year study period. So, subjects without any NSIs and those who were involved in only one NSI during the year of the investigation were compared with recidivists who were involved in at least one additional NSIs.

Safety and health management systems in hospitals play a pivotal role in preventing occupational injuries, especially NSIs; therefore, this study was aimed to evaluate the key factors of HSH-MSs. For this reason, the managerial factors associated with HSC in literature were reviewed. The systematic identification, measurement, and control of Occupational Health and Safety (OHS) risks, as well as program evaluation, were reported as the HSH-MSs intervention by Yassi in 1998.<sup>[20]</sup>

Occupational Safety and Health Administration and the U.S. Department of Labor designed a questionnaire to assess the hospital's implementation of the key activities of a safety and health management system, which also use to assess injury and illness prevention program.<sup>[21]</sup> In this study, this tool containing 53 questions was translated and validated to use in Iranian hospitals. Based on the 6 sections provided in this questionnaire, we assessed management leadership (8 items) and employee participation (11 items). Because a strong safety climate is more likely to develop when open lines of communication are maintained such that safety information flows not only from management to employees but also from employees to management.<sup>[22]</sup>

Furthermore, as the response to unsafe behaviors is critical to the formation of a positive safety climate,<sup>[23]</sup> the hazard identification (10 items) and hazard prevention and control (8 items) were evaluated. Besides, based on the fact that education and training programs may include safety education to inspire personal precaution, using needle safety devices<sup>[24,25]</sup> and enforcement of legal regulations,<sup>[26]</sup> the fifth section, education and training (10 items), was assessed. Finally, a review of the safety and health management program was investigated in the program evaluation and improvement section contained six items. There are four options for each item; no action (no points awarded), indicates that the hospital has not taken the action; strongly disagree (one point awarded), indicates that the hospital has taken some action but has done so ineffectively or infrequently; agree (two points awarded), indicates that the hospital has taken the action and it has been effective some of the time; and strongly agree (three points awarded),

indicates that the hospital routinely takes the action described and does so effectively. The documented evidence of HSH-MSs was evaluated based on ISO 9111: 2018<sup>[27]</sup> and ISO 45001: 2018.<sup>[28]</sup> The three external auditors who collaborated in the study had the The International Register of Certificated Auditors (IRCA) certification and at least two years of internal/external ISO 45001:2018 or OHSAS 18001 auditory experiences officially. Finally, both the total points and every six subscale points of HSH-MSs were used.

A 20-item HSCS designed by Gershon *et al.*<sup>[29]</sup> was used. This scale was designed to measure hospital safety climate with respect to an institutional commitment to blood-borne pathogen risk management programs. This scale comprises of the six different dimensions which are<sup>[1]</sup> demonstrable management support for safety programs (four items),<sup>[2]</sup> the absence of hindrances to safe work practices (three items),<sup>[3]</sup> availability of personal protective and engineering control equipment (two items),<sup>[4]</sup> minimal conflict and good communication among staff members (three items),<sup>[5]</sup> frequent safety-related feedback/training by supervisors (five items), and<sup>[6]</sup> cleanliness and orderliness of the worksite (three items). Respondents answered validated and reliable Persian version of HSCS by using a 5-point Likert scale (strongly agree to strongly disagree).

All data were entered into a spreadsheet program and analyzed by statistical software. Multiple logistic regression analysis was also conducted to investigate correlations between NSIs, HSH-MSs, and the various dimensions of safety climate. Hospital Safety Climate Scale dimensions and the points of HSH-MSs (the total points and each six subscale) were used as the dependent variables, with the prevalence of NSI events and NSI recidivism as the independent variables. Independent variables were selected using backwards elimination with results expressed as odds ratios (OR) and 95% confidence intervals (95% CI). Probability (P) values below 0.05 were considered statistically significant throughout the analysis. A significance level was set at 0.05 and all of the tests were two-tailed. All procedures involving human subjects were approved by the Isfahan University of Medical Sciences and by the hospitals' committee on human subjects.

## Ethical considerations

All procedures involving human subjects were approved by the Isfahan University of Medical Sciences and by the hospitals' committee on human subjects. The permission was obtained from the Ethics Committee, Department of Research, Isfahan University of Medical Sciences, Iran.

## Results

The majority of nurses were married (71.0%) females (78.70%), with an average age of 33 years (range, 19–52). The majority of respondents were well educated (58.30% master's graduation and 37.50% bachelor's degree) and

employed as nurses. Additionally, 96.0% of nurses graduated in the field of nursing. The employees had Mean(SD) 8.50 (2.30) years of job tenure (range, 1–28 years). Regarding Hepatitis B vaccination status, 97.70% had received the complete schedule of 3 vaccinations. The complete demographic profile of respondents is presented in Table 1.

More than 54 percent ( $n = 579$ ) had sustained at least 1 NSIs in the previous 12 months [Table 2]. Interestingly, nurses claimed that 69.60% of all NSIs were reported to the hospital's infection control units. The most common causative devices were needles or vials, which injured 429 nurses and accounted for 74.10% of all NSIs. Angiocath was the second most common category, affecting 53 nurses and accounting for 9.10% of all NSIs. This was followed by other devices, 8.20% ( $n = 47$ ), suture needles, 4.30% ( $n = 25$ ), and blades, 4.30% ( $n = 25$ ). Regarding the hazardous operations, the most proportion of NSIs happened when nurses used the needles, 427 (73.60%) including transfusion: 178 (30.70%); during the venesection: 163 (28.20%); and Injection: 86 (14.70%). The other dangerous operations were contacted with other sharp devices, 101 (17.40%), during suturing, 30 (5.20%), transfusion, 9

(1.60%), during infectious waste disposal, 8 (1.40%), and displacement of contaminated clothing, 4 (0.70%). These results are shown in Table 2.

All nurses (100%) worked a three-shift rotating system. The documented evidence kept in the infection control units showed that the most number of NSIs 231(41.90%) occurred during the night shift (between 20.0 and 07.00) and the corresponding figures for the morning shift (between 07.00 and 14.00) and evening shift (from 14.00 to 20.00) were 170 (30.90%) and 150 (27.20%), respectively. Needlestick and Sharp Injuries recurrence accounted for 8.6% of the sample population, representing 92 nurses. Recidivists were more likely to be younger ( $p < 0.001$ ), female ( $p < 0.001$ ), married ( $p < 0.001$ ), with higher body mass index (BMI) ( $p = 0.024$ ), and in night shift ( $p < 0.001$ ). The level of education, job tenure, and the type of operations as well as used devices did not significantly differ between recidivists and non-recidivists ( $p > 0.05$ ).

Rather than the prevalence of NSIs, a total of 191 employees (17.90% of all the respondents) experienced splashes to the eyes or mouth and also 159 employees

**Table 1: Demographic characteristics of the nurses, and relationship with the prevalence of Needlestick and sharp injuries**

Variables	NINs* [491 (46.10%)]	INs [579 (53.90%)]	RCs [92 (8.60%)]	All nurses [1070 (100%)]	$p^{**}$
Sex					0.28
Male	22.10***	17.30	22.0	78.70	
Female	77.90	82.70	78.0	21.30	
Age, years					0.85
19–27	17.70	15.70	12.20	14.50	
27–35	45.10	50.50	52.20	47.20	
35–43	31.0	25.70	27.80	30.40	
43–52	6.20	8.20	7.80	7.80	
BMI****					0.56
Underweight	3.60	2.80	1.20	2.80	
Healthy weight	62.70	61.50	64.70	61.50	
Overweight	29.40	31.0	31.80	31.5	
Obese	4.20	4.70	2.40	4.20	
Marital status					0.32
Single	29.40	32.90	32.20	71.0	
Married	70.60	67.10	67.80	29.0	
Education					0.057
Associate	2.5	1.20	1.10	4.20	
Bachelor	40.70	39.90	32.60	37.50	
Master	56.80	58.90	66.30	58.30	
Job tenure					0.003
01–10	67.0	71.70	70.0	66.60	
10–20	28.90	23.0	26.70	28.20	
20–28	4.10	5.30	3.30	5.20	

\*NINs: without NSIs or non-injured nurses; INs: with one reported NSI or injured nurses; and RCs: with two or more reported NSIs or recidivists. \*\*Significant at  $p < 0.05$ . \*\*\*percentage of the variable among the studied groups; NINs, INs, RCs, and all nurses. \*\*\*\*Body Mass Index: Underweight: 0.0–18.5; Healthy weight: 18.5–25.0; Overweight: 25.0–30.0; and Obese:  $\geq 30.0$

(14.90% of all the respondents) experienced cuts with sharp objects such as knives. Furthermore, 90 nurses (8.40% of all the respondents) experienced contact with open wounds. Of these accidents, nurses claimed that all cases were reported to the infection control units.

The average score and standard deviation of HSH-MSs are shown in Table 3. The statistical analysis which was done with regression models showed that higher levels of HSH-MSs' score would be associated with a lower frequency rate of NSIs and also the NSIs recidivism rates among the studied nurses ( $p = 0.002$ ). The HSH-MSs' dimensions that most consistently demonstrated a statistically significant association with NSIs and NSIs recidivism rate were "management leadership" and "employee participation." Each of these domains demonstrated statistical significance at the 0.05 level.

The mean score (SD) of each HSCS dimension responded to

by the subjects are listed in Table 4. These results are divided into the three studied groups including NINs, INs, and RCs. As can be concluded from the table, the average score of all 6 HSCS dimensions among recidivists was clearly lower than the corresponding figures of injured nurses and non-injured nurses, respectively. Results also revealed that the three hospital safety climate dimensions including management support ( $p = 0.022$ ), absence of job hindrances ( $p = 0.016$ ), and workplace cleanliness/orderliness ( $p = 0.011$ ) were more closely associated with NSIs and NSI recidivism rate. The results additionally supported that the self-reported HSCS was also lower among the recidivists with Mean (SD) equal to 59.99 ( 2.10). This was followed by injured nurses with Mean (SD) equal to 70.20 (1.90), and non-injured nurses equal 74.13 ( 2.56 )(p = 0.002).

In statistical analysis, a stepwise multivariate multiple logistic regression model which included each of the HSH-MS and HSCS dimensions, we showed various

**Table 2: The prevalence rate of Needlestick and sharp injuries by causative devices and operations; and other blood exposures among the studied groups\***

Items	NINs [491 (46.10%)]	INs [579 (53.90%)]	RCs [92 (8.60%)]
<b>Devices</b>			
needles or vials	-	429 (74.10%) <sup>†</sup>	65 (70.65%)
Angiocath	-	53 (9.10%)	10 (10.87%)
Suture needles	-	25 (4.30%)	5 (5.43%)
blades	-	25 (4.30%)	4 (4.35%)
other devices	-	47 (8.20%)	8 (8.7%)
<b>Operations</b>			
Needle cap coverage	-	427 (73.60%)	35 (38.04%)
During the venesection	-	163 (28.20%)	28 (30.43%)
Transfusion	-	9 (1.60%)	2 (2.17%)
Injection	-	86 (14.70%)	7 (7.61%)
During infectious waste disposal	-	8 (1.40%)	0 (0.0%)
Displacement of contaminated clothing	-	4 (0.70%)	0 (0.0%)
During suturing	-	30 (5.20%)	4 (4.35%)
Other operations	-	101 (17.40%)	16 (17.40%)
<b>Other blood exposures</b>			
splashes to the eyes or mouth	29 (36.25%)	162 (45.25%)	37 (52.11%)
cuts with sharp objects	32 (40.0%)	127 (35.47%)	16 (22.53%)
contacts with open wounds	19 (23.75%)	71 (19.28%)	18 (25.36%)

\*NINs: without NSIs or non-injured nurses; INs: with one reported NSI or injured nurses; and RCs: with two or more reported NSIs or recidivists. <sup>†</sup>Prevalence rate ( $n$  (%)) among studied groups; NINs, Ins, and RCs

**Table 3: The average score of Hospital Safety and Health Management System and relationship with Needlestick and Sharp injuries among the nurses (n=1070)**

Items	Range*	Mean (SD)	$p$ <sup>†</sup>
management leadership (8 items)	0–24	15.60(1.58)	0.005
employee participation (11 items)	0–33	12.23(1.31)	0.013
Hazard identification (10 items)	0–30	16.67( 3.73)	0.191
Hazard prevention and control (8 items)	0–24	14.23( 1.31)	0.051
Education and training (10 items)	0–30	20.18 (4.80 )	0.635
Program evaluation and improvement (6 items)	0–18	10.00(1.21)	0.119
Hospital Safety and Health Management System (53 items)	0–159	88.92( 3.31)	0.002

\*The min and the max score of Hospital Safety and Health Management System (HSH-MS). <sup>†</sup>Significant at  $p < 0.05$

**Table 4: Statistical relationships between Hospital Safety Climate Scale (HSCS) and needlestick and sharps injuries among the three studied groups\***

Factor	NINs* [491 (46.1%)]	INs [579 (53.9%)]	RCs [92 (8.6%)]	p <sup>†</sup>
Personal protective and engineering control equipment availability	8.26 (1.37) <sup>‡</sup>	8.00 (1.43)	7.94 (1.02)	0.902
1. Accessibility of sharp containers in the work area.	4.09 (0.89)	3.90 (0.95)	3.73 (1.04)	
2. Availability of disposable gloves in the work area.	4.15 (0.79)	4.10 (0.82)	4.18 (0.63)	
Management support	15.37 (2.83)	14.64 (2.75)	12.86 (2.67)	0.022
3. Considering the protection of workers from occupational exposures to HIV as a high priority with management.	3.87 (0.95)	3.57 (0.98)	3.34 (0.99)	
4. Taking all reasonable steps to minimize hazardous job tasks and procedures.	3.66 (0.87)	3.56 (0.86)	3.26 (0.87)	
5. Encouraging the employees to be involved in safety and health matters.	3.93 (0.83)	3.77 (0.82)	3.61 (0.85)	
6. Doing the part to insure employees' protection from occupational HIV/AIDS with managers.	3.88 (0.84)	3.71 (0.83)	3.47 (0.87)	
Absence of job hindrances	9.46 (2.56)	8.70 (2.50)	7.45 (2.46)	0.016
7. Do not interface job duties with being able to follow Universal Precautions.	3.50 (0.89)	3.32 (0.91)	3.33 (0.96)	
8. Having enough time to follow Universal Precautions.	3.08 (1.12)	2.81 (1.06)	2.72 (1.14)	
9. Do not have too much to do to follow Universal Precautions.	2.88 (1.09)	2.56 (1.01)	2.60 (1.11)	
Feedback/Training	19.56 (3.22)	18.56 (3.28)	15.57 (3.01)	0.753
10. Correcting unsafe work practices by supervisors.	3.93 (0.80)	3.72 (0.81)	3.60 (1.01)	
11. Training safe work practices with supervisors.	3.94 (0.82)	3.69 (0.91)	3.49 (0.97)	
12. Having the opportunity to be trained to use personal protective equipment devices to protect from HIV exposures.	3.47 (1.03)	3.27 (1.01)	3.14 (1.07)	
13. Training the employees to be aware of and to recognize potential health hazards at work.	3.96 (0.84)	3.78 (0.77)	3.62 (0.80)	
14. Availability of a copy of the hospital safety manual.	4.16 (0.79)	4.03 (0.93)	3.81 (0.87)	
Cleanliness/orderliness	10.66 (2.33)	10.25 (2.55)	6.40 (2.20)	0.011
15. Keeping the work area clean.	3.92 (0.85)	3.75 (0.90)	3.40 (0.87)	
16. Keeping the work area from cluttering.	3.69 (0.84)	3.62 (0.94)	3.34 (1.02)	
17. Keeping the work area from crowding.	3.06 (1.14)	2.86 (1.14)	2.67 (1.10)	
Minimal conflict/good communication	10.82 (2.29)	10.33 (2.25)	9.77 (2.21)	0.796
18. minimal conflict within the department.	3.31 (1.02)	3.19 (1.07)	3.10 (1.10)	
19. Supporting each other with members.	3.62 (0.99)	3.40 (0.99)	3.13 (1.03)	
20. Open communication between supervisors and staff.	3.85 (0.94)	3.74 (0.89)	3.61 (1.07)	
The Hospital Safety Climate Score	74.13 (2.56)	70.20 (1.90)	59.99 (2.10)	0.002

\*NINs: without NSIs or non-injured nurses; INs: with one reported NSI or injured nurses; and RCs: with two or more reported NSIs or recidivists. <sup>†</sup>Significant at  $p < 0.05$ . <sup>‡</sup>The average score of subscales (Standard Deviation)

correlations between NSIs, NSI recidivism, HSH-MS, and HSC, as indicated in Table 5. As it is shown, the prevalence of NSIs and NSI recidivism was significantly lower when management leadership, employee participation and consequently, hospital safety and health management systems were rated highly. Thus, the nurses who worked in a hospital with higher management leadership for safety and health and also who had high levels of employee participation were roughly once as likely to experience blood fluid exposure incidents.

Also, the nurses who received higher senior managerial support were more than one time as likely to have suffered one and more NSIs in the previous 12 months. Similarly, the subjects who thought that there are job hindrances in the workplaces were slightly more than once as likely to have suffered one or multiple NSI during the last year.

Finally, the nurses who worked in hospitals in which a clean work area without cluttering or crowding conditions was not available were almost once as likely to always report one or more NSIs they suffered to infection control units. The complete results including OR and 95% CI for the prevalence rates as well as the recidivism rates of NSIs are shown in Table 5.

## Discussion

This study firstly investigated the prevalence of NSIs, NSIs recidivism rate, and the associated factors including nurse characteristics, causative equipment, and hazardous operation among hospital nurses. This was additionally the first study to identify the potential association of NSIs including the NSIs recurrence rate with HSH-MSs and HSCS among the targeted nurses. The results showed that more than the half of

**Table 5: Correlations between hospital safety and health management system, hospital safety climate, needlestick and sharps injuries, and injury recidivism**

Items	The prevalence rate of NSIs*		NSIs recidivism rate*	
	OR	(95% CI)	OR	(95% CI)
<b>HSH-MS<sup>†</sup></b>				
Management leadership	0.91	(0.69–1.21) <sup>‡</sup>	0.98	(0.55–1.74)
Employee participation	1.29	(0.92–1.82)	1.12	(0.83–1.49)
Hospital safety and health management system	1.05	(1.01–1.08)	0.92	(0.87–0.97)
<b>HSCS<sup>§</sup></b>	<b>OR</b>	<b>(95% CI)</b>	<b>OR</b>	<b>(95% CI)</b>
Management support	1.02	(0.93–1.11)	1.21	(0.77–1.22)
Absence of job hindrances	1.06	(0.98–1.16)	1.11	(0.96–1.30)
Cleanliness/orderliness	1.07	(0.98–1.08)	0.84	(0.73–1.15)
Hospital safety climate	1.03	(1.01–1.04)	0.97	(0.87–0.97)

\*Correlations evaluated using multiple logistic regression and expressed as odds ratios with 95% confidence intervals (adjusted for age, sex, shiftwork, BMI, Job tenure, and Hepatitis B vaccination status). <sup>†</sup>Hospital Safety and Health Management System tool translated and adapted from an original tool by the Occupational Safety and Health Administration (OSHA) and the US. Department of Labor.<sup>[21]</sup> <sup>‡</sup> $p < 0.05$ .

<sup>§</sup>Hospital Safety Climate Score (Persian version) translated and adapted from an original tool by Gershon *et al.*<sup>[29]</sup>

nurses who involved in the study were exposed to the risk of occupational exposure to blood-borne diseases such as HIV, Hepatitis B, and C through NSIs since these nurses injured themselves via the causative devices, especially needles or vials, during their routine clinical duties. This finding was lower than the other studies which were conducted all over the globe<sup>[6,30–32]</sup> but higher than the incidence rates reported from other national studies.<sup>[33,34]</sup> The studies reported that NSIs were the most common mode of blood and body fluid exposures in hospitals and other health care centers. The WHO reported that health care workers incur two million NSIs annually that lead to infections with Hepatitis B and C, and HIV. It also estimated that the global burden of disease from occupational exposure to be 40% of Hepatitis B and C infections, and 2.5% of HIV infections among health care workers as attributable to exposures at the workplaces.<sup>[35]</sup>

According to the results, among personal characteristics, just work experience as a nurse was significantly associated with NSIs. Namely, nurses with fewer years of experience had more NSI experiences, which is consistent with other international studies.<sup>[6,36,37]</sup> This study revealed that the high prevalence of NSIs in Iran may be associated with the shorter job tenure of Iranian nurses compared to other nations, such as 5.5 years in South Korea, 17.7 years in Canada, 16.7 years in New Zealand, 15.1 years in the US, 12.5 years in Germany, 9.2 years in Thailand, 8.0 years in China, and 7.3 years in Japan.<sup>[6,38]</sup> It can be claimed that enough working experience of the nurses may result in having advanced skills and techniques for handling needles and sharp devices safely, therefore they may be considered at lower risk of occupational exposure to NSIs.

This is the first study that examined needlestick and sharp injury recidivism; because the most previous studies have relied on the prevalence of NSIs. In this study, we did not restrict our sample to just the incidence of NSIs in hospitals, hence, we had the advantage of capturing the NSI recidivism rate among nurses. The findings showed that age, sex, marital

status, BMI, and shift work were the significant predictors of NSI recidivism. Our results suggest that younger age, female gender, being married, high levels of BMI, and working in the night shift are associated with a higher risk of NSI recidivism. Therefore, the NSI preventative programs aimed at this group may assist in the decline of the burden of NSI recidivism rate on population health. Needlestick and sharp injury recidivists, who represented 8.6% of the study sample, had a higher risk for occupational exposure to blood-borne pathogens than non-recidivists adjusting for confounders. These 92 subjects are at the risk of Hepatitis B and C as well as HIV more than their non-recidivist counterparts who did not have experiences of NSIs or even reported one injury during their clinical activities. In the literature review, we found that none of the previous studies investigated the NSI recidivism rate and the related risk factors; however, several studies reported the prevalence of multiple NSIs among their studied groups such as the 17.1% reported by Smith *et al.* study in Japan,<sup>[17]</sup> and also about 30% reported by Gershon *et al.*<sup>[29]</sup> Since experiences of NSIs, both single or multiple NSIs, are related to many adverse effects, including physical problems, economic burdens as well as psychological impacts,<sup>[39]</sup> and also enduring psychiatric illness can result from NSIs with a severity similar to other psychiatric trauma,<sup>[40]</sup> recognizing nurses who are at risk of NSI recurrence can recognize the targeted populations to identify and prioritize the blood-borne exposure control plan to reduce the prevalence of NSIs and recidivism rates.

Occupational injuries such as NSIs can increase the hospital's costs, disrupt staffing and workflow, lead to the early exit of experienced staff, and damage workplace morale.<sup>[41]</sup> As an injury prevention program, a safety and health management system in hospitals is considered as a practical tool to reduce the prevalence of injuries and increase proactively and continually the workplace safety and health issues. In this study, we investigated the key elements of health and safety management systems and the effectiveness of this prevention program on the prevalence of NSIs as well as NSI recurrence

rate in hospitals. The findings showed that two elements including management support and employee participation were significantly associated with the incidence of NSIs and NSI recidivism rate. In fact, hospitals in which there were higher levels of management support and employee participation had a lower rate of NSIs and a number of recidivists. This result is consistent with the study conducted by Abdullah *et al.*<sup>[42]</sup> who reported that employees will persist in continuously enhancing the safety when they perceive that the managers are openly more supportive of safety activities. The prevalence of NSIs can be reduced when the top hospitals' managers completely commit to boosting workplace safety and health performance and also provide enough sources to execute the safety and health management elements in their hospitals. They can also consider safety and health performance as a top organizational value and illustrate and communicate the safety and health commitment to nurses and other employees. This managerial behavior can lead to reductions in the incidence rates of injuries including NSIs and the NSI recidivism rate.

As the prior studies showed, management leadership and employee participation go hand in hand to create a workplace culture that develops safety and health. These key elements are widely regarded as the two most vital factors of a safety and health management system.<sup>[43,44]</sup> When the hospital managers involve their employees in health and safety management systems not only can they try to reduce safety and health hazards in their workplace but also they can play a crucial role in implementing the safety and health management systems.

The previous studies showed that safety climate is a vital contextual element in the hospital environment and is associated with staff's compliance with safe work practices and with job exposure events.<sup>[16,29]</sup> We surveyed a possible mechanism through which hospital safety climate influences occupational injury outcomes, especially the NSIs and NSI recidivism rate. We found that three specific dimensions of hospital safety climate including management support, absence of job hindrances and cleanliness/orderliness were identified from survey questions derived from self-reported answers as the most significant HSCS components, which were correlated with the prevalence of NSIs as well as NSI recidivism rate.

Our identification of the effect of management support, as a significant factor, in the incidence of NSIs is congruent with other studies. Gershon *et al.*<sup>[29]</sup> reported that senior management support is especially significant concerning exposure incidents in hospitals. Smith *et al.*<sup>[16]</sup> identified that NSIs were correlated with different components of hospital safety climate which included management role in protecting the employee from blood-borne disease and having an uncluttered workplace. Furthermore, Agnew *et al.*<sup>[45]</sup> found perceptions of staffing levels and managerial commitment as significant predictors for all the safety outcome measures.

It should be mentioned that because having higher levels of safety climate in hospitals leads to safe work practices

among nurses and additionally senior managers play a crucial role in increasing the level of safety climate, the employee's safety perception called safety climate is a key component of hospital safety management systems. In fact, hospitals' managers can build higher level of safety climate when their employees have active participation in safe activities and also top managers support safety measures and provide sufficient resources to implement the key components of safety and health management system in hospitals. Therefore, these measures are expected to reduce the prevalence of needlestick and sharp injuries.

## Conclusion

To sum up, this study demonstrated that hospital safety and health management systems and employee's safety climate are significant factors, which are correlated with not only the prevalence of recurrent NSIs but also the single NSI in hospitals. So, having a strong hospital safety and health management system and also employees' perceptions about the safety in their hospital can effect on doing safe work practices including safe use of needles and other causative devices. When top managers play their roles in supporting safety measures including eliminate job hindrances and create a clean and orderly environment as well as employees participate in safely doing the clinical duties, the incidence of NSIs is expected to be reduced.

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## Conflicts of interest

Nothing to declare.

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