Original Article

Needlestick and sharps' injury in healthcare students: Prevalence, knowledge, attitude and practice

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Abstract

Purpose: Needlestick and sharps injury is an occupational hazard, and it presents with a constant risk of exposure to blood-borne pathogens. Students are particularly at risk due to a lack of experience and handling skills. The present study was designed to assess the prevalence of needle stick injury and evaluate the knowledge, attitude, and practice regarding its prevention and management among students of a medical campus. **Methods:** A cross-sectional, questionnaire-based study was conducted among healthcare students of the medical campus in Sangli, Maharashtra. Overall, the study included 942 participants belonging to medical, dental, and nursing faculties. **Results:** Overall, the prevalence rate of needlestick and sharps injury was found to be 25.2%. The prevalence was highest amongst nursing students. The students had adequate knowledge about blood-borne virus (BBV) transmission and prevention of needlestick injury. However, there was a substantial shortfall in post-exposure prophylaxis knowledge amongst the students. A deficit in translation between knowledge to practice was noted, particularly in the case of needlestick injury prevention and management. **Conclusion:** The present study found that one in four students experience needlestick injury; overall knowledge regarding prevention and management of needlestick injury was lesser than desired, and gaps in knowledge and practice were identified in the present study. This can be rectified by curricular reforms, periodic educational programs and stern reinforcement of guidelines. Instilling reporting centers and devising a standing operating procedure in the event of needlestick injury are the needs of the hour.

Keywords: Blood-borne pathogen, hepatitis B virus, human Immunodeficiency virus, needlestick injuries, occupational exposure

Introduction

Needlestick and sharps injury (NSI/SI) is a grave occupational hazard amongst healthcare professionals (HCPs).[1] Such an incident is fraught with the risk of transmission of blood-borne pathogens, viz., hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). The risk of transmission of HBV is highest (6%–30%), followed by HCV (1.8%) and HIV (0%–10%).[2–5] Most of the NSI are preventable, and obtaining the information regarding the circumstances of the injury is of utmost importance to ply suitable preventive measures.

Students are more vulnerable to NSI during training periods due to their lack of practical experience and skill. Few studies also suggest that most health sciences curricula lack precise infection

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control and preventive procedures for NSI.[5,6] Most NSIs are preventable by proper knowledge of handling of the instrument, by following precautions, and sound knowledge of post-exposure prophylaxis (PEP). Research on this subject has explored various aspects like the incidence of NSI,[4–10] risk factors associated,[4,11] risk perception,[12] the circumstances involving injury,[7–10] and the type of injury. Some institution-based studies have also focused on the educational needs of the students.[3,5,13] However, understanding the gap in knowledge and the disparity between knowledge and practice will aid in structuring healthcare curricula and preventive guidelines for NSI. So far, only one research has assessed the differences in healthcare studies belonging to different specialties.[5]

Hence, in the present study, the authors aimed at comparing the knowledge, attitude, practice, and prevalence of NSI amongst medical, dental, and nursing students at an academic healthcare institute. The authors also assessed whether gender, clinical exposure, and stream of medicine to which the students belong had any bearing on NSI prevalence and awareness.

Materials and Methods

A cross-sectional, questionnaire-based study was conducted among 942 healthcare students during their training period. The sample consisting of health care students belonging to dental, medical, and nursing faculty were included in the study. Institutional ethical clearance was obtained before commencing the study. The self-administered questionnaire included thirty-seven questions to test students' knowledge about NSIs, blood-borne virus (BBV) transmission, and appropriate exposure management. The questionnaire was adopted, modified, and developed by referring to published literature.[3,5,10,12,14] The questionnaire was pretested on 30 students of the source population. Kappa statistics were employed to assess test–retest reliability, and the value obtained was 0.61, which suggested substantial agreement. The participants had been briefed about the purpose of the study, and after obtaining informed consent, they were asked to answer the questionnaire. The participants filled the questionnaires in the lecture hall, and to avoid contamination, the participants were requested not to discuss with others while answering the questionnaire. About thirty minutes were allotted to the participants to fill the questionnaire.

The filled questionnaires were collected, and the data from the case sheet was entered in Microsoft Excel. The statistical analysis was performed using SPSS version 20, and descriptive statistics were employed to study the prevalence of NSI. Chi-squared test, unpaired *t*-test, and ANOVA were used to evaluate the differences in sub-groups (i.e., based on profession, gender, and experience).

Results

Sample demographics

Out of the 942 study participants, 400 students (42.5%) belonged to the dental stream, 364 students (38.6%) belonged to the medical stream, and the remaining 170 students (18.9%) were from the nursing stream. Amongst these, 586 participants (62.2%) were female, and 347 participants (36.8%) were male.

Knowledge, attitude and practice of NSI prevention and management

Twenty-four questions assessed the knowledge, approach, and practice regarding NSI prevention and NSI management [Table 1]. Only 32% of participants correctly identified HBV as a virus with the highest transmission rate. The knowledge about the standard operating procedure (SOP) post exposure was less than desirable. Only 38.5% and 32.5% of participants identified the correct PEP against HIV and HBV. The participants lacked adequate knowledge regarding NSI prevention. Although 52.5% of students identified the correct method of needle disposal, only 20.9% of students used the proper method. The knowledge in general regarding NSI was adequate, but only 14.3% of students could identify high-risk exposure.

Regarding practice, we observed that students' adherence to protocol was unsatisfactory. Only 55.4% of students had been vaccinated against HBV. The students had shown a positive approach regarding NSI, wherein 84% of students opined that needlestick injury was a cause of concern and stated that NSI was preventable.

Profession against knowledge, attitude and practices of NSI prevention

On comparing knowledge the of BBV transmission amongst three study groups, it was found that dental students scored marginally better than medical and nursing students ($P < 0.05$). Nursing students had better knowledge about NSI prevention than other study group. But the difference was not statistically significant. Likewise, nursing students had better knowledge of PEP ($P < 0.05$) than medical and dental students. Medical students showed better adherence to protocol ($P < 0.05$) than dental and nursing students, and the difference was statistically significant ($P < 0.05$). The dental students had better risk perception ($P < 0.05$) than the students of medical and nursing professions [Table 2].

Gender against knowledge, attitude and practices of NSI prevention

Statistically, we found a significant difference in knowledge of NSI prevention, PEP, and risk perception between the two genders ($P < 0.05$). Female students scored better than male students in questions on NSI prevention. Also, regarding questions related to PEP, female students fared better than male students. Female students exhibited a positive attitude toward NSI prevention compared to male students [Table 3].

Level of education against knowledge, attitude, and practices of NSI prevention

Clinical students fared better than preclinical students concerning knowledge of BBV ($P = 0.00$). Clinical students had better

Table 1: Knowledge, attitude and practice of NSI prevention and management amongst the participants

Items in the Questionnaire	Correctly Answered Frequency *n* (%)
Knowledge	
BBV	
Identified BBV viruses	729 (77.4)
Correctly identified HBV as virus with highest risk of transmission	301 (32.0)
Post-exposure Procedure	
Correctly identified immediate measures to be taken after NSI	478 (50.7)
Had knowledge about PEP	447 (47.5)
Correctly identified that PEP can be offered only for HIV and HBV	447 (47.5)
Correctly identified the time to initiate PEP against HIV	512 (54.4)
Identified the WHO-recommended PEP guidelines against HIV	363 (38.5)
Identified PEP for HBV	309 (32.8)
Correctly recognized that there is no prophylaxis available for HCV	165 (17.5)
Had knowledge about universal precaution guidelines	478 (50.7)
NSI prevention	
Identified that blood sample of both HCP and patient need to be collected after NSI	614 (65.2)
Identified the correct method for recapping needle	467 (49.6)
Identified correct method for disposal of needle	495 (52.5)
Identified that it is unsafe to separate needle from syringe	358 (38.0)
NSI General	
What is sharps injury	604 (64.1)
Cause of sharps Injury	644 (68.4)
Identified high-risk injury	135 (14.3)
Were aware of safety devices for prevention of sharps injury	531 (56.4)
Practice	
Are vaccinated against HBV	524 (55.6)
Use correct method for disposal of needle	197 (20.9)
Attitude	
Identified NSI as a cause of concern	791 (84.0)
NSI is avoidable	642 (68.2)
Opined they would report to medical emergency room if they get NSI	472 (50.1)
Opined that NSI prevention cell is necessary	721 (76.5)

knowledge about PEP than preclinical students. Clinical students had better adherence to protocol ($P = 0.00$) and risk perception ($P = 0.00$) as well [Table 3].

Incidence of NSI amongst the study groups

A total of 237 students (25.15%) had experienced NSI [Table 4]. The incidence was maximum in dental students ($n = 98$), followed by medical ($n = 85$) and nursing ($n = 54$) students when the entire student population was considered. Nursing students had a maximum incidence of 30.3%, followed by medical and dental students with 24.5% and 23.4%, respectively [Table 4]. Most of the injuries were percutaneous with hollow bore needles (54.5%) and were experienced during the procedure (48.1%). The leading causes of NSI were during administration of anesthesia, blood collection, and suturing [Table 5]. One hundred eighty-one students did not report the injury, and 186 participants did not take PEP [Table 5].

Discussion

In the present study, we observed that the students' knowledge regarding NSI and NSI prevention was satisfactory, but their knowledge of PEP was lacking. Most of the students were unaware of various components of the WHO-recommended guidelines for PEP. These findings are in concurrence with studies by Madhavan *et al.*,[6] Ayub *et al.*[12] and Pavithran *et al.*[13] Although HBV has the highest risk of transmission amongst all the BBVs, it has an effective vaccine and PEP.[10,15] In the present study, only 32% of students correctly identified HBV as a virus with the highest risk of transmission and 55.6% were vaccinated against it [Table 1]. The authorities of the health institutes should ensure the protection of students by organizing an HBV vaccination drive and making it compulsory. In addition, regulatory bodies for different fraternities must record vaccination status of each practitioner during their registration or renewal. This will ensure the practitioner's necessary vaccination and reduce NSI/SI-led health risks.

High-risk behaviors identified were that 20.9% of students disposed the needles correctly while most of the students reported recapping the needles. Recapping the needles is an established high-risk practice as the risk of NSI is thrice more in HCPs who recap needles than those who do not recap the needles.[6,7,10,16] Hence, recapping needles is prohibited in many hospitals.[16] However, in dentistry, multiple injections are often required, and recapping of the needle is often done. If the needles must be recapped, the single-hand scoop method is the safest.[16]

Table 2: Comparison of knowledge, attitude and practices in students of three professional groups

Faculty (*n*)	Mean (SD)	Median	ANOVA		Post hoc comparison		
			F	*P*	D vs M	D vs N	M vs N
Knowledge							
BBV transmission							
D (400)	1.29 (0.73)	1	0.001*	0.957	0.001*	0.001*	0.001*
M (364)	1.28 (0.77)	1					
N (178)	1.03 (0.68)	1					
NSI prevention							
D (400)	1.86 (0.83)	2	0.507	0.804	0.485	0.803	0.507
M (364)	1.90 (0.86)	2					
N (178)	1.94 (0.78)	2					
PEP							
D (400)	3.77 (1.91)	4	0.001*	0.282	0.001*	0.001*	0.001*
M (364)	3.98 (1.91)	4					
N (178)	4.75 (1.82)	5					
General							
D (400)	1.56 (1.05)	2	0.001*	0.679	0.001*	0.001*	0.001*
M (364)	1.49 (1.08)	1					
N (178)	1.89 (0.94)	2					
Adherence to protocol (Practice)							
D (400)	0.99 (0.72)	1	0.001*	0.001*	0.560	0.049*	0.001*
M (364)	1.20 (0.73)	1					
N (178)	1.05 (0.65)	1					
Risk perception (Attitude)							
D (400)	2.45 (0.83)	3	0.001*	0.001*	0.002*	0.907	0.001*
M (364)	2.16 (0.84)	2					
N (178)	2.19 (0.77)	2					

ANOVA test *statistically significant at *P* value <0.05; D, Dental; M, Medical; N, Nursing

Table 3: Differences in knowledge, attitude and practices according to gender

	Male participants		Female participants		*P*
	Mean (SD)	Median	Mean (SD)	Median	
Knowledge					
BBV Knowledge	1.22 (0.75)	1	1.25 (0.74)	1	0.511
NSI prevention	1.88 (0.87)	2	1.89 (0.82)	2	0.916
PEP	3.86 (1.97)	4	4.15 (1.97)	4	0.025*
General	1.46 (1.03)	1	1.67 (1.15)	2	0.002*
Adherence to protocol (Practice)	1.15 (0.73)	1	1.04 (0.71)	1	0.032*
Risk perception (Attitude)	2.10 (0.84)	2	2.40 (0.81)	3	0.001*
	Clinical		**Pre-clinical**		***P***
Knowledge					
BBV Knowledge	1.38 (0.76)	1	1.12 (0.70)	1	0.001
NSI prevention	1.87 (0.82)	2	1.88 (0.89)	2	0.87
PEP	4.21 (1.86)	4	1.88 (0.89)	3	0.001*
General	1.53 (1.00)	2	1.51 (1.17)	1	0.746
Risk Perception (Attitude)	2.40 (0.81)	3	2.4 (0.88)	2	0.001*

#Nursing students have been excluded since the students had clinical exposure since first year and cannot be categorized as clinical and preclinical students. Unpaired *t* test: *Statistically significant at *P* value <0.05

Regarding knowledge of BBV transmission, dental students fared better than other groups, and the difference was statistically significant ($P < 0.01$). On the other hand, the nursing students had better knowledge regarding NSI prevention ($P < 0.01$). In contrast to this, in the present study, it was found that nursing students had the highest incidence of NSI at 30.3%. Similarly, Hussain *et al.*[5] reported the highest incidence (76.4%) among nursing students. Nursing students' better knowledge base can be explained by the fact that NSI prevention is a part of their curriculum, and the maximum incidence may be attributed to the nature of the work and the fact that they have earlier clinical exposure compared to students of other streams. The medical students demonstrated better adherence to protocol when compared to students of another profession ($P < 0.00$).

In the present study, though the number of female participants (62.2%) was more than male participants (36.8%), male participants reported more NSI (30.3%) than female

Table 4: NSI incidence according to stream and gender

	N (%)	*P*
Stream		
Medical	85 (24.5%)	0.17
Dental	98 (23.4%)	
Nursing	54 (30.3%)	
Gender		
Male	105 (30.3%)	0.019*
Female	130 (22.2%)	

NSI, Needlestick injury; Chi-squared test. *Statistically significant at *P* value <0.05

Table 5: Frequency of NSI and other related factors amongst the study population

	n (%)
Have experienced NSI	237 (25.2)
Have experienced NSI in the last year	175 (57.1)
Frequency of previous NSI	
1-2	35 (64.8)
3-5	14 (25.9)
6-10	1 (1.9)
> 10	4 (7.4)
Nature of injury	
Percutaneous with hollow bore needle	30 (54.5)
Percutaneous with sharp object	25 (45.5)
Stage of procedure when NSI was experienced	
Preparing for procedure	17 (32.7)
During the procedure	25 (48.1)
Cleaning up after the procedure	11 (19.2)
Type of procedure performed when NSI was experienced	
Administration of anesthesia	16
Blood collection	12
Recapping syringes	6
Suturing	11
Cleaning of instruments	6
Other surgical procedure (extraction, scaling etc.)	10
Did not report the incident	181 (78.4)
Reason for not reporting	
The instrument was not used	19 (46.3)
Did not know how to report	12 (29.3)
Did not think it was necessary to report	7 (17.1)
Was afraid to be blamed for it	4 (7.3)
Did not take post-exposure prophylaxis	186 (80.5)

participants (22.2%), and the difference was statistically significant ($P = 0.019$). The present study's observation supports this finding that female participants demonstrated better knowledge than male participants and had a more positive attitude toward NSI prevention [Table 3]. In contrast, few studies have reported female HCPs to be at a higher risk of NSI, and the presumed reason is underreporting of NSI by the male staff.[15,16] Hypodermic (i.e., intramuscular, subcutaneous, or intradermal) injections using disposable syringes and needles are identified as a common cause of NSIs,[17,18] which was also reflected in our findings. A majority of the NSI (48.1%) occurred during the procedure; similarly, Matsumoto *et al.*[16] reported that 55.3% of injuries occurred during the procedure, whereas Madhavan *et al.*[6] and Pavithran *et al.*[13] reported recapping as the second most prevalent cause of NSI.

Reporting an injury is of utmost importance for the proper management of NSI and for ensuring that PEP is received when necessary. One alarming observation of the study was the dismally low reporting rates of NSI incidents; 78.4% of participants did not report an injury, which is comparable to the findings of Hussain *et al.*[5] and Madhavan *et al.*[6] wherein 77.4% and 68% of students, respectively, did not report NSIs. The literature review indicates that half of the NSIs in USA go unreported, whereas the reporting rates in developing countries are as low as 25%.[17,18] The possible cause for low reporting rates may be stigmata associated with the NSI, erroneous presumption that risk of transmission is low, lack of standing order procedures after an incident, and lack of knowledge regarding the importance of reporting the incident.

Although the overall knowledge was less than desired in the present study, the study participants showed a positive attitude toward NSI prevention; but this alone does not ascertain adherence to universal precaution guidelines. Regular educational classes and induction sessions for the recruits bring out a positive change in knowledge, practice, and attitude toward safety protocols.[2,3]

The magnitude of NSI was first realized in the 1980s with the increase in AIDS. However, with the advent of Universal precautions guidelines, the incidence of NSI has declined in the last three decades.[1] Nevertheless, it continues to be one of the most common occupational safety hazards, especially in developing countries.[19–24] The lack of resources, educational interventions, nationwide reporting facility and follow-up of incidences were found to be the root causes of this problem.

All healthcare institutes play a vital role in teaching the students safety and infection control practices during their formative years. Hence, including NSI prevention as a part of the curriculum and introducing it in early training years will result in a more compliant attitude toward safety procedures. Dedicated and periodic hands-on programs, innovative technological tools like online modules, simulated scenarios, and software have proven beneficial and teach safety and NSI prevention.[25,26] Recently, Wu *et al.*[27] designed virtual reality training to familiarize the newly recruited nurses and physicians with NSI prevention protocols. This system improved the participants' confidence and reduced their anxiety and NSI rates. NSI is highly preventable using NSI prevention practices and safety devices. On the other hand, a systematic review reported that having a nationwide policy is instrumental in reducing the incidence of NSI.[28] Institutional prevention and monitoring programs are of utmost importance to protect the HCPs and students of the institute. But nationwide regulatory policies and monitoring programs are essential to protect family physicians and private practitioners.

Conclusion

In the present study, we found that one in four students had experienced NSI during their training period, and amongst those

experiencing NSI, only one in four students reported the injury. We identified the gaps in the students' required knowledge, attitude, and practices. Few steps taken at the institutional level like compulsory HBV vaccination, organizing lectures and hands-on sessions on NSI prevention and formulating standard operating procedures in the event of sharps injury will go a long way in ensuring the students' and patients' safety. Additionally, governing authorities need to revise the curricula for better learning outcomes and NSI prevention. Phasing out of conventional devices and using safety devices need to be propounded, and finally, a national NSI registry and surveillance should be in place for swift response and follow-up for comprehensive protection of all HCPs including family physicians. The study is limited by recall bias of the student, regarding the experience, by its cross-sectional design and restriction to one institutional medical campus. Further research is needed to formulate the curricular reforms and educational programs for NSI prevention and to study their effectiveness.

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Conflicts of interest

There are no conflicts of interest.

References

1. King KC, Strony R. Needlestick. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021. PMID: 29630199.
2. Rishi E, Shantha B, Dhami A, Rishi P, Rajapriya HC. Needle stick injuries in a tertiary eye-care hospital: Incidence, management, outcomes, and recommendations. Indian J Ophthalmol 2017;65:999-1003.
3. Jaggi N, Nirwan P, Chakraborty M. Process improvement to effectively manage and reduce sharps injuries in a Tertiary Hospital in Northern India. J Healthc Qual Res 2020;35:141-8.
4. Bindra S, Ramana Reddy KV, Chakrabarty A, Chaudhary K. Awareness about needle stick injures and sharps disposal: A study conducted at army college of dental sciences. J Maxillofac Oral Surg 2014;13:419-24.
5. Hussain JS, Ram SM, Galinde J, Jingade RR. Occupational exposure to sharp instrument injuries among dental, medical, and nursing students in Mahatma Gandhi Mission's Campus, Navi Mumbai, India. J Contemp Dent 2012;2:1–10.
6. Madhavan A, Asokan A, Vasudevan A, Maniyappan J, Veena K. Comparison of knowledge, attitude, and practices regarding needle-stick injury among health care providers. J Family Med Prim Care 2019;8:840-5.
7. Yoshikawa T, Wada K, Lee JJ, Mitsuda T, Kidouchi K, Kurosu H, *et al.* Incidence rate of needlestick and sharps injuries in 67 Japanese hospitals: A national surveillance study. PLoS One 2013;8:e77524.
8. Treviño H 2nd, Romero Arenas MA. Systematic review of blood-borne pathogen exposure rates among medical students. J Surg Res 2020;255:66-70.
9. McDowall J, Laher AE. Cross-sectional survey on occupational needle stick injuries amongst prehospital emergency medical service personnel in Johannesburg. Afr J Emerg Med 2019;9:197-201.
10. Pereira MC, Mello FW, Ribeiro DM, Porporatti AL, da Costa S Junior, Flores-Mir C, *et al.* Prevalence of reported percutaneous injuries on dentists: A meta-analysis. J Dent 2018;76:9-18.
11. Goel V, Kumar D, Lingaiah R, Singh S. occurrence of needlestick and injuries among health-care workers of a tertiary care teaching hospital in North India. J Lab Physicians 2017;9:20-25.
12. Ayub A, Goyal A, Kotwal A, Kulkarni A, Kotwal A, Mahen A. Infection control practices in health care: Teaching and learning requirements of medical undergraduates. Med J Armed Forces India 2013;69:107-12.
13. Pavithran VK, Murali R, Krishna M, Shamala A, Yalamalli M, Kumar AV. Knowledge, attitude, and practice of needle stick and sharps injuries among dental professionals of Bangalore, India. J Int Soc Prev Community Dent 2015;5:406-12.
14. Motaarefi H, Mahmoudi H, Mohammadi E, Hasanpour-Dehkordi A. Factors associated with needlestick injuries in health care occupations: A systematic review. J Clin Diagn Res 2016;10:IE01-4.
15. Hakeem A, Alsaigh S, Alasmari A, Aloushan A, Bin Saleh F, Yousef Z. Awareness, concerns, and protection strategies against bloodborne viruses among surgeons. Cureus 2019;11:e4242.
16. Matsumoto H, Sunakawa M, Suda H, Izumi Y. Analysis of factors related to needle-stick and sharps injuries at a dental specialty university hospital and possible prevention methods. J Oral Sci 2019;61:164-70.
17. Sriram S. Study of needle stick injuries among healthcare providers: Evidence from a teaching hospital in India. J Family Med Prim Care 2019;8:599-603.
18. Cooke CE, Stephens JM. Clinical, economic, and humanistic burden of needlestick injuries in healthcare workers. Med Devices (Auckl) 2017;10:225-35.
19. Mengistu DA, Tolera ST. Prevalence of occupational exposure to needle-stick injury and associated factors among healthcare workers of developing countries: Systematic review. J Occup Health 2020;62:e12179.
20. Auta A, Adewuyi EO, Tor-Anyiin A, Edor JP, Kureh GT, Khanal V, *et al.* Global prevalence of percutaneous injuries among healthcare workers: A systematic review and meta-analysis. Int J Epidemiol 2018;47:1972-80.
21. Bouya S, Balouchi A, Rafiemanesh H, Amirshahi M, Dastres M, Moghadam MP, *et al.* Global prevalence and device related causes of needle stick injuries among health care workers: A systematic review and meta-analysis. Ann Glob Health 2020;86:35.
22. Cheetham S, Ngo HT, Liira J, Liira H. Education, and training

for preventing sharps injuries and splash exposures in healthcare workers. Cochrane Database Syst Rev 2021;4:CD012060.

23. Chen M, Zhang L. Prevalence of needlestick injuries among nursing interns: A systematic review and meta-analysis. Ann Palliat Med 2021;10:7525-33.
24. Al Johani A, Karuppiah K, Al Mutairi A, Al Mutair A. Narrative review of infection control knowledge, and attitude among healthcare workers. J Epidemiol Glob Health 2021;11:20-5.
25. Silva AMBD, Bim LL, Bim FL, Sousa AFL, Domingues PCA, Nicolussi AC, *et al*. Patient safety and infection control: Bases for curricular integration. Rev Bras Enferm 2018;71:1170-7.
26. Yang H, Zhang H, Lu Y, Gu Y, Zhou J, Bai Y. A program to improve the knowledge, attitudes, and practices of needle stick and sharps injuries through bundled interventions among nurses: An KAP mode-based approach to intervention. Psychol Health Med 2022;27:999-1010.
27. Wu SH, Huang CC, Huang SS, Yang YY, Liu CW, Shulruf B, *et al*. Effect of virtual reality training to decreases rates of needle stick/sharp injuries in new-coming medical and nursing interns in Taiwan. J Educ Eval Health Prof 2020;17:1. doi: 10.3352/jeehp. 2020.17.1.
28. Ou YS, Wu HC, Guo YL, Shiao JSC. Comparing risk changes of needlestick injuries between countries adopted and not adopted the needlestick safety and prevention act: A meta-analysis. Infect Control Hosp Epidemiol 2021:1-7. doi: 10.1017/ice. 2021.372.