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Original research

The incidence of needle stick and sharp injuries and their associations with visual function among hospital nurses

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Abstract

Purpose: To determine the one-year incidence of needle stick and sharp injuries (NSIs and SIs) and their associations with visual function among Iranian nurses.
Methods: In this cross-sectional study, 278 nurses working at one hospital were selected through stratified random sampling. After applying the exclusion criteria, the final analysis was performed on the data of 267 nurses. The data of occupational injuries were collected through a researcher-administered questionnaire. Visual function indices including distance and near best corrected visual acuities (BCVAs), color vision, stereoacuity, distance and near heterophorias, accommodative amplitude and facility, contrast sensitivity (CS) for high and low spatial frequencies (SFs), near point of convergence (NPC), saccadic and pursuit eye movements, distance and near convergence and divergence fusional reserves and peripheral vision were evaluated through optometric examinations using standard protocols.
Results: The one-year incidence of NSIs and SIs was 41.2% [95% Confidence interval (CI): 35.3–47.1] and 19.1% (95% CI: 14.4–23.8), respectively. Color vision deficiency, pursuit deficiency, abnormal near heterophoria, and decreased CS for high SF had a significant association with the increased incidence of NSIs with odds ratios of 3.26, 2.32, and 1.35, respectively. Moreover, saccadic deficiency, abnormal near heterophoria, and decreased near fusional divergence reserve were significantly associated with the increased incidence of SIs with odds ratios of 2.42, 2.40, and 1.27, respectively.
Conclusions: Our findings showed a relatively high incidence of NSIs and SIs in Iranian nurses and their associations with some visual function indices. Therefore, pre-employment and periodic visual examinations are recommended to detect and remove the corresponding visual risk factors. Moreover, preventive strategies should be adopted to decrease the occurrence of the aforementioned injuries.

Keywords: Needle stick injuries; Sharp injuries; Visual function; Nurses

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Introduction

Needle stick injuries (NSIs) and sharp injuries (SIs) are among the most common occupational injuries in healthcare workers (HCWs) that comprise about 12% of all working people worldwide.[1,2] It is estimated that of 35 million HCWs worldwide, 3 million experience these injuries every year.[3] Among HCWs, the highest incidence of these injuries has been reported among nurses.[4,5]

NSIs and SIs in nurses are important from two aspects. The first aspect is the impact(s) of these injuries on the affected person since these injuries can lead to the transmission of bloodborne diseases like HIV, hepatitis B and C, and other dangerous bloodborne infections.[6,7] According to a World Health Organization's (WHO) report, NSIs and SIs are responsible for 16,000 new cases of hepatitis C, 66,000 new cases of hepatitis B, and 1000 new cases of HIV infection among HCWs worldwide, 1100 of whom die or become significantly disabled every year.[8] The second aspect is the economic effects of these injuries on the health system.[9] The estimated annual costs of tests and treatments resulting from NSIs and SIs range from USD 6.1 million in France to USD 118–591 million in the USA.[10]

Considering the high prevalence of NSIs and SIs in nurses and their important outcomes, researchers have emphasized the importance of reducing these injuries through recognizing the related risk factors.[2,11,12] Most studies in this regard have assessed the incidence of these injuries and their associations with some factors mainly demographic and occupational characteristics.[13–18] To the best of our knowledge, no study has evaluated visual function as a predisposing factor in the occurrence of NSIs and SIs.

Some studies have investigated the association between visual function and the occupational performance and accidents in some occupations like drivers and computer users, and it has been proved that visual system disorders can decrease efficiency, increase errors and accidents, and therefore, decrease job productivity.[19,20] Accordingly, standard protocols have been developed for visual screening examinations and interventions.[21] However, to the best of our knowledge, no study has been performed on nurses despite the sensitivity of their occupation and there is no standard relevant protocol to date. It should be mentioned that the protocols related to visual standards cannot be generalized to different occupations since the involvement and importance of various visual function indices vary in different occupations. Considering the aforementioned, the present study was conducted to determine the incidence of NSIs and SIs and their associations with visual function indices among nurses.

Methods

Study setting and sampling

This cross-sectional study was conducted at Baqiyatallah Hospital, Tehran, Iran in 2016. Baqiyatallah Hospital is a subspecialty hospital and tertiary referral center managing all types of medical and surgical diseases. The target population of the study was all nurses working at different wards of the hospital (a total of 32 wards) with at least 1 year of work experience. The study was approved by the Ethics Committee of Baqiyatallah University of Medical Sciences. Informed consent was obtained from all nurses prior to the study, and their data were kept confidential.

Power analysis was used to determine the sample size. According to the results of the pilot study on 30 nurses, an effect size of 0.3 was obtained; then considering an alpha of 0.05 and power of 80%, the estimated sample size was 278. To calculate the effect size, we determined the difference of all visual indices between injured and non-injured participants in the pilot group and determined the effect size based on the visual index that gave the largest sample size. The G Power software version 3.1.9.2 (Heinrich-Heine University, Dusseldorf, Germany) was used to calculate the sample size. The samples were selected using stratified random sampling. Each hospital's ward was considered a stratum, and in each stratum, sampling was done with regards to the proportion of the number of the nurses in the stratum to the total number of the nurses (proportion to size). After determining the number of samples in each ward, a list of all nurses working in the ward was used to select the samples using a random number table.

Questionnaire

The data of occupational injuries (NSIs and SIs) were collected using a researcher-administered questionnaire which included 2 parts. The first part contained questions on demographic and occupational variables like age, sex, work experience, work hours per week, number of night shifts per week, academic degree, and type of employment. The second part contained 4 questions on occupational injuries in the past year. The first question addressed the occurrence of NSIs as "Did you experience NSIs by yourself in nursing practice in the past year?" with yes and no as answers. The second question was about the frequency of NSIs in the past year with once, twice, three times, and more than three times as answers. The third question was about the occurrence of SIs as "Did you experience any cuts or lacerations in any parts of the body by blades or other sharp objects (other than needle stick) by yourself in nursing practice in the past year?" with yes and no as answers. The fourth question was related to the frequency of SIs in the past year with once, twice, three times, and more than three times as answers. The comments and viewpoints of occupational medicine and optometry experts were used to confirm the content validity of the questionnaire. Moreover, the test–retest method with an interval of one week was used to determine the reliability of the questionnaire ($R = 0.92$).

Eye examination protocol

In each section of the hospital, ocular examinations were performed in an environment with normal room illumination in the mesopic level by an experienced optometrist. First, distance and near uncorrected visual acuities (UCVAs) were measured at 6 m and 40 cm using distance and near Snellen E charts, respectively. Then objective refraction was done using the Heine Beta retinoscope (Heine Corp, Optotechnik, Germany). After that, the best distance and near optical corrections were determined using subjective refraction and distance and near best corrected visual acuities (BCVAs) were recorded.

The next stage included the measurement of contrast sensitivity (CS) using the Frankfurt-Freiburg Acuity and Contrast Test System (FrACT) version 5.6 on a laptop computer. Testing was performed monocularly using sinusoidal gratings at low (5 cycles/degree) and high (15 cycles/degree) spatial frequencies (SFs). For this test, the person sat at a distance of 1 m from the monitor exactly facing it wearing optical correction. At each selected SF, the participant determined the direction of gratings as their contrast decreased. Finally, the system determined the contrast threshold in that SF as percentage which was then converted to decibel using the formula $dB = 10\log(100/T)$. After the measurement of CS, color vision was evaluated using the Ishihara color vision test at 40 cm through optical correction.

In the next stage, binocular vision, accommodative, and ocular motility examinations were done all through distance or near optical correction depending on the test distance. First, distance and near unilateral and alternate cover tests were performed at 6 m and 40 cm and the magnitude of distance or near heterophoria was measured using a prism bar. The target used for the cover test was one letter above the BCVA threshold on the distance and near Snellen charts. To measure near point of convergence (NPC), an accommodative target (a single letter one line above the BCVA on the near Snellen chart) was moved toward the participant slowly along the midline and the participant was asked to report when diplopia occurred. The distance where the participant reported diplopia or the examiner observed loss of fusion objectively was measured from the spectacle plane or lateral canthus (if no glasses were used) and recorded as NPC. To increase the sensitivity of the test, the measurements were repeated three times, and the average of three measurements was considered as the final NPC. Accommodative amplitude was measured using the Donder's push-up method first for the right eye followed by the left eye. A near Snellen chart was used to show one line above the near BCVA threshold to the person. Then the chart was moved toward the participant slowly, and the participant was asked to report when she/he could no longer able to see the letters clearly (fist sustained blur). The distance between the first sustained blur point and the spectacle plane or lateral canthus was recorded as near point of accommodation (NPA). NPA was measured three times, and the average of three measurements was recorded as the final NPA, which was then converted to diopter (D) using the formula 100/NPA. Accommodative facility was measured for each eye separately using ±2D flipper lenses at 40 cm. The target used for this test was one line above the near BCVA threshold on the near Snellen chart. Each instance of clearing both plus and minus lenses was considered a cycle, and the number of cycles in 1 min was noted as accommodative facility expressed as cycle per minute (cpm).

Convergence and divergence fusional reserves were measured using base-out (BO) and base-in (BI) prisms of a prism bar, respectively, by the step method at 40 cm and 6 m. The target used for these tests was a vertical column of 20/40 letters on the near and distance Snellen charts. To conduct this test, a prism bar was placed before the right eye of the person who was asked to keep the target clear and single and report the occurrence of sustained blur and diplopia as the prism increased at a rate of 2 prism diopters per second. After diplopia occurred, the amount of prism was decreased at the same rate, and the participant was asked to report when single vision was recovered. At the end, the amount of prism in the points of blur, diplopia, and recovery of binocular vision was recorded as blur/break/recovery.

Stereoacuity was assessed using the Randot Stereotest (Stereo Optical Corp, Chicago, USA) with contoured circles in 10 levels of disparity. Each level of disparity included three circles, and the person had to select the circle with disparity through a forced choice method. The test continued until the person was unable to detect the circle with disparity from two other circles. Finally, stereoacuity was recorded in s/arc.

The Southern California College of Optometry Grading System (SCCO) was used to evaluate saccadic and pursuit eye movements. To assess saccadic movements, a target with a large print equal to a visual acuity of 20/80 was placed on the right side, and a similar target was placed on the left side at an approximate distance of 40 cm from the participant. The distance between the two targets was about 20 cm. The person was asked to move his/her eyes between the two targets alternately for 10 times without moving the head. A score of +4, +3, +2, and +1 was given if the movements were accurate, if there was some undershooting, if there was gross undershooting or any overshooting, and if the person was unable to do the test, respectively.

To evaluate pursuit movements, a 20/80 target was moved to the extents of about 20 cm from the primary gaze as left–right–left (one cycle), up–down–up (one cycle) and in 2 diagonal orientations (one cycle each) at a distance of 40 cm from the patient, and the patient was asked to follow the target without moving the head. A score of +4, +3, +2, and +1 was given if the pursuits were accurate, if there was 1 fixation loss, if there were 2 fixation losses, and if there were more than 2 fixation losses, respectively.

The qualitative confrontation method was used to evaluate the peripheral vision. For this test, the examiner sat in front of the person in such a way that for evaluation of the right eye's field of the participant, the examiner's left eye confronted the participant's right eye and vice versa. Moreover, the examiner's and participant's seats were adjusted to have the same height. Then the examiner slowly moved a red target from the non-seeing peripheral parts in the nasal, temporal, superior, and inferior sectors into the participant's visual field and asked the participant to report when the target was first visualized. In this way, the examiner compared the participant's visual field with his own qualitatively.

Definitions

Myopia and hyperopia were defined as a spherical equivalent of subjective refraction ≤ -0.5 *D* and $>+0.5$ *D*, respectively. Astigmatism was defined as cylindrical power <-0.50 *D*. Presbyopia was defined as the need for near addition $\geq +0.50$ *D* based on near subjective refraction. Uncorrected refractive error and uncorrected presbyopia were defined as the presence of these conditions in a participant for which he/she has not received the appropriate correction or he/she does not routinely use the correction during nursing practice. Color vision was considered abnormal if less than 9 out of 15 Ishihara test pages were detected correctly. Stereoacuity > 70 s/arc was considered as poor stereopsis.

A near exophoria more than 6 prism diopters or any near esophoria was considered as abnormal near heterophoria. A distance exophoria more than 3 prism diopters or any distance esophoria was considered abnormal distance heterophoria. An accommodative amplitude below the expected minimum amplitude for age according to the Hofstetter's formula (15−0.25 age)[22] was regarded as an abnormal accommodative amplitude. A SCCO score $\leq +2$ for the saccadic and pursuit movements was considered abnormal. A monocular accommodative facility below 6 cpm was also regarded as abnormal. Peripheral vision deficiency was defined as field limitations in any of the temporal, nasal, superior, and inferior sectors in the right or left eye. All of the cutoff values were chosen based on the guidelines proposed by reference textbooks.[23,24]

Exclusion criteria

Participants with distance or near BCVA less than 20/40 in either eye, amblyopia, strabismus, and history of ocular trauma were excluded from the study.

Statistical analysis

The SPSS software version 20 was used for statistical analysis. For univariate analysis, the normality of the data was assessed using the Kolmogorov−Smirnov test. For continuous quantitative variables, independent samples *t*-test and Mann−Whitney test were used for variables with a normal and non-normal distribution, respectively. Fisher's exact test and Chi square test were used to analyze categorical data. Then all study variables (visual, demographic, and occupational variables) were entered into a multiple logistic regression model to calculate the odds ratios and control the effect of confounders in a backward manner. *P* values less than 0.05 were considered statistically significant.

Results

Two hundred seventy-eight nurses participated in this study. Five nurses were excluded after applying the exclusion criteria, and the questionnaire data of six nurses were incomplete; therefore, the final analysis was performed on the data of 267 nurses. Table 1 presents the baseline data of the participants.

Table 1
Baseline characteristics of the participants.

Variable	Number (%)
Sex	
Male	128 (47.9)
Female	139 (52.1)
Education	
Bachelor of Science (BSc)	264 (98)
Master of Science (MSc) and upper	3 (2)
Type of employment	
Permanent	238 (89.1)
Contract	20 (7.5)
Postgraduate service	9 (3.4)
Variable	**Mean ± SD**
Age (years)	33.06 ± 6.28
Work hours per week (h)	50.37 ± 13.47
Night shift per week (number of night shifts per week)	1.52 ± 1.17

The incidence of NSIs in the participating nurses was 41.2% (95% CI: 35.3−47.1) in the past year, 63.6% and 36.4% of whom experienced NSIs once and more than once, respectively. Moreover, the incidence of SIs was 19.1% (95% CI: 14.4−23.8) in the nurses in the past year, 80.7% and 19.3% of whom experienced SIs once and more than once, respectively.

Table 2 shows the categorical visual indices in injured and non-injured participants for NSIs and SIs. Due to the high correlation of right and left eyes in the accommodative amplitude ($R = 0.88$) and accommodative facility ($R = 0.93$), only the data of the right eye are presented. According to Table 1, for both NSIs and SIs, the percentage of the participants with abnormal near heterophoria, saccadic deficiency, and pursuit deficiency was significantly higher in injured versus non-injured participants.

Table 3 provides a comparison of the continuous quantitative visual indices between injured and non-injured participants for NSIs and SIs. Due to the high correlation of the right and left eyes in distance BCVA ($R = 0.84$), near BCVA ($R = 0.93$), and CS for the high ($R = 0.97$) and low ($R = 0.96$) SFs, only the data of the right eye regarding these indices are presented. As for NSIs, there was a significant difference in CS for high SF, NPC, near BO blur, and near BI break between the injured and non-injured participants as the mean NPC was significantly higher in the injured group and the mean count fingers (CF) for high SF, and also mean near BO blur and near BI break were significantly lower in the injured group versus the non-injured group.

As for SIs, there was a significant difference in mean NPC and near BI blur between injured and non-injured patients, as the mean NPC was significantly higher, and the mean near BI blur was significantly lower in the injured group versus the non-injured group.

In the next stage, all study variables (visual, demographic, and occupational variables, Table 1) were entered into a multiple logistic regression model in a backward manner.

Table 2
Univariate analysis of categorical visual indices for needle stick and sharp injuries (NSIs and SIs).

Variables	Needle stick injuries (NSIs)			Sharp injuries (SIs)		
	Yes (110) Number (%)	No (157) Number (%)	*P* value	Yes (51) Number (%)	No (216) Number (%)	*P* value
Uncorrected refractive error	6 (5.4%)	18 (11.4%)	0.12	3 (5.8%)	21 (9.7%)	0.58
Uncorrected myopia (range, −0.50 to −1.25*D*)	2 (1.8%)	6 (3.8%)		2 (3.9%)	7 (3.2%)	
Uncorrected hyperopia (range, +0.75 to +1.50*D*)	3 (2.7%)	8 (5.1%)		1 (1.9%)	10 (4.7%)	
Uncorrected astigmatism (range, −0.75 to −1.25*D*)	1 (0.9%)	4 (2.5%)		0 (0.0%)	4 (1.8%)	
Uncorrected presbyopia	4 (3.6%)	5 (3.1%)	1.00	2 (3.9%)	7 (3.2%)	0.68
Color vision deficiency	9 (8.1%)	5 (3.1%)	0.09	3 (5.8%)	11 (5%)	0.73
Poor stereopsis	13 (11.8%)	12 (7.6%)	0.28	6 (11.7%)	19 (8.7%)	0.59
Abnormal near phoria	41 (37.27%)	30 (19.1%)	0.001*	20 (39.2%)	51 (23.6%)	0.03*
Abnormal distance phoria	9 (8.1%)	13 (8.2%)	1.00	3 (5.8%)	19 (8.7%)	0.77
Deficient AA of right eye	8 (7.2%)	7 (4.4%)	0.42	3 (5.8%)	12 (5.5%)	1.00
Deficient AF of the right eye	23 (20.9%)	22 (14%)	0.18	8 (15.6%)	37 (17.1%)	1.00
Saccadic deficiency	19 (17.2%)	11 (7%)	0.01*	11 (21.5%)	19 (8.7%)	0.01*
Pursuit deficiency	13 (11.8%)	6 (3.8%)	0.01*	7 (13.7%)	12 (5.5%)	0.04*
Peripheral vision defect	2 (1.8%)	2 (1.2%)	0.98	0 (0%)	4 (1.3%)	1.00

D: Diopter, AA: Accommodative amplitude, AF: Accommodative facility, *P value < 0.05.

Table 3
Univariate analysis of continuous visual indices for needle stick and sharp injuries (NSIs and SIs).

Variables	Needle stick injuries (NSIs)			Sharp injuries (SIs)		
	Yes (110) Mean ± SD	No (157) Mean ± SD	*P* value	Yes (51) Mean ± SD	No (216) Mean ± SD	*P* value
BCDVA of the right eye (log MAR)	0.010 ± 0.043	0.015 ± 0.052	0.47	0.013 ± 0.049	0.13 ± 0.048	0.96
BCNVA of the right eye (log MAR)	0.010 ± 0.041	0.017 ± 0.056	0.32	0.011 ± 0.043	0.016 ± 0.052	0.65
CS of right eye for low SF (decibel)	16.77 ± 2.96	16.65 ± 3.12	0.75	16.62 ± 2.92	16.72 ± 3.08	0.83
CS of right eye for high SF (decibel)	12.90 ± 1.83	13.36 ± 1.70	0.03*	13.22 ± 1.74	13.06 ± 1.80	0.56
Near point of convergence (NPC) (cm)	7.15 ± 2.64	6.45 ± 2.06	0.02*	7.58 ± 3.30	6.74 ± 2.19	0.02*
Distance BO blur (PD)	9.80 ± 1.66	9.76 ± 1.97	0.84	9.84 ± 1.96	9.76 ± 1.82	0.79
Distance BO break (PD)	15.91 ± 2.34	16.05 ± 3.03	0.68	15.98 ± 2.73	16.00 ± 2.77	0.95
Distance BO recovery (PD)	10.43 ± 1.87	10.78 ± 2.55	0.21	10.33 ± 1.90	10.71 ± 2.38	0.28
Distance BI break (PD)	6.46 ± 1.33	6.60 ± 1.19	0.36	6.49 ± 1.15	6.56 ± 1.27	0.72
Distance BI recovery (PD)	3.89 ± 1.06	3.85 ± 1.03	0.77	3.86 ± 0.91	3.87 ± 1.07	0.96
Near BO blur (PD)	13.88 ± 3.68	14.80 ± 3.39	0.03*	13.88 ± 3.31	14.55 ± 3.58	0.22
Near BO break (PD)	17.65 ± 4.37	18.66 ± 3.95	0.05	17.49 ± 3.92	18.42 ± 4.19	0.14
Near BO recovery (PD)	12.42 ± 3.50	3.18 ± 3.91	0.10	12.35 ± 3.32	12.99 ± 3.85	0.27
Near BI blur (PD)	12.24 ± 2.27	12.54 ± 1.80	0.22	12.30 ± 2.07	12.94 ± 1.70	0.04*
Near BI break (PD)	16.38 ± 2.98	17.20 ± 2.66	0.01*	17.29 ± 2.60	16.76 ± 2.87	0.22
Near BI recovery (PD)	12.32 ± 2.85	12.83 ± 2.30	0.11	12.98 ± 2.61	12.54 ± 2.53	0.27

MAR: Minimum angle of resolution, cm: Centimeter, PD: Prism diopter, BCDVA: Best corrected distance visual acuity, BCNVA: Best corrected near visual acuity, CS: Contrast sensitivity, SF: Spatial frequency, BO: Base-out, BI: Base-in, SD: Standard deviation, *P value < 0.05.

Table 4
Final multiple logistic regression model (backward manner) for needle stick and sharp injuries (NSIs and SIs).

Variable	Needle stick injuries (NSIs)		Variable	Sharp injuries (SIs)	
	OR (95% CI)	*P* value		OR (95% CI)	*P* value
Color vision deficiency	3.26 (1.02–10.47)	0.04	Saccadic deficiency	2.42 (1.03–5.70)	0.04
Pursuit deficiency	3.16 (1.12–8.92)	0.03	Abnormal near phoria	2.40 (1.19–4.81)	0.01
Abnormal near phoria	2.32 (1.30–4.11)	0.004	Insufficient near BI blur	1.27 (1.06–1.53)	0.01
Low CS for high SF	1.35 (1.05–1.74)	0.01			

CS: Contrast sensitivity, SF: Spatial frequency, BI: Base-in, OR: Odds ratio, CI: Confidence interval.

Table 4 shows the final regression model for NSIs and SIs. According to Table 4, color vision deficiency, pursuit deficiency, abnormal near heterophoria, and decreased CS for high SF had a significant association with the increased incidence of NSIs with odds ratios of 3.26, 3.16, 2.32, and 1.35, respectively. Moreover, saccadic deficiency, abnormal near heterophoria, and decreased near fusional divergence reserve were significantly associated with the increased incidence of SIs with odds ratios of 2.42, 2.40, and 1.27, respectively.

Discussion

In the present study, we determined the one-year incidence of NSIs and SIs and their associations with visual function indices in Iranian nurses. According to our results, the incidence of NSIs and SIs was 41.2% and 19.1%, respectively. According to the literature, the incidence of these injuries ranges from 13.9% to 70.4%,[2,11,14,25,26] and our findings are in the midpoint of this range. Some previous studies have evaluated the associations of NSIs and SIs with some factors (mainly demographic and occupational variables). According to the findings of these studies, poor mental health,[13] long work hours,[6] little work experience,[14] fatigue and lack of sleep during night shifts,[15] and haste and carelessness on busy shifts[16] were identified as potential risk factors in this regard.

We assessed the association of a set of visual indices with NSIs and SIs. Abnormal near heterophoria was one of the visual indices associated with an increased risk both NSIs and SIs. Near heterophoria increases the demand on the vergence system which is associated with multiple symptoms like blurred vision, diplopia, eye strain, sleepiness, pulling sensation around the eyes, and headache during near visual activities which can adversely affect performance during near work.[24] Since injections and working with sharp and cutting devices are mainly near activities, these symptoms can affect the nurses' performance and increase the risk of NSIs and SIs.

We found that ocular motor dysfunction was another risk factor of NSIs and SIs in this study. According to the results, pursuit deficiency increased the risk of NSIs by a factor of 3.16. Moreover, the risk of SIs was 2.42 times higher in individuals with saccadic deficiency as compared to their healthy counterparts. Saccadic and pursuit eye movements are two important groups of basic eye movements.[27] Saccades are the quickest ocular movements as jerky movements that constantly keep the visual axis on the target in the dynamic visual space through changing the ocular fixation.[28] Pursuit movements are smooth eye movements that make it possible to maintain a stable foveal fixation on moving objects in the visual space.[29] Ocular motor disorders manifest as decreased velocity, decreased accuracy, and increased latency of saccadic and pursuit movements.[30] As mentioned earlier, saccadic and pursuit movements have an important role in visual function, and their disorders are associated with frequent loss of target, poor comprehension, and a short attention span.[24]

Injection and working with sharp and cutting devices are fine tasks in nursing profession usually involving fine objects like the blades and needles.[31] Handling these devices correctly and efficiently requires accurate fixation of the nurse's eyes on them simultaneously with frequent changes of gaze direction (for example frequent gaze changes with blade movement during removing sutures—importance of saccadic movements) and during moving these objects (needle movement during injection and recapping-importance of pursuit movements). These items are important for high levels of comprehension and attention required for correct handling of the devices. Therefore, it is logical to consider an association between saccadic and pursuit dysfunctions and increased incidence of NSIs and SIs.

Low CS was another risk factor of NSIs with an odds ratio of 1.35. We believe that CS is of utmost importance in the nursing profession, especially during recapping. It should be mentioned that in many cases, there is little contrast between the needle (which is usually gray in color) and its cap (transparent and colorless). Therefore, low CS can increase the risk of NSIs during recapping due to lack of differentiation between the needle and cap. It should be mentioned that according to previous studies, a considerable percentage of NSIs occur during recapping,[3,32] which further supports this finding.

Color vision dysfunction was another risk factor for NSIs with an odds ratio of 3.26. It is rather difficult to explain the association between color vision dysfunction and NSIs. It seems that color differences between the plunger, barrel, needle, and cap play an important role in better identification of the needle in different situations and help to prepare the grounds for a successful injection procedure (during injection, recapping, and disposal). Therefore, color vision dysfunction can increase the risk of NSIs during the aforementioned processes.

We found no significant associations between other visual indices including visual acuity and uncorrected refractive error with NSIs and SIs. We believe this lack of association is important. It should be mentioned that visual acuity is the most important and sometimes the only parameter that is tested in occupational examinations in Iran and other visual indices are often ignored. The results of our study highlight the necessity of a comprehensive assessment of the visual system.

Of the limitations of this study is that we used self-report to collect the data of occupational injuries. Also, all measurements were done by a single examiner, and we do not know the reliability. Moreover, we did not evaluate the rate of exposure to high risk situations. As the risk of occupational injuries may not be similar among nurses working in different sections of the hospital (possibly higher among nurses working in the emergency and surgical wards), this issue might have a confounding effect on our findings; however, it should be noted that, the aforementioned sections included a limited number of participants (considering sampling from 32 hospital sections), and most of our participating nurses had a similar status regarding the risk of exposure to occupational injuries.

Another issue that should be pointed is that all visual function indices were measured with the best optical correction, while according to Table 2, a percentage of subjects had uncorrected refractive errors (either for distant or near) on their habitual basis. So, the real life situation (during which nurses experienced occupational injuries) would be different from testing condition. However, most of the participants in this study had small amounts of ametropia (as seen in Table 2), and it is not expected that these small refractive errors would cause significant differences between the measurements with and without the optical correction.

In conclusion, our findings showed a relatively high incidence of NSIs and SIs in Iranian nurses and their associations with some visual indices. Therefore, pre-employment and periodic ocular examinations should be recommended to detect and remove the corresponding visual risk factors via appropriate management strategies. Moreover, preventive strategies like applying work restrictions in nurses with untreatable disorders should be adopted to decrease the occurrence of the aforementioned injuries.

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