The Association Between Workload and Needlestick Injuries Among the Nurses in the Hospitals Affiliated with Ahvaz University of Medical Sciences

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Abstract

Background: This study investigated the workload and its effects on the prevalence of needlestick injuries (NSIs) among the nurses in the hospitals affiliated with Ahvaz University of Medical Sciences (AUMS).

Methods: In this cross-sectional study, 416 registered nurses working in different wards of the hospitals affiliated with Ahvaz University of Medical Sciences (AUMS) were randomly selected. Data collection instruments were a demographic questionnaire and NASA-TLX workload questionnaire.

Results: The prevalence of NSIs in the total work experience and the last year were 72% and 50%, respectively. The mean total score of NASA-TLX calculated to the extent of 78.27 ± 12.2. The regression modeling demonstrated that NSIs significantly correlated with patients treated/d (OR: 1.136, CI: 1.02 - 1.27, P value: 0.002), Timing of injury (OR: 2.13, CI: 1.20 - 3.79, P value: 0.010), and the third dimensions of NASA-TLX index (time pressure) (OR: 1.031, CI: 1.02- 1.05, P value: < 0.001).

Conclusions: The study showed a high prevalence of NSIs among nurses. Corrective measures such as planning training programs targeting at using personal protective equipment (PPE), modification of work schedule by limiting working hours and the number of shifts per month, and providing sufficient human resources are essential for the effective prevention of NSI incidents among the studied nurses.

Keywords: Needlestick, Nurses, Workload

1. Background

Needlestick injuries (NSIs) are among job-related risk factors for the transmission of different bloodborne pathogens such as hepatitis C virus, hepatitis B virus, human immunodeficiency virus (AIDS) in healthcare workers (HCWs). Studies showed that 2.1 million, 926,000, and 327,000 HCWs each year are exposed to sharps injuries contaminated with hepatitis B virus, hepatitis C virus, and human immunodeficiency virus/AIDS, respectively (1, 2). The costs spent on the treatment of the injured HCWs due to sharps injuries is considered an economic burden in many countries and more aggressive and inclusive preventive actions have also been taken into account (3).

Studies showed that workload (WL) and time pressure (TP) are likely to cause NSIs (4). WL represents the amount of mental effort required to conduct a task. This definition has a close association with the concept of attention as a

restricted capacity pool of energy or resources; task performance requires resource demands not to exceed available capacity to be fulfilled (5). When a human operator experiences different WL demands in response to a task, his/her capacity to deal with those demands is crucial (6). WL is one of the main causes of occupational exposures among nurses (7), which can influence their function and safety (8, 9), additionally increases the human errors rates (10). Increased WL makes the nurses work faster that result in a decline in attention and accuracy and can increase the likelihood of NSIs (11). Furthermore, WL affects the adoption of standard precautions (SPs) regarding occupational exposures. In other words, nurses' compliance with SPs is decreased with increasing their WL (12). It has recently been demonstrated that increased WL is associated with increased reports on lack of consistent adherence to safety precautions on needlesticks, e.g. not recapping needles (13). Van Bogaert et al. reported that the incidence of NSIs

was three times higher among nurses with increased WL (14). Another research showed that heavy WL has been found to increase the likelihood of NSIs in nurses from 50 percent to 2 folds (15).

WL measurement can be conducted subjectively or objectively. Objective measurements can be conducted with relatively small sample size and can provide comparatively more precise results than subjective measures; however, they are more complicated and entail technical skills and applied experiences (16). These methods yield a WL value based on certain physiological responses of the operator such as pupillary reflex or muscle activity (17). Electroencephalography (EEG) is widely applied to measure WL objectively (16). Subjective evaluations are economical and can be conveniently administered but due to individual bias cannot provide precise data and often require a large sample size. Subjective workload assessment technique (SWAT) and the national aeronautics and space administration-task load index (NASA-TLX) are the most common subjective scales (16). NASA-TLX index is a highly reliable and valid human factor to measure WL that can also be used to measure WL among nurses (18). In these techniques, operators self-assess WL using different rating scales or certain questionnaires (17).

2. Objectives

Nursing is considered a very important profession in Iran since nurses comprise a large subpopulation of the health care staff. However, with regards to short-staffed nurses and high patients/nurses ratio in the hospitals of this country, the nurses are working in the environments characterized by high predisposition rates to NSIs. Taking this into account, the present study investigated the association between WL and NSIs incidence rate in the nurses of hospitals affiliated with Ahvaz University of Medical Sciences (AUMS).

3. Methods

In this cross-sectional study conducted from February 2016 to April 2017, data were collected using anonymous questionnaires. The sample size was determined according to the study of Vahedi et al. (19). Considering P (prevalence) = 65%, d (accuracy) = 5%, confidence interval = 95%, and attrition rate = 20% and using Medcalc software, the sample size was determined 416. Registered participants were the nurses who had worked in different wards of five AUMS-affiliated hospitals for at least one year. The samples were randomly selected from the lists of the nurses'

names provided by the hospitals. Simple random sampling method was conducted by generating random numbers by a calculator and selecting the individuals from a numbered list of the nurses.

3.1. Data Collection Instruments

An anonymous and self-administered questionnaire was used to collect the data related to each participant. The questionnaire consisted of two parts: (1) demographic items for collecting individual's characteristics such as age, work experience, working hours per week, gender, marital status, education level, frequency of shifts per a month and items on the frequency and NSI-related factors (such as frequency of NSIs in the previous year, the shift when NSIs occurred, number of injections per a day and number of patients treated per a day) (2). WL was assessed by NASA-TLX index. This index consists of six aspects: mental demand (MD), physical demand (PD), temporal demand (TD), performance (PE), effort (EF), and frustration (FR) (18). Twenty step bipolar scales are used to derive the scores from these aspects. A score ranging from 0 to 100 (to the nearest 5) is calculated for each scale. A scaling procedure is used to integrate the six scores into a total score; this procedure requires a paired comparison to be conducted before WL measurement. Paired comparisons require the respondent to select more relevant aspect to his/her respective WL from all pairs of the six aspects. The frequency of choosing an aspect is the weight of that aspect for a given task from the respondent's perspective. A workload score (range; 0 - 100) is calculated for each task by multiplying the weight by the score on each aspect, summing the scales, and dividing the outcome by 15 (the total number of paired comparisons) (20). The face validity of NASA-TLX has already been studied (21).

3.2. Data Analysis

Statistical analysis was performed using SPSS version 19. Descriptive statistics, including mean $\pm$ standard deviation (SD) were used to describe the variables. The normality of data distribution was investigated by the Kolmogorov-Smirnov test. The t-test was used to compare the quantitative variables of the study between the two independent qualitative groups. Chi-square test was used to compare the mean values of the qualitative variables among over two qualitative groups. Logistic regression analysis was used to determine NSI-related factors in the nurses. In the regression analysis, if the P value of univariate tests between the variables and NSIs was $\leq$ 0.25, the variable was included in the regression model (22). In all tests, the significance level (P) was considered < 0.05.

4. Results

The mean age of the participants was 31.73 ± 7.00. The proportion of female to male nurses was 68.5%, and most of the participants had bachelor's degree in nursing with the mean work experience of 7.04 years. In addition, 299 (72%) nurses reported at least one NSI during their whole work experience and 206(50%) nurses experienced at least one NSI in the previous year (Table 1).

Table 1. Descriptive Characteristics of 416 Participated Nurses

Variables	Value[a]
Work experience, y	7.04 ± 6.03
Working hours per week, h	47.81 ± 10.57
Number of shifts per month	30.53 ± 8.14
Patients treated per day	9.00 ± 5.39
Number of injection per day	5.76 ± 1.98
Sex	
Male	131 (31.50)
Female	285 (680.5)
Education	
Diploma	13 (3.10)
Associate's diploma	84 (20.20)
B.Sc.	319 (76.70)
Marital status	
Single	205 (49.30)
Married	211 (50.70)
Frequency of needlestick in the total of work experience	
Yes	299 (72.00)
No	117 (28.00)
Frequency of needlestick in the last year	
0	93 (31.10)
1 – 2	187 (62.56)
3 – 4	15 (5.01)
> 5	4 (1.33)
Time at injury incidence	
Morning	134 (44.80)
Afternoon	95 (31.80)
Night	70 (23.40)
Age group, y	
< 30	236 (56.70)
31 – 40	138 (33.20)
41 – 50	37 (8.90)
> 50	5 (1.20)
Work experience, y	
0 - 5	226 (54.30)
6 - 15	149 (35.80)
16 - 25	38 (9.10)
> 25	3 (0.70)

[a] Quantitative variables were reported as mean ± SD and qualitative variables as frequency (%).

Table 2 presents the results for NASA-TLX. The mean to-tal score on NASA-TLX was determined 78.27 ± 12.2. Regarding different aspects of NASA-TLX, the minimum and maximum mean scores were derived on frustration and effort (62.31 and 89.48), respectively. Independent *t*-test showed a significant correlation between experiencing NSIs and the aspects mental demand, temporal demand, and frustration of NASA-TLX index (P < 0.05).

The association between experiencing NSIs and demographic characteristics is presented in Table 3. A statistically significant correlation was observed between the occurrence of NSIs and age, work experience, the time at injury incidence, and the number of patients treated per day (P < 0.05).

To investigate the effective factors on NSIs, multiple logistic regression was used. Based on the results of chi-square and independent *t*-test, age, job tuner, education level, number of patients treated per day, the time at injury incidence, the aspects mental demand, physical demand, temporal demand, and frustration of NASA-TLX index were included in the logistic regression model (P < 0.25). Backward stepwise method was used for variable selection to reach the best final model explaining NSI. Regression modeling yielded patient treated per day, the time at injury incidence and the aspect temporal demand of the NASA-TLX index remained in the model. According to the pseudo R^2 coefficient (Cox & Snell R Square) of determination, 12.1% of the changes related to NSIs could be explained by these variables (Table 4).

5. Discussion

In the current study, the 72% incidence rate of NSIs in the total of work experience and the 50% incidence rate of these injuries in the previous year revealed that the studied nurses were at high risk of NSIs, which is consistent with other studies. For example, the incidence rate of NSIs among 180 nurses in a teaching hospital in Shahroud, Iran (23) was 63.3%. Consistently, in Egypt, 273 of 371 (62.3%) the nurses reported to have experienced at least one NSI during the last year (24). Moreover, in 526 nurses and midwives participated in a study in Uganda (25), the incidence rate of NSIs during the last year was determined 57%. However, the one-year prevalence of NSIs in our study (136.42) was remarkably higher than those reported in the nurses in developed countries 28% (65.23) in Poland (26) and 22% (90.41) in Germany (1).

In the current study, NSIs were reported to occur mainly in the morning shift (44.8%), which is in agreement with other studies (27, 28). This can be attributed to the pressure due to heavy WL and time constraints in this shift work (29). The morning shift is considered a heavy WL shift

Table 2. Comparison of NASA-TLX Aspect Means Across NSIs Groups 416 Participated Nurses[a]

Workload Aspects	Total	Needlestick		P Value[b]
		Yes	No	
Mental demand	75.22 ± 21.34	77.06 ± 18.75	70.51 ± 26.37	0.005
Physical demand	77.34 ± 21.05	78.18 ± 19.21	75.21 ± 25.13	0.197
Temporal demand	79.84 ± 19.99	82.94 ± 16.36	71.92 ± 25.85	< 0.001
Performance	85.25 ± 14.60	85.10 ± 14.28	85.64 ± 15.44	0.735
Frustration	62.31 ± 26.64	64.15 ± 24.7	57.61 ± 30.68	0.024
Effort	89.48 ± 13.32	89.72 ± 12.88	88.89 ± 14.44	0.580
Total workload	78.27 ± 12.20	79.23 ± 10.44	75.82 ± 15.64	0.010

[a] Results were reported as mean ± SD for each variable.
[b] Based on independent two samples t-test.

Table 3. The Association Between Needlestick and Demographic Characteristics in the Studied Population (N = 416)[a]

Demographic Characteristics	Needlestick		P Value
	Yes	No	
Sex			0.660[b]
Male	96 (73.3)	35 (26.7)	
Female	203 (71.2)	82 (28.8)	
Education level			0.230[b]
Diploma	12 (92.3)	1 (7.7)	
Associate diploma	61 (72.6)	23 (27.4)	
B.Sc.	226 (70.8)	93 (29.2)	
Marital status			0.930[b]
Single	148 (72.2)	57 (27.8)	
Married	151 (73.6)	60 (26.4)	
Time at injury incidence			0.041[b]
Morning	38 (22.1)	134 (77.9)	
Afternoon	40 (29.6)	95 (70.4)	
Night	39 (35.8)	70 (64.2)	
Age, y	32.14 ± 7.53	30.66 ± 5.22	0.023[c]
Work experience, y	7.43 ± 6.36	6.04 ± 4.96	0.019[c]
working hours/wk, h	48.00 ± 9.55	47.33 ± 12.85	0.560[c]
Number of shifts per month	30.59 ± 8.78	30.38 ± 7.41	0.820[c]
Patients treated/day	8.73 ± 2.29	8.17 ± 2.12	0.024[c]
Number of injection/day	5.82 ± 2.03	5.62 ± 1.84	0.33 0[c]

[a] Quantitative variables were reported as Mean ± SD and qualitative variables as frequency (%).
[b] Chi-square test.
[c] Independent samples t-test.

for the nurses in Iran with respect to the number of patients they care for and the number of tasks and health care services they deliver. Certain factors such as admission to new patients, turnover of patients, documentation and bureaucracy, surgical procedures, and other health care services such as blood sample taking are comparatively more frequent in the morning shift work in Iran's hospitals, escalating WL daily routine daily health care services delivered by nurses and thus the risk of errors such as NSIs is

increased in fulfilling duties.

Our results indicated a significant positive correlation between the number of patients treated per day and NSIs among the participants such that NSIs increased with increasing the number of patients treated per day, which is consistent with other studies (30). A possible explanation is that elevated patient load and short-staffed nurses result in a proportionate increase in nursing occupation intensity and work pressure so that nurses cannot focus on

Table 4. Logistic Regression Model Indicating Factors that Influence on NSIs

Variables	OR (CI 0.95)[a]	B (SE)[b]	Wald Statistical	P Value	R[2c]
Patients treated per day	1.14 (1.02 - 1.27)	0.128 (0.06)	5.45	0.019	
Temporal demand	1.03 (1.02 - 1.05)	0.031 (0.01)	16.96	< 0.001	
Time of injury					0.12
Night	1	-	-	-	
Morning	2.13 (1.20 - 3.79)	0.76 (0.29)	6.72	0.010	
Afternoon	1.48 (0.82 - 2.66)	0.33 (0.30)	1.70	0.190	

[a] Odds ratio (95% confidence interval) resulted from logistic regression model, selection variable was done using backward stepwise method.
[b] Regression coefficient (standard error).
[c] Pseudo R-square (Cox & Snell R Square).

their duties and may frequently experience NSIs [31]. Studies have reported that when the number of nurses is insufficient, the incidence rate of NSIs can be increased by 100% compared with the corresponding rate in normal conditions, which can be attributed to intensified WL [12].

The present study showed that there was a significant positive correlation between temporal demand and NSIs such that increased temporal demand led to increased NSIs rate among the participants. This finding is also in agreement with other researches [32-34]. Nurses who work in hospitals have to face a disproportionate ratio between demands and resources, leading to increased likelihood of occupational stress. Time pressure is one of such stressors [35] that lead to highly emotional reactions [36], physiological and psychological stress, and impaired performance [37]. Stress is associated with occupational injury [38] which, if accompanied by increased WL, can put health and well-being at high risk [39]. Stress and haste have been frequently reported risk factors for NSIs [40]. Available evidence indicates that stress is a common risk factor for NSIs [41, 42].

5.1. Limitations

Regarding the cross-sectional design and the self-reported data in the present study, its findings should be generalized cautiously because such data may suffer from certain drawbacks related to deception, denial, or recall. In addition, we did not measure workload with objective methods, and our findings could have been more conclusive if are supplemented by objective measurements.

5.2. Conclusions

The findings of the present study showed that nurses were exposed to a high risk of NSIs.

According to this study, patients treated per day, the time at injury incidence, and temporal demand were introduced as the contributing factors to increasing NSIs. Based

on our results, for the effective prevention of NSIs among the nurses, the measures below are recommended:

• Planning for systematic educational programs targeted at using PPE, as well as in-service training courses for promoting good injection practices;

• Modifying shiftwork scheduling mainly to reduce working hours and the number morning shifts;

• Hiring sufficient workforce in order to reduce workload;

• Development of safety management systems and educational courses on workplace safety.

Footnotes

Conflict of Interests: The authors declared no conflict of interests regarding this study.

Ethical Considerations: IR.AJUMS.REC.1394.649.

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