ORIGINAL ARTICLE

Musculoskeletal Load Assessment in Hospital Nurses with Patient Transfer Activity

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ABSTRACT

Manual patient handling is known to be the major source of musculoskeletal load among hospital nurses. The objectives of the present study were determination of frequency of musculoskeletal disorders (MSDs) and its associated factors together with assessment of musculoskeletal load due to patient transfer by PTAI method in hospital nursing staff of Shiraz University of Medical Sciences (SUMS), Iran. In this cross-sectional study, 400 randomly selected nurses of SUMS hospital participated. Data were collected by anonymous demographic and Nordic Musculoskeletal Disorders Questionnaires together with PTAI index checklist. Statistical analyses were undertaken using SPSS, version 16. Age and job tenure means of participants were 30.76±6.44 and 6.92±5.75 years, respectively. 88.2% of the nursing staff reported some forms of musculoskeletal symptoms during the 12 months prior to the study. The results of PTAI index assessment demonstrated that in 4%, 8.5% and 87.5% of the subjects, musculoskeletal load were at levels 1, 2 and 3, respectively. The results revealed that PTAI index score was significantly associated with musculoskeletal disorders occurrence ($p<0.001$). Musculoskeletal load was high among nurses with patient transfer activity. Age, nurse to bed ratio, marital status, shift work and PTAI score were associated risk factors for MSDs in the studied nursing staff.

Keywords: *Musculoskeletal load, Nursing personnel, Patient transfer, PTAI index*

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are one of the major kind of occupational injuries [1, 2]. Each job has its own health problems and medical personnel are not an exception [3-5]. WMSDs risk factors are known to include workplace activities such as manual lifting, frequent bending and twisting, excessive force and poor working posture [6-10]. Furthermore, demographic characteristics and psychosocial factors are known to be important predictive variables [9-12].

Medical and healthcare personnel suffer from musculoskeletal disorders more than construction, mining, and manufacturing workers [13-15]. WMSDs in medical personnel and healthcare workers can lead to impaired daily activities, leaving the job or debilitating conditions for nurses, nursing assistants and hospital workers [16-21]. Based on Union of Europe report, number of occupational accidents in health care personnel is 34% more than event average in other occupations [22]. Among health care personnel, physical and psychosocial factors are documented as MSDs risk factors and combination of both increases the risk [23-25].

Due to the nature of tasks, nursing job is known to have high psychophysical demands [8, 26-28]. Furthermore, nursing personnel are exposed to high

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Table 1. Interpreting the PTAI index

>80%	**Level 1:** If the index figure exceeds 80%, the situation in terms of patient transfer ergonomics is good in the evaluated transfers. The evaluator and/or occupational health care representative provide instructions on maintaining and further improving the situation.
60–80%	**Level 2:** If the index figure is 60-80%, the load of patient transfers is quite high, and measures to correct the problems identified in the evaluation form should be taken at the workplace.
<60%	**Level 3;** If the index figure is 60%, the employer must take immediate measures to improve ergonomic working methods. The development measures should utilize the input of employees, occupational health care, the occupational safety and health organization and possibly external experts.

level of musculoskeletal load than other health care personnel [29]. As far as physical activities concern, after industrial jobs, nursing is in the second rank in which work-related musculoskeletal disorders (WMSDs) occur with high prevalence [7, 30-31]. Low back pain with 30-60% prevalence is the most common MSDs among nurses and afterward shoulder disorders with 43-53% prevalence [32]. Additionally, nursing staff have nearly 30% more sick leaves as compared to other working population [33]. It is believed that, patient transfer is the most stressful part of nursing job [34-35].

Although WMSDs is a multi-factorial phenomenon that can be caused by biomechanical, organizational, psychological and individual factors [7, 36-37], but the etiology of musculoskeletal injuries among nursing staff shows that the major causes of these type of injuries are patient transfer (including moving or changing position of patients using physical strength), static postures, monotonous, boring tasks and time pressure [7, 38-39]. Nursing staff with patient transfer tasks are affected by lumbar problems more than others [40]. Inappropriate methods in patient transfer activities as well as nursing personnel's low awareness about use of aid devises are known to be the main causes of occupational injuries in this job group [40].

Since there has been few studies to assess biomechanically patient handling activities and their adverse outcomes among Iranian hospital staff, the present study was conducted to determine frequency of musculoskeletal disorders (MSDs) and its associated factors as well as to assess musculoskeletal load due to patient transfer patient transfer by PTAI method in hospital nursing staff of Shiraz University of Medical Sciences (SUMS). It is believed that MSDs risk factors identification and assessment can be considered as the basis for ergonomic interventional programs and improving working conditions in this profession.

MATERIALS AND METHODS

This cross-sectional study was conducted from August 2011 to March 2012 among 400 randomly selected nurses from 75 wards of 11 hospitals of SUMS.

Study subjects and sample size

The study population consisted of nursing personnel (including nurses, nurse assistants and nurse co-assistants) with patient transfer tasks and more than one

year of job tenure. Individuals with history of diseases or accidents affecting the musculoskeletal system were excluded from the study. Subjects were selected from all hospital wards in which patient transfer was carried out. Stratified random sampling; proportional to size method was used. Based on Choobineh et al. study in which frequency of musculoskeletal disorders in nurses of SUMS hospitals was reported to be 80% [8], with confidence interval of 95% and accuracy of 4%, sample size was calculated to be equal to 400 nursing staff.

Data gathering tool

Data were collected by anonymous questionnaires. Data collection tool consisted of three sections: a) Individual characteristics section (age, job tenure, marital status, number of children, education, nurse to bed ratio, working hours and working system), b) The general Nordic Questionnaire of musculoskeletal symptoms to examine reported cases of MSDs among the study population. Reported MSDs symptoms were limited to the past 12 months [41] and c) PTAI checklist developed in Department of Health Sciences, University of Jyväskylä Finland, 2005 [42-43].

The PTAI consists of 15 items. The first 9 items are assessed through observation by an investigator and the remained 6 items are completed by interviewing nursing personnel. Each item is evaluated on three criteria and is classified as "In order", "Partly in order" or "Not in order" according to the number of sub criteria that are in order. In these Items, different factors such as workplace environment, the need to use lifting aids, requiring the use of non-mechanical means to help patient transfer (e.g. holder belts), the load on the upper and lower limbs, trunk and low back, transfer skills, guidance on the use of patient transfer aids, work cycle, frequency of patient transfer and physical and mental stress caused by patient transfer are evaluated.

The PTAI index was calculated according to the following mathematical expression:

$$\frac{a + (0.67 \times b) + (0.33 \times c)}{d} \times 100 = \% \, PTAI$$

Where,
a: Number of cases in order
b: Number of cases with 2 criteria in order
c: Number of cases with 1 criterion in order

Table 2. Demographic and organizational characteristics of the study population (n = 400)

Demographic and organizational characteristics	Total (n=400)	Musculoskeletal disorders		p-value
		Yes (n=353)	No (n=47)	
Age (yr) (mean±SD)	30.78±6.44	31.22±6.36	27.49±6.13	0.001[†]
Job tenure (yr) (mean±SD)	6.92±5.75	7.21±5.76	4.73±5.25	0.005[†]
BMI (kg/m^2) (mean±SD)	22.78±2.97	22.80±2.97	22.59±3.08	0.649[†]
Daily working hours (hr) (mean±SD)	9.59±1.35	9.60±1.36	9.44±1.28	0.440[†]
Weekly working hours (hr) (mean±SD)	49.48±7.63	51.21±8.70	49.25±7.46	0.098[†]
Nurse to bed ratio (mean±SD)	0.34 ±0.21	0.33±0.21	0. 4±0.19	0.023[†]
Sex:				
Woman	359 (89.8%)	321 (89.4%)	38 (10.6%)	0.041[‡]
Man	41 (10.2%)	32 (78.0%)	9 (22.0%)	
Marital status:				
Single	186 (46.5%)	158 (84.9%)	28 (15.1%)	0.063[‡]
Married	214 (53.5%)	195 (91.1%)	19 (8.9%)	
Number of children:				
=0	248 (62.0%)	209 (84.3%)	39 (15.7%)	0.001[‡]
≥1	152 (38.0%)	144 (94.7%)	8 (5.3%)	
Education:				
High school degree and diploma	63 (15.8%)	56 (88.9%)	7 (11.1%)	
Associate's degree	40 (10.0%)	37 (92.5%)	3 (7.5%)	0.649[‡]
BSc and above	297 (74.2%)	260 (87.5%)	37 (12.5%)	
Job title:				
Nurse	295 (73.8%)	258 (87.5%)	37 (12.5%)	
Nurse assistant	55 (13.8%)	53 (96.4%)	2 (3.6%)	0.136[‡]
Nurse co-assistant	50 (12.4%)	42 (84.0%)	8 (16.0%)	
Work system:				
Shift work	353 (88.2%)	317 (89.8%)	36 (10.2%)	
Day work	47 (11.8%)	36 (76.6%)	11 (23.4%)	0.014[‡]

[†]*Independent t-test between the two groups (with and without MSDs)*
[‡] *Chi-square test between the two groups (with and without MSDs)*

d: Total number of all responses

Then, as shown in Table 1, the result was interpreted based on the PTAI index [43].

Data analysis and statistical procedures

Statistical analyses were performed using SPSS, version 16. Frequency of musculoskeletal disorders was estimated with confidence interval of 95%. Chi-square test was applied to investigate differences in frequency of MSDs as for independent variables including sex, marital status, education, type of employment, and shift working system. Independent sample t-test was used to assess differences in means of age, job tenure, daily and weekly working hours, nurse to bed ratio and BMI between the two groups with and without MSDs. MSDs associated risk factors were determined by multiple logistic regression analysis (forward: Wald). In the regression analysis, if the p-value of univariate analysis

for assessing association between the variables and reported symptoms was ≤0.25, the variable was included in the regression model [44]. In all tests, the level of significance was set at 0.05.

RESULTS

Demographic and organizational characteristics in the entire study population as well as frequency of reported musculoskeletal problems in at least one region of the subjects' bodies are presented in Table 2. As shown, the means of age and job tenure were 30.78±6.44 and 6.92±5.75 years, respectively. The mean of working hours per day and per week were 9.59±1.35 and 49.48±7.63 hours, respectively. The mean of nurse to bed ratio was 0.34 ±0.21 and the mean of BMI was 22.78±2.97kg/m^2. 89.8% of subjects were women and 53.5% were married. The study population consisted of 73.8% nurses, 13.8% nurse assistants and

Table 3. Frequency of musculoskeletal disorders in different body regions of nurses studied over the past 12 months (n=400)

Body region	No. (percent)	Confidence interval (CI$_{95\%}$)
Neck	169(42.2)	(37.2 - 47.2)
Shoulder	168(42.0)	(37 - 47)
Elbow	84(21.0)	(17 - 25)
Hand/wrists	258(64.5)	(59.5 - 69.5)
Upper back	135(33.8)	(28.8 - 38.8)
Lower back	286(71.5)	(67 - 76)
Hip	66(16.5)	(12.5 - 20.5)
Knee	214(35.5)	(30.5 - 40.5)
Leg	273(68.2)	(63.2 - 73.2)

Table 4. PTAI index level in study subjects

PTAI index	Frequency (%)
Level 1 (>80%)	16 (4.0)
Level 2 (60–80%)	34 (8.5)
Level 3 (<60%)	350 (87.5)

12.4% nurse co-assistants. 84.2% of the subjects had college degrees and 88.2% of the subjects worked in shift system. Study of demographic and organizational characteristics among nursing staff with and without MSDs groups revealed that differences in means of age (p=0.001), job tenure (p=0.005), nurse to bed ratio (p=0.023), sex (p=0.041), number of children (p=0.001) and shift working system (0.014) were significant between the two groups (Table 2). BMI, hours of work per day and per week, marital status and education were not significantly different between the two groups (p>0.05).

Table 3 illustrates the frequency of MSDs in each body regions of the subjects during the past 12 months. Low back 71.5% (CI$_{95\%}$: 67-76), leg 68.2% (CI$_{95\%}$: 63.2-73.2), hand/wrist 64.5% (CI$_{95\%}$: 59.5-69.5), neck 42.2% (CI$_{95\%}$: 37.2-47.2) and shoulder 42% (CI$_{95\%}$: 37-47) symptoms were the most prevalent reported problems among the subjects.

The results of PTAI index assessment in the studied subjects are presented in Table 4. As shown, 4.0% of nursing staff were categorized in level 1 (index >80%), 8.5% in level 2 (index 60–80%) and 87.5% in level 3 (index <60%) of PTAI exposure index. According to the results, approximately 90.0% of study subjects were in level 3 and exposed to high level of musculoskeletal load and, therefore, they were at high risk for developing MSDs.

Table 5 displays significant factors associated with MSDs in the studied nursing staff. Statistical analysis between the two independent groups (with and without musculoskeletal disorders) showed that age, job tenure,

number of working hours per week, nurse to bed ratio, gender, marital status, number of children, shift working and PTAI index were eligible to be included in the logistic regression model (p<0.25). The final model showed that age, nurse to bed ratio, marital status, shift work system and PTAI score had significant relationship with MSDs. Additionally, the results showed that for every one year increase in age, chance of MSDs occurrence enhanced by 1.26 (p=0.017). Also, with each unit increase in nurse to bed ratio, chance of MSDs occurrence decreased by 2.7 (p<0.030). Regression modeling also revealed that the chance of MSDs occurrence among married subjects was 3.58 times more than single individuals (p<0.012) and among shift workers was 5.15 times more than day workers (p<0.001). Besides that, regression analysis demonstrated that PTAI score remained in the model indicating that the higher PTAI index, the higher the chance of MSDs occurrence among nursing staff. Regression modeling indicated that the chance of MSDs occurrence among PTAI index level 2 and 3 were 2.40 (p=0.020) and 4.33 (p=0.022) times more than PTAI index level 1, respectively.

DISCUSSION

The findings revealed that the studied nursing staff consisted of a relatively young population with low job tenure and normal BMI. The frequency of MSDs in this study was 88.2% which was in agreement with the results of other studies conducted on nursing personnel [8, 10, 13, 15, 29].

Table 5. Regression models indicating factors with the strongest on influence occurrence of MSDs in the study population (n=400)

Variables	B (SE)[†]	p-value[‡]	OR (CI$_{95\%}$)[††]
Age	0.210 (0.094)	0.017	1.26 (1.12-1.67)
Nurse to bed ratio	-1.30 (0.604)	0.030	0.27 (0.08-0.88)
Marital status			
Single			1.0
Married	1.27 (0.510)	0.012	3.58 (1.32-9.73)
Work system			
Day work			1.0
Shift work	1.67 (0.439)	0.001	5.15 (1.49-17.86)
PTAI index			
>80%			1.0
60–80%	0.87 (0.376)	0.020	2.40 (1.15-5.02)
<60%	1.46 (0.641)	0.022	4.33 (1.23-15.20)

[†] *Regression Coefficient (Standard Error)*

[‡] *Binary logistic regression analysis*

[††] *Odds Ratio (Confidence Interval $_{95\%}$)*

The frequency of MSDs in various body regions showed that lower back (71.5%) was the most commonly affected region among the study population. This is consistent with the result of other studies [32]. The frequency of reported symptoms in legs and hands/wrists regions ranked second and third, respectively. According to the researchers' observations, it could be explained that nursing personnel with patient transfer tasks were commonly working in standing position and required exerting excessive force with their hands for handling tasks (i.e. changing position, lifting and transferring patients).

Based on the results, the differences between means of age and job tenure in the two groups (i.e. with and without disorders) were statistically significant (*p*<0.05) such that frequency of MSDs in younger staff with low job tenure was significantly less than older subjects with higher job tenure. BMI index was higher in the group with MSDs, but BMI mean difference between the two groups was not statistically significant (*p*>0.05). Nurse to bed ratio is an organizational factor that can be considered as a contributing factor for musculoskeletal disorders occurrence [45]. Nurse to bed ratio in the present study was found to be low. But, the important point was that this ratio in the two groups (with and without MSDs) was significantly different (*p*=0.023) such that in the group with MSDs the ratio was lower. Based on this finding, one might tentatively infer that shortage of nursing personnel in patient transfer tasks could lead to more musculoskeletal load on nursing staff and ultimately occurrence of musculoskeletal disorders.

Similar to the result of other studies [12], MSDs symptoms were more prevalent among female than male nursing staff. Additionally, association was found between shift working and MSDs which was in line with the results of other studies [46]. This association could be attributed to the load of work at unusual working time. Also, researchers' observations showed that stress induced by night shift due to the lack of enough nursing staff was more than that of day shift.

PTAI index assessment in the study subjects revealed that 87.5% of the participants were exposed to the high risk of musculoskeletal injuries and risk level 3. Therefore, according to PTAI guideline and instruction, immediate measures should be undertaken to improve ergonomic working methods and to eliminate or minimize musculoskeletal loads in nursing staff [43].

WMSDs are multi-factorial health problems that can be induced by physical, organizational, psychological and individual factors [7, 36-37, 47]. Data analysis using binary logistic regression revealed that after adjusting for confounding variables, occurrence of MSDs in the studied nursing staff was associated with age, nurse to bed ratio, marital status, shift work and PTAI score. Statistical analysis displayed that the occurrence of MSDs in the studied population was related with PTAI exposure score. Chance of MSDs occurrence among nursing staff enhanced as PTAI score increased. The modeling indicated that the chance of MSDs occurrence among subjects in level 2 were about 2.5 times higher than subjects in level 1 and this chance among subjects in level 3 were 4 times more than higher than subjects in level 1.

Totally, the findings of our study demonstrated that failure to meet criteria such as workplace conditions (i.e. temperature, air flow and lighting), the physical parameters of the workplace (i.e. enough space and adaptive equipment such as patients' beds and chairs), use of lifting aids and other assistive devices, training of patient transfer skills, correct working postures, etc. could be effective factors in occurrence of MSDs. Based on the results, any interventional program for

preventing or reducing MSDs among SUMS hospital nursing staff with patient transfer tasks had to focus on the above mentioned parameters. Furthermore, other associated factors, in particular, nurse to bed ratio should also be taken into consideration.

CONCLUSION

Assessment of MSDs risk using PTAI index in nursing staff with patient transfer tasks indicated that approximately 90% of the subjects were exposed to high level of musculoskeletal loads and disorders. Age, nurse to bed ratio, marital status and shift work were also associated risk factors for MSDs in the studied nursing staff.

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