

Perceived Demands and Musculoskeletal Disorders in Operating Room Nurses of Shiraz City Hospitals

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Abstract: Excessive demands on Operation Room (OR) nurses may result in high rates of Musculoskeletal Disorders (MSDs). This study was conducted among Shiraz city hospital OR nurses to determine the prevalence of MSDs and to examine the relationship between perceived demands and reported MSDs. In this cross-sectional study, 375 OR nurses participated (response rate: 80%). The Nordic Musculoskeletal Disorders Questionnaire and the Job Content Questionnaire were used as collecting data tools. Lower back symptoms were found to be the most prevalent problem in the OR nurses studied with a past year prevalence of 60.6%. Perceived physical demands were significantly associated with musculoskeletal symptoms (odds ratio ranged from 2.04 to 7.24). Manual material handling (MMH) activities were most frequently associated with reported symptoms. Association was also found between perceived psychological demands and reported symptoms (odds ratio > 1.68). Based on the findings of this study, it could be concluded that operation room was not only a physically but also psychologically demanding environment. Any interventional program for preventing or reducing MSDs among OR nurses had to focus on reducing physical demands, particularly excessive MMH demands as well as considering psychological aspect of working environment.

Key words: Musculoskeletal symptoms, Operation room nurses, Perceived demands, Psychosocial factors

Introduction

Musculoskeletal disorders (MSDs) represent one of the leading causes of occupational injury and disability in the developed and industrially developing countries^{1–6}. Risk factors are known to include workplace activities such as heavy lifting and repetitive tasks⁷, while demographic characteristics and psychosocial factors are also known to be important predictive variables^{8–12}.

Among healthcare workers, MSDs represent a major

occupational problem and a significant cause of morbidity^{11, 13}. Many studies have shown an association between MSDs and workplace factors. For instance, studies have revealed that hospital nurses form an occupational group regularly affected by MSDs^{4, 14–25}. Some studies have shown that physical and psychological demands might cause health care workers to leave their profession^{16, 25}.

While most investigations have concentrated on general hospital nurses, little is known about ergonomic stresses in a more specific group of hospital workers, such as the Operation Room nurses (OR nurses)^{26–32}.

OR nurses are among those in the hospital to be

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exposed to MSDs risk factors. In this occupation, as categorized by Meijssen *et al.*³⁰⁾ there are some risk factors that could be responsible for discomfort and disorders of musculoskeletal system. The risk factors include static stress (e.g., prolonged standing and fixed postures, holding equipments such as retractors during surgical procedure) and manual handling (e.g. pulling/pushing or lifting instruments sets, patients and heavy equipments).

Thirty years ago Dudley³³⁾ noted that “. . . looked at from the ergonomic point of view most major operations are, at first sight, a mess.” (which means that everything is not properly designed). Even after 30 yr, there are still ergonomics problems in operation rooms. This was illustrated by a study using a direct observation method in which it was found that OR nurses were exposed to prolonged awkward working postures during operation.

OR nurses may also suffer from stress and burnout caused by night work, and other psychological and organizational factors³⁴⁾. In this situation, high rates of MSDs are expected.

In Iran, personnel working in the operation room typically are not nurses. Personnel who want to work as an OR nurse undertake a two-year education program at university, after which they become accredited. In the circulator role, they accompany the patient in all phases of the surgical procedure and are the link between the sterile team and the environment. In the scrub person role, they pass instruments as members of the sterile team and assist the surgeon in the procedure itself. Usually, an OR nurse works in rotation, which means that when they have a scrub role for the surgery, they work as circulator for the next one.

Although it seems that an OR nurse's duties as a circulator are some how like a general nurse but as a scrub he/she has to assist the surgeon during surgery, but general nurses does not have such this duty. Due to some differences between OR and general nurse duties, extrapolating results from general hospital nurse to OR nurse is not justified. This study was, therefore, conducted among OR nurses of Shiraz city hospitals, Iran with the following objectives: a) determination of the prevalence rate of musculoskeletal symptoms (ache, pain and/or discomfort) among OR nurses, b) identification of major factors associated with symptoms in the study population, and c) examination of the relationship between perceived physical and psychological demands and reported symptoms in different body regions of OR nurses, taking into consideration the impact of other potentially confounding variables. It is believed that the results of this study can be an appropriate base for planning and implementing interventional ergonomics programs in the workplace and improving OR nurses' health.

Subjects and Methods

Design and samples

In this cross-sectional study conducted from February 2007 to September 2007, data were collected via anonymous questionnaires from 375 of 470 active OR nurses in Shiraz city hospitals, Iran, with at least one year of job tenure who participated voluntarily in this study.

The six-page questionnaire consisted of three parts and covered the following items: personal details (including gender, age, weight, height, body mass index (BMI), job tenure, daily working time (h), monthly working time (h), marital status, number of children, education, working schedule, health and medical background); musculoskeletal problems in different body regions; and perceived job demands. Reported musculoskeletal symptoms were limited to the past 12 months. Each participant received the questionnaire in person in her/his workplace. Of all eligible subjects, 375 returned the questionnaire (response rate was totally 80%). The study protocol was reviewed and approved by Shiraz University of Medical Sciences ethics committee.

Measurement of variables

The Persian version of general Nordic Questionnaire of musculoskeletal symptoms was used to examine reported cases of MSDs among the study population³⁵⁾. The Job Content Questionnaire (JCQ) was used to measure perceived job demands³⁶⁾. The JCQ contains items of work demands including both physical and psychological aspects. It has been used to study the relationship between work demands and work-related outcomes (i.e., MSDs, cardiovascular disease, etc.) in different countries³⁷⁾. Additional occupation-specific physical demand items for nursing job, as recommended by Trinkoff *et al.*¹⁶⁾, were also included. Physical and psychological demands were measured using the twelve-item and the eight-item JCQ scales, respectively²⁵⁾ (See the appendix for items). Each item was scored based on a four-point scale (i.e., strongly agree to strongly disagree or often to never). Items were in Persian language and their linguistic validity had been assessed through forward and backward translation methodology. In this methodology, the items was translated into Persian by a qualified translator, native speaker of Persian and proficient in English (forward translation), and then translated back into English by a qualified English translator, blind to the original English questions (backward translation). The JCQ center reviewed the back-translated English version for comparison with the original version. Based on the reviews, some items were corrected. To check the Iranian workforce's understanding and interpretation of the translated items and thereby validate the conceptual equivalence

lence between the English and the Persian version (cognitive debriefing), the P-JCQ was administered among 20 hospital nurses. The nurses were asked to put a note beside the ambiguous questions. Based on the JCQ center amendments and the nurses' notes, the final P-JCQ was prepared. The process of linguistic validation of the P-JCQ has been presented in details elsewhere³⁸. Reliability and validity of the P-JCQ were explored among 107 hospital nurses in a separate study showing satisfactory psychometric properties of the questionnaire³⁹.

Based on the methodology used by Trinkoff *et al.*¹⁶, responses for perceived physical demands were dichotomized (1 and 2 vs. 3 and 4) and summed to produce total scores ranged from 0 to 12. The results were then categorized as low (0 to 2), medium (3 to 9), and high (10 to 12) physical demands. Items for perceived psychological demands were dichotomized also (1 and 2 vs. 3 and 4) and summed into a demand score to produce total scores ranged from 0 to 8. Perceived psychological demands were then categorized as low (0 to 5) and high (6 to 8) psychological demands.

The reliability of the responses to questions in the questionnaire has been determined and approved in a previous study conducted by Choobineh *et al.*²⁵ on hospital nurses using test-retest methodology.

Data analysis

Statistical analyses were performed using SPSS (version 11.5) and STATA (version 7). χ^2 tests were used to assess univariate associations between perceived variables and reported musculoskeletal symptoms. Multiple logistic regression analysis (forward: Wald) was performed for each of outcome retaining the variables (individual and perceived) in the models to adjust for potential confounding. In the regression analysis, if the *p*-value of χ^2 test for assessing association between the variable and reported symptoms was ≤ 0.25 , the variable was included in the regression model of that region (inclusion criteria)⁴⁰. For each body region, this procedure was performed for all individual and perceived variables.

Results

Table 1 summarizes personal details of the OR nurses who participated in the study. From all subjects 66.4% were female and 33.6% were male. Table 2 presents the prevalence of MSDs symptoms in different body regions of the OR nurses during the last 12 months. As Table 2 shows, the most commonly affected regions among the OR nurses were lower back (60.6%), ankles/feet (59.0%), knees (58.1%) and upper back (54.6%). Women were significantly more affected than men in shoulders,

wrists/hands, upper back, lower back and ankles/feet ($p < 0.05$).

During the preceding year, due to musculoskeletal problems, 38.5% of the OR nurses studied had to visit a physician; 25.1% of the OR nurses studied took medical rest; and 18.8% of them needed to use physiotherapy services. Fifty seven percent of the participants believed that musculoskeletal problems would cause them to change their jobs in future.

Regarding to the definition of WHO for aged workers⁴¹, respondents were categorized into two age groups: group 1 were less than 45 yr old while group 2 represented those 45 yr old or older. Around 90% of the participants were in group 1. Except for wrists/hands, there was no significant difference between the two groups according to the prevalence of MSDs (Table 3). Based on the result, it seemed that wrists/hands symptoms had higher prevalence among younger OR nurses than their older counterparts.

Since the work posture and duration of surgery may be dependent on the type of operations being performed, they were categorized into three groups including orthopedics and neurosurgery, cardiac surgery and other surgeries. The duration of operation in group one is longer than the two other groups. However, psychological demand seems high in group two. Table 4 depicts the prevalence of MSDs symptoms in different body regions of the OR nurses based on the type of operation. Statistical analysis assessing associations between the type of operation and reported symptoms in different body regions showed that prevalence of knee problems in groups one and two (64.9% and 69.7%, respectively) was significantly higher than that of group 3 (51.7%) with a *p*-Value of 0.025. Since prolonged standing posture is common in their tasks, this result was expected. In other body regions, no significant difference was found between prevalence rates of reported symptoms among the three groups ($p > 0.05$).

Table 5 presents significant factors associated with musculoskeletal problems for each body region. The significant factors for each body region are the result of a multiple logistic regression analysis performed to adjust for potential confounding. As Table 5 shows, some items of perceived physical as well as psychological demands were significantly associated with reported musculoskeletal symptoms of different body regions. Pulling, pushing, moving, lifting and lowering heavy objects, working while bent or twisted at the waist and repetitive motions with hands/wrists were the main physical factors retained in the regression models with odds ratios generally greater than 2. Conflicting demands, waiting on work from other people or departments and not enough time to get the job done were the main psychological factors retained in the regression models with odds ratios generally greater than

Table 1. Some personal details of the OR nurses participated in the study

Personal variables	Male (n=126)	Female (n=249)	Total (n=375)
Age (yr)			
M (SD)	34.16 (9.08)	30.20 (7.80)	31.54 (8.46)
Min-Max	19–62	20–56	19–62
Weight (kg)			
M (SD)	72.79 (9.70)	58.08 (9.47)	63.09 (11.81)
Min-Max	51–95	40–98	40–98
Height (cm)			
M (SD)	173.57 (6.62)	161.93 (6.34)	165.94 (8.48)
Min-Max	160–186	140–178	140–186
Body Mass Index			
M (SD)	24.18 (3.01)	22.11 (3.31)	22.83 (3.35)
Min-Max	16.25–32.53	15.76–37.34	15.76–37.34
Job tenure (yr)			
M (SD)	11.19 (8.36)	7.41 (7.03)	8.6 (7.6)
Min-Max	1–33	1–35	1–35
Daily working time (h)			
M (SD)	11.33 (2.56)	9.90 (3.10)	10.4 (3.0)
Min-Max	6–20	4–20	4–20
Monthly working time (h)			
M (SD)	256.63 (70.65)	202.27 (45.95)	221.20 (61.42)
Min-Max	60–420	66–350	60–420
Marital status (%)			
Single	19.8	49.0	39.3
Married	80.2	51.0	60.7
Children (%)			
Yes	57.7	30.0	39.2
No	42.3	70.0	60.8
Working schedule (%)			
Shift	84.1	85.1	85.5
Fixed	15.9	14.9	14.5
Type of operation (%)			
Orthopedic & Neurosurgery	55.4	21.5	32.8
Cardiac Surgery	14.0	6.6	9.1
Other operations	30.6	71.9	58.1

Table 2. Frequency of reported symptoms in different body regions of the male and female OR nurses during the 12 months prior to the study

Body Regions	Male (n=126) (%)	Female (n=249) (%)	Total (n=375) (%)	p-value*
Neck	50.8	52.5	51.9	0.823
Shoulders	40.8	57.0	51.7	0.004
Elbows	20.8	23.9	22.9	0.517
Wrists/Hands	35.0	53.1	47.1	0.001
Upper back	46.6	58.4	54.6	0.034
Lower back	51.7	65.0	60.6	0.014
Hips/Thighs	26.1	33.1	30.7	0.175
Knees	57.5	58.4	58.1	0.865
Ankles/Feet	48.3	64.2	59.0	0.004

*Fisher's Exact Test of the prevalence of the symptoms between male and female groups.

Table 3. Frequency of reported symptoms in different body regions of the OR nurses during the 12 months prior to the study based on age groups (n=375)

Body Regions	Age groups		<i>p</i> -value*
	Age<45 (n=335) (%)	age≥45 (n=40) (%)	
Neck	53.1	40.5	0.147
Shoulders	51.9	48.6	0.711
Elbows	23.2	16.2	0.334
Wrists/Hands	49.2	27.0	0.010
Upper back	55.8	43.2	0.148
Lower back	60.1	64.9	0.571
Hips/Thighs	31.2	21.6	0.232
Knees	57.9	56.8	0.894
Ankles/Feet	59.8	48.6	0.194

* χ^2 analysis of the prevalence of the symptoms between age groups.

Table 4. Frequency of reported symptoms in different body regions of OR nurses during the 12 months prior to the study based on the operation type

Body Regions	Operation type			<i>p</i> -value*
	Orthopedics and neurosurgery (n=119) (%)	Cardiac surgery (n=33) (%)	Other operations (n=211) (%)	
Neck	56.1	54.5	48.0	0.354
Shoulders	50.0	54.5	52.0	0.886
Elbows	26.3	33.3	18.5	0.081
Wrists/Hands	44.7	42.4	49.3	0.628
Upper back	57.5	57.6	52.7	0.667
Lower back	64.9	51.5	58.5	0.314
Hips/Thighs	31.0	30.3	30.4	0.994
Knees	64.9	69.7	51.7	0.025
Ankles/Feet	57.9	60.0	61.0	0.862

* χ^2 analysis of the prevalence of the symptoms between operation type groups.

1.68. This indicates that among all factors included in the regression models, the mentioned physical and psychological items had noticeable association with reported symptoms in different body regions.

Gender and BMI were the only demographic factors retained in the regression models. Gender was found to be a significant factor for shoulders, wrists/hands, lower back and ankles/feet with odds ratios ranging from 1.71 to 2.14. It meant that musculoskeletal symptoms occurrence was more probable in the mentioned regions among women (66.4% of the OR nurses studied) as compared to men (33.6% of the OR nurses studied). BMI was a significant factor for lower back problems with odds ratio equal to 2.12. Shift working was also revealed to be associated with musculoskeletal problems in neck, upper back and knee regions with odds ratio ranging from 2.29 to 3.38, meaning those OR nurses working in shift system

were more at risk of symptoms of the mentioned regions as compared to those who were day workers.

The association between the level of perceived demands and reported symptoms in different body regions of the male and female OR nurses are presented in Table 6. Since the number of OR nurses categorized in low perceived physical demands level was small, to perform meaningful statistical analysis, the low and the medium physical demands levels were combined to form a low-medium physical demands level. As Table 6 shows, in total population, the prevalence of symptoms in all body regions except the lower back and the neck were significantly higher in high physical demands level group ($p<0.05$), indicating the association between high perceived physical demands and the prevalence of symptoms. Regarding psychological demands, the same result was obtained, showing that in all body regions; except for the

Table 5. Models indicating factors with the strongest influence on musculoskeletal symptoms in different body regions of the OR Nurses

Body region	Variables retained in the model			
	Variables	Odds ratio	95%CI*	p-value
Neck (n=339) [†]	Pull/push heavy objects	5.35	1.50–19.12	0.010
	Shift working	2.54	1.33–5.01	0.005
Shoulders (n=325) [†]	Lifting or lowering objects to/from shoulder height	3.04	1.65–5.59	<0.0001
	Conflicting demands	1.68	1.04–2.73	0.035
	Shift working	3.26	1.59–6.67	0.001
	Gender	1.71	1.03–2.81	0.037
Elbows (n=267) [†]	Lifting or lowering objects to/from shoulder height	2.63	1.06–6.53	0.037
Wrists/Hands (n=312) [†]	Repetitive motions with hands/wrists	2.88	1.31–6.31	0.008
	Waiting on work from other people or departments	2.13	1.30–3.48	0.003
	Gender	2.14	1.26–3.64	0.005
Upper back (n=258) [†]	Pull/push heavy objects	6.16	1.31–29.02	0.021
	No enough time to get the job done	2.25	1.26–4.01	0.006
	Shift working	2.29	1.09–4.85	0.03
Lower back (n=321) [†]	Working while bent or twisted at waist	2.04	1.09–5.31	0.030
	BMI	2.12	1.16–3.88	0.014
	Gender	1.71	1.04–2.80	0.034
Hip/Thighs (n=329) [†]	Waiting on work from other people or departments	2.01	1.15–3.49	0.014
	No enough time to get the job done	1.85	1.03–3.36	0.041
Knees (n=279) [†]	Often moving/lifting very heavy loads	7.24	1.54–34.14	0.012
	Waiting on work from other people or departments	2.30	1.36–3.90	0.002
	Shift working	3.38	1.57–7.25	0.002
Ankles/Feet (n=329) [†]	Lifting or lowering objects to/from floor	4.97	1.73–14.29	0.003
	Waiting on work from other people or departments	2.14	1.32–3.47	0.002
	Gender	2.03	1.24–3.30	0.005

* Confidence interval, [†]Number of observations.

neck, the prevalence of symptoms were significantly higher in the high psychological demands level group ($p<0.05$). This indicated association between high perceived psychological demands and the prevalence of symptoms. As shown in Table 6, similar results were obtained for female OR nurses. This meant that in most body regions the prevalence of symptoms were higher among the high demands group as compared to that of the other group. Among male OR nurses, although in some body regions the prevalence of symptoms was significantly higher among high demands level group, but it was not the case for most regions.

Discussion

Musculoskeletal symptoms prevalence

A vast majority of the study population had experienced some form of MSDs during the past 12 months (85.7%). Lower back symptoms were the most prevalent problem. This is in accord with the findings of Meijssen *et al.*³⁰⁾ on

the low back pain prevalence in OR nurses that was 58% and the other studies conducted on health care workers^{15, 18–20, 22–23, 25, 42)}. Bos *et al.*³²⁾ found higher prevalence of the lower back in the OR nurse (76.6%) that could be due to different assignments and variety of tasks. Taking the long hours of continuous work of the OR nurses with standing posture into consideration, a high rate of reported symptoms in knees and ankles/feet was expected. Similar to what Bos *et al.*³²⁾ found, the study population suffer from neck and shoulder problem more than the general nurses with prevalence of 36.4% and 39.8%, respectively, as Choobineh *et al.*²⁵⁾ reported. This could be attributable to more prolonged standing posture with the head bent forward. Comparison of the results of this study with the results of the National Health Survey of Iran⁴³⁾ revealed that the prevalence rates of MSDs in different body regions of the OR nurses studied were significantly higher than those of the general Iranian population, in accordance with the findings of Meijssen *et al.*³⁰⁾ in the Netherlands, which indicates that OR nurse's job

Table 6. Frequency of reported symptoms in different body regions of the male and female OR nurses during the 12 months prior to the study

Body regions	Perceived demands					
	Physical			Psychological		
	Low-medium*	High†	<i>p</i> -value‡	Low**	High††	<i>p</i> -value‡‡
Male:	(n=13)	(n=101)		(n=35)	(n=84)	
Neck	4 (33.3%)	51 (52.6%)	0.237	13 (40.6%)	44 (54.3%)	0.215
Shoulders	2 (16.7%)	42 (43.3%)	0.118	9 (28.1%)	38 (46.9%)	0.090
Elbows	0 (0.0%)	24 (24.7%)	0.065	5 (15.6%)	19 (23.5%)	0.449
Wrists/Hands	3 (25.0%)	37 (38.1%)	0.530	8 (25.0%)	32 (39.5%)	0.191
Upper back	3 (25.0%)	48 (50.3%)	0.128	8 (25.0%)	41 (51.3%)	0.019
Lower back	5 (41.7%)	53 (54.6%)	0.542	14 (43.8%)	44 (54.3%)	0.404
Hip/Thigh	0 (0.0%)	28 (29.2%)	0.034	6 (18.8%)	24 (30.0%)	0.249
Knees	3 (25.0%)	57 (58.8%)	0.033	14 (43.8%)	51 (63.0%)	0.090
Ankles/Feet	1 (8.3%)	48 (49.5%)	0.011	10 (31.3%)	45 (55.6%)	0.023
Female:	(n=24)	(n=206)		(n=60)	(n=168)	
Neck	9 (37.5%)	110 (54.7%)	0.132	29 (48.3%)	87 (54.0%)	0.454
Shoulders	9 (37.5%)	124 (61.7%)	0.028	25 (41.7%)	101 (62.7%)	0.006
Elbows	1 (4.2%)	53 (26.2%)	0.020	9 (15.0%)	46 (28.4%)	0.053
Wrists/Hands	6 (25.0%)	116 (57.4%)	0.004	21 (35.0%)	98 (60.5%)	0.001
Upper back	10 (41.7%)	122 (60.4%)	0.085	23 (38.3%)	104 (62.2%)	0.001
Lower back	13 (54.2%)	135 (66.8%)	0.257	32 (53.3%)	111 (68.5%)	0.041
Hip/Thigh	4 (16.7%)	73 (36.3%)	0.068	9 (15.3%)	67 (41.4%)	<0.0001
Knees	9 (37.5%)	124 (61.4%)	0.029	23 (38.3%)	107 (66.0%)	<0.0001
Ankles/Feet	12 (50.0%)	36 (67.3%)	0.112	30 (50%)	115 (71.0%)	0.004
Total:	(n=37)	(n=307)		(n=95)	(n=252)	
Neck	13 (36.1%)	161 (54.0%)	0.052	42 (45.7%)	131 (54.1%)	0.179
Shoulders	11 (30.6%)	166 (55.7%)	0.005	34 (37.0%)	139 (57.4%)	0.001
Elbows	1 (2.8%)	77 (25.8%)	0.001	14 (15.2%)	65 (26.7%)	0.030
Wrists/Hands	9 (25.0%)	153 (51.2%)	0.004	29 (31.5%)	130 (53.5%)	<0.0001
Upper back	13 (36.1%)	170 (57.2%)	0.021	31 (34.1%)	145 (59.9%)	<0.0001
Lower back	18 (50.0%)	188 (62.9%)	0.149	46 (50.0%)	155 (63.8%)	0.025
Hip/Thigh	4 (11.1%)	101 (34.0%)	0.004	15 (16.5%)	91 (37.6%)	<0.0001
Knees	12 (33.3%)	181 (60.5%)	0.002	37 (40.2%)	158 (65.0%)	<0.0001
Ankles/Feet	13(36.1%)	184 (61.5%)	0.004	40 (43.5%)	160 (65.8%)	<0.0001

*Score 0–9, †Score 10–12, ‡Fisher's Exact Test of the prevalence of the symptoms between low-medium and high groups,

**Score 0–5, ††Score 6–8, ‡‡Fisher's Exact Test of the prevalence of the symptoms between low and high groups.

can be considered as a high-risk occupation for developing MSDs.

Musculoskeletal symptoms associated factors

a) Perceived physical demands

Statistical analysis of the data, similar to the other studies findings^{28–31}, showed that perceived physical demands i.e., pulling/pushing heavy objects, moving/lifting/lowering heavy loads, repetitive motions with hands/wrists and bent or twisted posture of the trunk, were significantly associated with musculoskeletal symptoms in different body regions. In accordance with Addington's

results²⁸), there was no relationship between lifting or lowering and low back problem, while bending and twisting at the waist had association. Among the perceived physical demands investigated in this study, manual material handling activities including pulling/pushing heavy objects such as a stretcher and moving/lifting/lowering heavy loads such as patients, surgical sets, etc. were found to be the most frequently and strongly associated with reported musculoskeletal symptoms in different body regions with a high odds ratio. However, this is not in line with the findings of studies conducted on nursing staff in which awkward posture was reported to be the

main contributing factor for MSDs among nurses^{16, 25}). Biomechanical studies in medical domain have shown the danger of patient-handling activities that exceed body tolerances¹⁵). Our findings are in accordance with the results of a study conducted on Italian X-ray technologists in which physical workload was found to be associated with occurrence of MSDs¹¹).

b) Perceived psychological demands

Statistical analysis revealed that some psychological factors including conflicting demands that others made, waiting on work from other people or departments (i.e. central sterilization department or CSR) and no enough time to get the job done were significantly associated with musculoskeletal symptoms in different body regions and retained in the regression models. This is in agreement with Meijssen *et al.*³⁰), however, Choobineh *et al.*²⁵) found no psychological factor associated with musculoskeletal problems among nurses. Kerr *et al.*⁴⁴) pointed out that when physical demands were included in a model of musculoskeletal problems, the significance of psychological demands disappeared. In our study, remaining psychological factors in the regression models may indicate the strong influence of these factors and imply that the OR nurses studied could encounter high level of psychological demands.

Bongers *et al.* (2002) in an extensive review on the role of psychosocial factors in the development of musculoskeletal symptoms found that in the majority of the studies reviewed an association between psychosocial factors and upper extremity symptoms had been reported. High perceived workload, time pressure, low control on the job and poor social support were among those factors consistently associated with these disorders in many studies⁴⁵). In the present study, no psychological factor was retained in the neck and the elbows regression models, but for shoulders and wrists/hands, conflicting demands and waiting on work from others were remained in the regression models, respectively, with noticeable odds ratios showing the influence of these psychological factors on adverse symptoms of these two body regions, which was in agreement with the report of Bongers *et al.*

Totally, Our findings are in line with the results of other such studies suggesting psychological issues as increasingly important MSDs risk factors for nurses in Asia and other parts of the world⁴⁶). The results are also similar to those of Italian X-ray technologists study in which psychological workload was found to be associated with occurrence of MSDs¹¹), as well as that of Szeto *et al.* (2009) who found psychosocial factors to be significantly associated with the symptoms severity of the lower back⁴⁷).

c) Demographic factors

Gender was a significant factor retained in the models for shoulders, wrists/hands, lower back and ankles/feet with odds ratios ranging from 1.71 to 2.14. This indicated that the chance of musculoskeletal disorders occurring in the above mentioned regions among females was more likely than males. This is in agreement with the findings of Choobineh *et al.*²⁵).

BMI was also a significant factor for lower back problems with odds ratio equalled to 2.12. This meant that among those with abnormal BMI (BMI<18.5 or BMI>26), the chance of musculoskeletal problems occurring in the lower back region was nearly twice more likely than among the subjects with a normal BMI. Although age was found to be a significant factor for wrists/hands symptoms in χ^2 test, but it was not retained in the regression model of this region. It could be inferred that age was a confounding variable for this region which was omitted from the model in regression analysis. There was no association between working hours nor job tenure and prevalence of MSDs. This is in accord with Bos *et al.*³²).

Shift working was also a significant factor retained in the regression models of neck, upper back and knees regions, which increased the chance of MSDs occurring nearly 2 to 3 times among the OR nurses. This finding is in line with some studies reporting more risk on the rotating shift¹³). For other regions, no significant association was found between the symptoms and shift working which was in accord with some other studies showing no significant relationship¹³).

Perceived demands level influence

Statistical analysis revealed that in the total population when comparing the low and the high perceived demands groups, both high physical and psychological demands had influence on the prevalence of symptoms in almost all body regions with the exception of the lower back and the neck for physical and the neck for psychological demands. This indicates the consistency of the results of statistical analyses presented in Tables 5 and 6. For psychological demands, similar results were obtained among female OR nurses, but the pattern for male differed. This indicated the influence of gender on the association between level of perceived psychological demands and symptoms occurrence. It could imply that in the OR nurses studied women were more susceptible to psychological demands than men. For physical demands, the results revealed that the level of perceived demands had significant influence on MSDs symptoms occurrence among both men and women; however the body regions influenced were not the same in both genders (i.e. hip/thigh, knees and ankles/feet among men and shoulders, elbows, wrists/hands and knees among women).

Since the analysis was limited to currently OR nurses, those who had left jobs due to musculoskeletal symptoms may have been excluded from the study and healthy worker effect might occur. Thus, the data may underestimate reported symptoms and the association of perceived demands with musculoskeletal symptoms.

In conclusion, the results of this study highlighted the importance of perceived, both physical and psychological, demands in relation to reported musculoskeletal symptoms in different body regions. Among the perceived physical demands studied here, those involving manual material handling, were most frequently and strongly associated with reported musculoskeletal symptoms in nearly all body regions. Based on the findings of this study, operation room was recognized as not only a physically but also psychologically demanding environment. Any interventional program for preventing or reducing musculoskeletal problems should focus particularly on reducing excessive manual material handling demands as well as the psychological aspects of the working environment.

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Appendix

Physical demand items:

My job requires:

Lots of physical efforts*

Rapid and continuous physical activity*

In my job, I am:

Often moving/lifting very heavy loads*

Working for long periods with my head or arms in awkward positions*

Working for long periods with my body in awkward positions*

How often in a typical workday do you:

Lift or lower patients/objects to/from floor[†]

Lift or lower objects to/from shoulder height[†]

Work while bent or twisted at waist[†]

Push/pull heavy objects or people[†]

Stand in one place/static position (>30 minutes)[†]

Perform repetitive motions with hands/wrists[†]

Apply pressure with hands/fingers (e.g., to prevent bleeding)[†]

*Original items from the JCQ³⁶⁾.

[†]Items from Trinkoff *et al*¹⁶⁾.

Psychological demand items*:

My job requires:

Working very hard

Working very fast

An excessive amount of work

Long periods of intense concentration on the task

Enough time to get the job done

My job:

Is free from conflicting demands that others make

Has tasks that are often interrupted before they can be completed

Requires waiting on work from other people or departments

*Original items from the JCQ³⁶⁾.