

# Combined Effects of Physical Demands and Shift Working on Low Back Disorders Among Nursing Personnel

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*The aim of this study was to investigate the synergistic effects of physical demands and shift working on low back disorders (LBDs) among nursing personnel. The study used 2 questionnaires: a self-administered questionnaire composed of parts of Nordic musculoskeletal questionnaire to assess LBDs and job content questionnaire to assess physical demands. The participants were divided into 4 groups: from group 1 (low physical demands day workers) to group 4 (high physical demands shift workers). In regression analysis, high physical demands were associated with the prevalence of LBDs independently (OR 4.4, 95% CI [2.40, 8.00] and  $p < .05$ ), but there was no association between shift working and LBDs ( $p > .05$ ). Odds ratio in high physical demands shift workers was 9.33 compared to the reference group ( $p < .001$ ). Calculated synergistic index was 7.37. Simultaneous impacts of shift working and high physical demands may increase the prevalence of LBDs among nursing personnel.*

low back pain   nurses   musculoskeletal pain   shift work

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## 1. INTRODUCTION

Nursing is a stressful and physically demanding occupation with high risk of musculoskeletal disorders (MSDs) [1, 2]. Nursing is on a second rank, after industrial jobs, in terms of the physical workload among different types of jobs [3]. Different studies reported MSDs as the most prevalent complaints among employees [4, 5, 6]. The cross-sectional study among Iranian nurses reported that the prevalence of low back pain in the past 12 months was ~73% [7]. In a large multi country survey, 17%–39% of 43 000 nurses from five countries decided to change their jobs in the next year because of physical and psychological demands [8]. Barzideh, Choobineh, Tabatabaee, et al. reported that physical job demands were associated with prevalence of MSDs among nurses [1]. Nursing work involves demanding

physical activities such as lifting heavy objects, often in awkward postures, which sometimes entails forceful movements of the upper limbs [9]. Combination of compression, rotation, flexion and direct forces during patient transferring also increases the risk of injuries [10, 11, 12]. A survey of healthcare workers showed that extreme flexion and frequent heavy lifting had a major effect on prevalence of low back pain [13].

Nurses very often work on rotating and night shifts. In Japan, 75% of nurses are working shifts [14]. Physical and mental health demands of fixed shift work are more favorable than rotating shift work [15]. Prevalence of MSDs among night shift work nurses were reported more often than among day work nurses [16]. However, there is a controversy about effects of shift working on MSDs.

There are few studies evaluating effects of physical demands and shift working on the low back disorders (LBDs) in nursing personnel. The aim of this study was to investigate the synergistic effect of physical demands and shift working on LBD among nursing personnel, despite evaluating independent impacts of physical demands and shift working on LBDs.

## 2. METHODS

### 2.1. Participants

This study was designed as a cross-sectional study of nursing personnel in a large general hospital in Tehran, Iran, in 2011. The participants ( $N = 650$ ) of the study were nursing personnel who had at least one year of working experience in their present vocation. They were selected from the nursing personnel of hospitals including head nurses, nurses, nurses' aides, official nurses and nurse technicians. Nursing personnel with history of MSDs caused by trauma or rheumatologic disorders and those with incomplete data were excluded. The participants were informed about the protocol of the study before they gave their written consent. The participants filled out questionnaires in their working hours. The questionnaires were anonymous and personal information remained classified during the study. The Committee of Ethics of the Tehran University of Medical Science approved the study.

### 2.2. Questionnaire Study

Data for this study were collected with a questionnaire composed of three sections: individual demographics and occupational characteristics, questions from the Nordic musculoskeletal questionnaire on LBDs and questions on physical demands from the job content questionnaire (JCQ).

The first section of the self-administered questionnaire included questions on age, gender, weight and height (for estimating body mass index), marital status, number of children, educational level, exercise, smoking habits, chronic systemic disease (Arthritis, diabetes, hypertension, etc.), type of work and work experience in the current job. This section contained a question

"What was your work schedule during the past year? (day work or shift work)", which divided participants into day and shift workers. Shift work was considered as working at hours other than 7:00–18:00 [17].

The second part of the questionnaire included questions from the Nordic musculoskeletal questionnaire assessing LBDs. The Nordic musculoskeletal questionnaire is a standard tool in epidemiological studies evaluating MSDs in different fields [18, 19]. In this section the participants answered a question "Did low back disorders (pain, tingling sensation, numbness and stiffness or limitation in movement) have disrupted your daily activities (occupational and entertainment activities or working at home) during the past 12 months?". Possible answers to this question were *yes* or *no*.

The JCQ measured perceived physical demands of nurses [20]. The JCQ has been used in developed and developing countries in relation to cardiovascular diseases, MSDs, depression and other health outcomes [21]. Reliability and validity of the Persian (Farsi) version of the JCQ has been approved [22]. Selection of the items was based on the literature under supervision of two associate professor of occupational medicine [23, 24]. Each item was scored using a 1–4 scale (*often* to *never* or *strongly agree* to *strongly disagree*). Responses were dichotomized as 1–2 = 0 and 3–4 = 1. New scores were summed to calculate total score of 12 items ranging from 0 to 12. On the basis of the literature, the scores were considered as 0–2 = low, 3–9 = medium and 10–12 = high physical demands. The participants with low and medium scores were qualified as low physical demands group and the participants with high scores as high physical demands group.

The participants were divided into four groups according to the level of physical demands and work schedules. Group 1 consisted of the participants with low physical demands and day work schedule (reference group), group 2 consisted of the participant with high physical demands and day work schedule, group 3 consisted of the participants with low physical demands and shift work schedule, and group 4 consisted of the participants with high physical demands and shift work schedule.

### 2.3. Statistical Analysis

Mean, standard deviation (*SD*) and range of quantitative variables were calculated. Variables were compared with  $\chi^2$  test and independent *t* test. Logistic regression analysis with adjustment for confounding variables investigated the association of physical demands and shift working with prevalence of LBDs. Quantitative variables were dichotomized on the basis of median for regression analysis. Smoking habit was classified into two categories: smoker and nonsmoker. Exercises were classified into three categories: regular, irregular and no exercise. In this study, regular exercise was defined as 30 min of exercise

80.1% of the participants were women and 19.9% were men. The mean (*SD*) age of the subjects was 32.4 (6.7) years. Prevalence of LBDs among the participants was 59.5%.

The number of participants in group one, two, three and four were 119 (22.4%), 72 (13.5%), 157 (29.5%) and 184 (34.6%), respectively. Table 1 shows demographic and occupational characteristics of the participants. Mean age and mean work experience were significantly higher in group 2 ( $p = .003$ ) and group 1 ( $p < .001$ ), respectively, compared to the other groups.

Table 2 shows prevalence of LBDs according to the work schedule and level of physical

**TABLE 1. Characteristics of Participants**

Characteristic	Total	Group 1	Group 2	Group 3	Group 4	<i>p</i>
Age (years) <sup>a</sup>	32.4 (6.7)	33.5 (8.0)	34.2 (7.9)	32.1 (5.6)	31.2 (5.8)	.003
Work experience (years) <sup>a</sup>	8.6 (6.2)	10.8 (7.3)	10.3 (6.5)	7.8 (5.7)	7.4 (5.3)	<.001
BMI <sup>a</sup>	24.2 (3.9)	24.6 (4.2)	24.6 (3.7)	24.3 (4.2)	23.7 (3.6)	.161
Smoking <sup>b</sup>	12 (2.3)	3 (2.5)	2 (2.7)	3 (1.9)	4 (2.2)	.766
Gender <sup>b</sup>						
female	426(80.1)	94(79.0)	51(70.1)	128(81.5)	153(83.2)	.155
male	106(19.9)	25(21.0)	21(29.9)	29(18.5)	31(16.8)	<i>ns</i>
Exercise <sup>b</sup>						
yes, regular	47 (8.9)	12(10.3)	7 (9.7)	16(10.3)	12 (6.5)	<i>ns</i>
yes, irregular	252(47.6)	53(45.3)	29(40.3)	82(52.9)	88(47.6)	.381
no	230(43.5)	52(44.4)	36(50.0)	57(36.8)	85(45.9)	<i>ns</i>

Notes. a = *M* (*SD*), b = *n* (%); group 1 = low physical demands day participants, group 2 = high physical demands day participants, group 3 = low physical demands shift participants, group 4 = high physical demands shift participants; BMI = body mass index;

three or more times per week [25]. SPSS version 11 was used for calculations and analyzes. Values at  $p < .05$  were statistically significant. The results of statistical analysis were expressed as odds ratio (*OR*) with 95% confidence intervals (95% CI). Synergistic index assessed simultaneous effect of physical demands and shift working on LBDs.

### 3. RESULTS

Of the 650 questionnaires given to nursing personnel, 560 were returned (response rate: 86.1%). Of the 560 returned questionnaires, 28 were excluded because of incomplete answers and 532 questionnaires (81.8%) were analyzed. Over

**TABLE 2. Prevalence of Low Back Disorders**

Variable	Prevalence, <i>n</i> (%)	<i>p</i>
Work schedule		
day work	98 (51.0)	.001
shift work	219 (64.2)	
Physical demands		
low	218 (52.8)	<.001
high	99 (82.5)	
Group		
1	80 (49.4)	<.001
2	18 (60.0)	
3	138 (55.0)	
4	81 (90.0)	

Notes. Group 1 = low physical demands day participants, group 2 = high physical demands day participants, group 3 = low physical demands shift participants, group 4 = high physical demands shift participants.

demands. Prevalence of LBDs was higher among shift workers and high physical demands workers compared to day workers ( $p = .001$ ) and low physical demands workers ( $p < .001$ ). The highest prevalence of LBDs (90%) was in group 4 ( $p < .001$ ). Table 3 shows results of logistic regression analysis by adjustment for confounding variables which assessed the association between LBDs and variables more precisely. Although high physical demands were significantly associated with prevalence of LBDs ( $OR\ 4.4, p < .001$ ), there was no significant association between shift working and LBDs ( $p > .05$ ). LBDs were signifi-

cantly associated with the female participants and work experience of over 7 years;  $OR$  for females was 2.7 ( $p < .001$ ) and for work experience of over 7 years  $OR = 2.39$  ( $p = .001$ ). Table 4 shows results of logistic regression analysis by adjustment for confounding variables in four study groups;  $OR$  for group 4 (high physical demands shift workers) was 9.33 (95% CI [4.1, 21.2] and  $p < .001$ ) compared to reference group. Table 5 indicates confounders (adjusted  $OR$ ) of reported LBDs by individual physical demands items among the participants. According to the results, three physical demands items

TABLE 3. Results of Logistic Regression Analysis: Characteristics of Participants

Characteristic	Adjusted OR	95% CI	p
Physical demands			
low	1.00	ns	ns
high	4.40	[2.40, 8.00]	<.001
Work schedule			
day work	1.00	ns	ns
shift work	1.20	[0.78, 1.94]	.401
Age (years)			
≤30	1.00	ns	ns
>30	1.03	[0.62, 1.70]	.920
Work experience (years)			
≤7	1.00	ns	ns
>7	2.39	[1.44, 3.10]	.001
BMI			
≤25	1.00	ns	ns
>25	0.82	[0.53, 1.27]	.369
Gender			
male	1.00	ns	ns
female	2.70	[1.75, 5.0]	<.001
Exercise			
regular	1.00	ns	ns
irregular	1.76	[0.84, 3.64]	.120
no	1.76	[0.84, 3.67]	.133

Notes.  $OR$  = odds ratio,  $CI$  = confidence interval,  $BMI$  = body mass index.

TABLE 4. Results of Logistic Regression Analysis: Groups

Group	Adjusted OR	95% CI	p
1	1.00	ns	ns
2	1.77	[0.70, 4.42]	.224
3	1.36	[0.86, 2.13]	.184
4	9.33	[4.10, 21.17]	<.001

Notes. Adjusted for age, work experience,  $BMI$ , gender and exercise.  $OR$  = odds ratio,  $CI$  = confidence interval; group 1 = low physical demands day workers, group 2 = high physical demands day workers, group 3 = low physical demands shift workers, group 4 = high physical demands shift workers.

TABLE 5. Confounders (Adjusted OR) of Reported LBDs

Physical Demand	Adjusted OR for LBDs	95% CI	p
My job requires			
lots of physical effort	1.20	[0.69, 2.23]	.292
rapid and continuous physical activity	1.12	[0.63, 2.32]	.563
In my job I			
often move/lift very heavy loads	1.33	[0.72, 2.47]	.357
work for long periods with my head or arms in awkward posture	0.98	[0.56, 1.72]	.953
work for long periods with my body in awkward posture	2.53	[1.44, 4.43]	.001
How often in a typical workday do you			
lift or lower patients/objects to/from floor?	0.69	[0.38, 1.27]	.233
lift or lower objects to/from shoulder height?	1.18	[0.63, 2.19]	.609
work while bent or twisted at waist?	1.14	[0.69, 1.87]	.618
push/pull heavy objects or people?	0.78	[0.44, 1.39]	.404
stand in one place/static posture (>30 min)?	1.32	[0.84, 2.07]	.233
perform repetitive motions with hands/wrists?	1.74	[1.02, 2.95]	.041
apply pressure with hands/fingers (e.g., to prevent bleeding)?	1.78	[1.14, 3.07]	.014

Notes. Nurses without demands and with OR 1.00 were reference group for each item. OR = odds ratio, CI = confidence interval, LBDs = low back disorders.

had significant association with LBDs: working for long periods while body is in awkward postures ( $OR\ 2.53, p = .001$ ), performing repetitive motions with hands/wrists ( $OR\ 1.74, p = .041$ ) and applying pressure with hands/fingers ( $OR\ 1.78, p = .014$ ). Synergistic index of high physical demands and shift working on LBDs was 7.37.

#### 4. DISCUSSION

The high rates of MSDs experienced by workers in the health care sector have been a major problem [26]. In this study, prevalence of LBDs was 59.5%; results are similar to those from the study among hospital nurses in Shiraz, Iran, where the frequency of lower back symptoms was 54.9% [24]. The prevalence of low back pain among nurses in Taiwan was 43% [27]. Lin, Tsai, Chen, et al. have calculated the point prevalence of low back pain and the pain was the only disorder which may describe observed difference between two studies in terms of prevalence of low back pain. Results of the present study show a significant positive association between perceived physical demands and prevalence of LBDs regarding the pure effect of physical demands on LBDs. The participants who have reported their condi-

tions as high physical demands were in a group with higher risk of LBDs compared to the low physical demands nurses ( $OR\ 4.4$ ). Investigating the impact of each physical demand item showed that awkward body posture, repetitive motions and pressure with hands or wrists are associated with prevalence of LBDs independently. Many studies have shown that perceived physical demands such as polling/pushing heavy objects, moving/lifting/lowering heavy load, performing repetitive motions with hands/wrist and bending or twisting the body were significantly associated with MSDs [28, 29, 30, 31].

The results of the present study are in accordance with the findings of Choobineh, Rajaeefard and Neghab's study which found that high levels of perceived physical demands (scores 10–12 of JCQ) were significantly associated with prevalence of LBDs compared to low-medium levels (scores 0–9 of JCQ). Choobineh et al. also reported that "bent or twisted posture at waist" and "awkward body posture" could increase the risk of LBDs [24]. Trinkoff, Lipscomb, Geiger-Brown, et al. found that high physical demands were associated with prevalence of back MSDs [23]. In some aspects (especially in methodology), the present study is similar to Trinkoff et al.'s study but the present study focused on shift



working. Roll, Selhorst and Evans in their study demonstrated an association between bending and twisting at the waist with low back problems, but there was no association between lifting or lowering [28]. The risk of LBDs and spinal loading during the awkward posture and transfer of patients were demonstrated in biomechanical studies [12]. Some studies indicated that adequate knowledge on ergonomics and ergonomic intervention programs may have good results in preventing MSDs among workers [6, 32].

Although in the present study the prevalence of LBDs was higher among shift workers (64%) than among day workers (51%) ( $p = .001$ ), after adjustment for confounding factors, the association was insignificant. A study on petrochemical employees showed that prevalence of health problems such as MSDs in shift workers was higher than in day workers [33]. According to Eriksen, Bruusgaard and Knardhal, shift working, heavy lifting, moderating work demands, losing support in a workplace, working in nursing home are risk factors for low back pain among nurses' aides [34]. A study in Shiraz city hospitals revealed an association between shift working and prevalence of MSDs in neck, upper back and knees region but there was no association with LBDs [35]. Bos, Krol, van der Star, et al.'s study showed that shift working was a significant risk factor for increasing the chance of neck, upper back and knees disorders among the operating room nurses [36]. However, Myers, Silverstein and Nelson found that day workers had 75% of excessive risk to be affected by shoulder and back injury compared to night workers [16].

Investigation of combined effects of physical demands and shift working showed that prevalence of LBDs among high physical demands and shift work nurses was significantly higher than among the other groups (90%). After adjustment for confounders, risk of being affected by LBDs in shift workers with high physical demands was 9.33 times more than reference group (day workers with low physical demands). For day work nurses with high physical demands *OR* 1.7, but this association was not significant. Although a previous analysis showed that high physical demands could increase the prevalence of LBDs

independently, protective effect of day working has decreased the impact of high physical demands on LBDs in this group. In the present study, synergistic index was 7.37, which shows that shift working and physical demands had a considerable synergic effect on LBDs.

Gender (female) and work experience were significantly associated with LBDs; result of gender effect are similar to the result of the study in Shiraz city hospitals which reported disorders of lower back, shoulders, wrists/hands and ankles/feet as more prevalent MSDs among Iranian nurses [35]. In the present study, work experience of over 7 years is significantly associated with prevalence of LBDs. According to Lin, Tsai, Chen, et al.'s study, years at work could be associated with disabling low back pain and the pain severity [27].

The present study was designed as a cross-sectional survey and data collection was self-reported. Collecting data through direct interviews with participants may increase the accuracy of such studies. However, it takes more time and is expensive. Prospective studies investigating associations with more control on study variables are recommended.

## Conclusion

This study suggests that simultaneous effect of shift working and high physical demands may increase the prevalence of LBDs among nursing personnel. More attention to ergonomic interventions and work scheduling should be paid.

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