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Effects of patient-handling and individual factors on the prevalence of low back pain among nursing personnel

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Abstract.
BACKGROUND: Patient-handling is one of the main tasks of nursing personnel; it imposes compressive and shear forces on nurses' lower spine. The aim of this study was to determine the prevalence of Low Back Pain (LBP), risk factors in the incidence of such disorders, and patient handling risk assessment among nursing personnel.
METHODS: This study was carried out on 243 randomly selected nursing personnel who played a role in handling the patients (58 wards). Patient Transfer Assessment Instrument (PTAI) checklists alongside Standardized Nordic Musculoskeletal Questionnaires (NMQ) were used for data collection. The statistical analyses such as independent t-test and Chi-Square test were used.
RESULTS: Prevalence of LBP among nursing personal was 69.5% in the previous 12 months. Significant correlations were found among age, working hours per week, work experience, BMI, gender and shift-work. Results of PTAI index assessment revealed that more than 90% of subjects were in medium and severe risks of LBP. PTAI index scores were significantly associated with LBP ($P < 0.05$).
CONCLUSION: PTAI index is regarded as an efficient tool for risk level classifications and identification of effective factors on LBP incidence among nursing personnel involved in patient transfer. In this regard and for the aim of ergonomic intervention towards the reduction of LBP incidence among nurses, the modification of improper factors which are identified in PTAI index such as the use of advanced patient handling equipment, increase in work posture guidance and work arrangements, can be mentioned.

Keywords: Patient Transfer Assessment Instrument, risk factor, risk assessment, patient handling

1. Introduction

Low back pain (LBP) is one of the most common musculoskeletal disorders among nurses and other healthcare workers [1–5]. The prevalence of LBP among nurses is the same and even more than in other occupational groups such as office workers, marketing personal, transportation operatives, construction, etc. [6–8]. LBP imposes large costs to employees and societies [9] and might have numerous consequences such as reduced quality of life, occupational disability, absence of sickness and changing and/or leaving a profession [10, 11].

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Not only was the LBP the cause of 6.3% of long-term absence of sickness in Danish nurses between 2004 and 2005, but also it was 8.7% of compensation claims by nursing personnel in four U.S. states between the period of May 2006 and October, 2009 [10, 12]. In addition, two thirds of the health care staff had complained about low back pain during the last year [13].

High prevalence of musculoskeletal disorders, especially LBP, increases the costs of care, loss of working days and turn-over rate among nurses [14, 15].

The etiology of LBP is complicated and includes physical, psychosocial, individual, socio-cultural and organizational work factors [16–18]. All of these factors do not have the same effects on LBP. Physical factors in patient-handling such as weight of the patient, asymmetric nature of the load, frequency of lifting, and awkward postures in patient support have been reported to be a major contributing factor to LBP among health care workers [16, 19, 20].

Patient-handling has a burden of severe biomechanical load on spinal parts of the body that impact the prevalence of LBP among nurses [21]. Schlossmacher and Amaral research showed that the prevalence of low back pain symptoms in nursing professionals was approximately between 15% and 72% and the main cause was the transfer of the patient from bed to chair [22].

Previous studies have shown that the ergonomic intervention has included LBP learning and awareness, trainings such as patient-handling techniques, lifting teams and transferring equipment, which can decrease the loads and injuries related to patient-handling tasks [23, 24]. Training on safe patient transfer techniques besides work modifications has been approved as a cost-effective intervention method that could lead to the reduction of musculoskeletal loads [25]. Karahan and Bayraktar reported that training alone is insufficient for preventing LBP; however, it is one of the most efficient and cost-effective ways to prevent LBP [26].

Different methods, including subjective and objective methods have been developed in the assessment of work techniques during patient transfers which indicated whether a certain technique was used or not [27]. In this regard, Patient Transfer Assessment Instrument (PTAI) is an objective method for assessing the load of patient handling that was introduced in 2005 and revised in 2007 [28]. PTAI can be used for evaluation of the ergonomic working postures and the workers' skills during patient handling [29]. The evaluation method was carried out by observing 15 factors in which nine factors can be investigated by the assessor's observation of how subjects work, and the last six factors can be assessed based on workers' interviews [27, 29].

Standardization of PTAI methods was conducted based on other patient handling and transfer methods (MAPO, DINO, Care Thermometer, Dortmund Approach). In addition, PTAI has been accepted by ISO's Technical Report 12296 (Ergonomics -Manual handling of people in healthcare units) [27].

PTAI mostly surveys the ergonomic occupational posture and patient transporter's skills. Since there were no mechanical facilities in almost all the studied hospitals, PTAI seems to be an appropriate method for this study. The critical issue shows the importance of the ergonomic occupational postures as well as increase in staff's skills. Thus, PTAI method, which relies on the ergonomic occupational postures and staff's skills, has been used in the present study.

The results of using the PTAI presented useful information about influential factors on the occurrence of LBP among nursing personnel. Consequently, the control and modification of these factors can reduce the prevalence of LBP among nursing personnel and improve their services [30].

The aim of this study was to determine the prevalence of low back pain, assess the risk of developing LBP in patient handling, and distinguish the major risk factors affecting the prevalence of low back pain among nursing personnel.

Few studies have been conducted using the PTAI in order to assess the risk of LBP occurrence among patient handling personnel by this method.

Determination of the most important factors causing LBP can be an index to finding the ergonomic intervention in order to improve working conditions. Therefore, considering the identified risk factors can result in decreased prevalence of LBP.

2. Material and methods

This cross-sectional study was conducted in three educational hospitals of Kerman University of Medical Sciences (Iran-2014). Research population included all personnel whose tasks were related to handling and transferring patients in studied hospitals (nurses, nurse assistant, nurse co-assistant and paramedics). Nursing personnel were selected by simple random sampling (using a table of random numbers). The inclusion criteria were work

experience for more than a year. Employees who had congenital or accident-related musculoskeletal diseases, leisure and sporting activities as well as musculoskeletal injuries, were excluded from the study.

For assessing the risk of MSDS in lower back region of nursing personnel, all personnel in clinical wards involving patient handling in each of the studied hospitals were included in the study (58 wards) and Para-clinical wards, and that, personnel who were not involved in patient-handling were excluded. According to the specified size of the population, cross-sectional type of study, acceptable error of 5% ($\alpha = 0.05$), power 0.8 and the possibility ratio (75%) which were employed in the calculation sample size based on internal studies and the prevalence of MSDs in the low back region of nurses [31–36]. The sample size was obtained to be 250; However, due to lack of cooperation and incomplete answers in some questionnaires, 7 cases were excluded.

In order to respect the rights, principles and ethical considerations, all the subjects were aware of the purpose and importance of the study and were guided to complete questionnaires with informed consent. Throughout the study, they were also assured that the data is only used for research purposes, and their information was confidentially reserved. Emphasis was also laid on the fact that at every stage of the research, participants can withdraw their participation in the survey.

2.1. The instruments used for data collection

A) Demographic and Organizational data questionnaire included age, weight, height, working hours per week, work experience, employment status, marital status, work shift and educational level. Work in shift has been considered in terms of shift-work and day-shift. Shift-work is a regular or irregular work plan in the morning, evening and night shifts during the week. Day-shift is defined as beginning at 7 am and ending at 6 pm [37].

BMI was calculated by the weight in kilograms divided by the square of the height in meters and it was classified into four: underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9) and obese (>30) based on World Health Organization (WHO)'s standards [38].

B) Nordic Musculoskeletal Questionnaire – NMQ: This questionnaire has been designed in order to determine the prevalence of MSDs in different regions of the body. The musculoskeletal disorders are described as a wide range of injuries to the tendons, ligaments, nerves, and supporting structures [39]. In the current study, Nordic questionnaire was used to measure the prevalence of LBP. Validity and reliability of the questionnaire (in different versions, including Persian) have been confirmed in several studies [16, 40].

C) Patient Transfer Assessment Instrument-PTAI: PTAI Index (developed by Department of Health Sciences at University of Jyväskylä, Finland, in 2005) is a Finnish semi-quantitative method. PTAI Method is a practical tool that can be used by occupational safety and health professionals for the evaluation of the risk of patient handling in units [28, 41].

In this regard, a total of 15 items were observed, assessed and interviewed. A) Items of observation (items 1–9) were included: 1- Physical work environment, 2- Features of work environment, 3- Use of Mechanical Hoist, 4- Use of non-Mechanical lifting equipment, 5- Distance and height of transfer, 6-Load on upper limbs and trunk, 7- Load on lower back, 8-Load on lower limbs, and 9- Patient transfer skills and fluency.

Sections 1–9 of the evaluation form were filled on the basis of patient transfer observations and all three criteria must be categorized into three groups, 1) in order, 2) partially in order and 3) not in order.

Interview questions for the employees (items 10–15) were included: Guidance in working postures, guidance in the use of transfer equipment, work organization, mental load in patient transfer, physical load in patient transfer and frequency of manual patient transfers. In this part, the interview identified the opinion of nurses about the overall load of patient transfer. Nurses answered using: 1) in order, 2) partially in order and 3) not in order.

The PTAI index was calculated according to the following equation:

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

a: number of in order
b: number of partially in order
c: number of not in order
d: total number of responses

PTAI method determines the risk of musculoskeletal injuries in three levels (negligible, moderate and severe). Level 1: If the index is exceeding 80%, the situation in terms of patient-transfer ergonomics is good in the evaluated transfers. The evaluators and/or occupational healthcare representatives

provide instructions to maintain and further improve the situation. Level 2: If the index is between 60–80%, the load of patient transfers will be quite high, and actions to correct the problems identified in the evaluation form should be established at the workplace. Level 3: If the index is 60%, the employer must take immediate measures to improve ergonomic working methods. The developed measures should utilize the input of employees, occupational healthcare, occupational safety, health organization and possibly external experts [42].

Based on Karahula et al.'s pilot study on occupational physiotherapists, validity and reliability of PTAI method has been tested in four surgical wards in the Central Finland Healthcare District. Also, according to the specialists and seminar participants who commented on the PTAI, its content validity was assessed by sending the prototype of the instrument to the specialists and it was acceptable for evaluating the patient transfer load among nursing personnel [41, 43].

Also, based on a study on Iranian nurses, Intra-observer reliability of PTAI method through the use of "Intra Class Correlation (ICC)" statistical test, was obtained to be 0.80 which was quite acceptable [44].

2.2. Data collection

After a referral from Coordination of Nursing to the units, written coordination and verbal consent forms were approved. Questionnaires were given to people who participated in the study. The aim of this study was explained to participants and they were convinced about the procedures for completing the questionnaire. In this study, data were collected by two questionnaires and a two-parted-PTAI check-list. The second part of the PTAI-check list and the two questionnaires were completed by nursing personnel and the researcher, respectively.

2.3. Data analysis

Data analysis was done using SPSS.22 and descriptive statistics such as frequency, percentage, mean and standard deviation to describe subjects' demographic and organizational data. Normal distribution of data was approved by Shapiro-Wilk and Kolmogorov-Smirnov methods, and *t*-test statistical analysis was also applied in order to determine the relationship between independent quantitative variables such as age, weight, height, number of worked hours per week and work experience. Incidence of LBP and Chi-Square test were used to determine the relationship between qualitative variables such as BMI, gender, employment status, marital status, work shift, educational and risk levels of PTAI technique and the occurrence of LBP. Also, the significance levels for all tests were considered to be less than 0.05.

3. Results

3.1. Participants

Out of 243 nursing personnel in this study, 31.4% were aged less than 30 years and about 15% had worked less than 10 years. They were mostly women (87.7%) and only 15.6% (38 subjects) were in day-work.

BMI investigation showed that 46% of the subjects were overweight. Spell out 80.7% of them were married. 65.1% of them had bachelor degree.

Survey on the prevalence of back pain showed that almost 60% was indicated having LBP.

3.2. Prevalence of low back pain

Based on the results of the NMQ questionnaire, the prevalence of LBP during 12 months was recorded to be 69.5% (Table 1). In this study, demographic and

Table 1
Demographic and Organizational characteristics of nursing personnel

Variable	Mean	Standard deviation
Age (year)	33.6	3.18
Weight (kg)	65.79	9.15
Stature (cm)	163.73	6.32
Work experience (year)	10.69	6.37
Working hours per week (hours)	42.35	6.37
	Classification	Frequency (%)
Gender	Female	213 (87.7)
	Male	30 (12.3)
BMI (kg/m^2)	underweight	4 (1.6)
	normal weight	127 (52.3)
	overweight	99 (40.7)
	obese	13 (5.3)
Work Shift	Shift work	205 (84.4)
	Day work	38 (15.6)
Marital status	Married	196 (80.7)
	Single	47 (19.3)
Educational level	Pre-Bachelor degree	57 (23.4)
	Bachelor degree	158 (65.1)
	Master degree	28 (11.5)
Symptoms of LBP prevalence	Yes	169 (69.5)
	No	74 (30.5)

Table 2
Relation between demographic and organization characteristics and the prevalence of LBP in the past 12 months among nursing personnel

Variable		Low Back Pain		*P*-value
		Existence ($n=169$)	Absence ($n=74$)	
Age (year) (mean ± SD)		33.75 ± 6.24	33.26 ± 8.32	0.001*
Working hours per week (hours) (mean ± SD)		43.63 ± 3.12	41.12 ± 2.92	0.008*
Work experience (year) (mean ± SD)		11.05 ± 5.49	9.86 ± 7.99	0.001*
Gender	Female	148 (69.5)	65 (30.5)	0.038†
	Male	24 (80)	6 (20)	
BMI	underweight	4 (100)	0 (0.0)	0.027†
	normal	78 (61.4)	49 (38.6)	
	overweight weight	77 (77.8)	22 (22.2)	
	obese	7 (53.8)	6 (46.2)	
Work Shift	Shift work	145 (59.7)	60 (24.7)	0.011†
	Day work	24 (9.8)	14 (5.8)	

*Independent *t*-test. †Chi-square test.

Table 3
Analysis of the constituent factors of PTAI technique among nursing personnel

	Factors of PTAI technique	The statues of PTAI factors (%)		
		In order (3/3 criteria)	Partially in order (2/3 or 1/3 criteria)	Not in order (0/3 criteria)
Objects of Observation	1- Physical work environment (*temperature, draught, lighting*)	166 (68.3)	77 (31.7)	0 (0.0)
	2- Features of work environment (s*pace, adjustability, floor and working shoes*)	114 (46.9)	124 (51)	5 (2.1)
	3- Use of mechanical hoist *(Equipment available, appropriateness, used correctly/not needed*)	0 (0.0)	0 (0.0)	243 (100)
	4- Use of non-mechanical lifting equipment (*Equipment available, appropriateness, used correctly/not needed*)	10 (4.1)	215 (88.5)	18 (7.4)
	5- distance and height of transfer (*No steps, knee-elbow level, no reaching*)	13 (5.3)	224 (92.2)	6 (2.5)
	6- Load on upper limbs and trunk (*Holding up, elbows and shoulders, wrists and fingers*)	5 (2.1)	230 (94.6)	8 (3.3)
	7- Load on lower back (*Flexion, rotation, body control*)	4 (1.6)	215 (88.5)	24 (9.9)
Interview Questions	8- Load on lower limbs (*knees-feet alignment, no squatting/on knees)*	7 (2.9)	231 (95)	5 (2.1)
	9- Patient transfer skills and fluency *(Guidance/facilitation, grip, transfer skills)*	9 (3.7)	230 (94.7)	4 (1.6)
	10- Guidance in working postures	13 (5.3)	48 (19.8)	182 (74.9)
	11- Guidance in use of transfer Equipment	30 (12.3)	61 (25.1)	152 (62.6)
	12- Work organization	11 (4.5)	33 (13.6)	199 (81.9)
	13- Mental load in patient transfer	4 (1.7)	154 (63.4)	85 (34.9)
	14- Physical load in patient transfer	87 (35.8)	144 (59.2)	12 (5)
	15- Frequency of manual transfers	142 (58.4)	30 (12.3)	71 (29.3)

Table 4
The results of risk assessment by PTAI index, and its relation with LBP among nursing personnel

Index	Risk level	Score	Low Back Pain		Frequency (%)	*P*-value
			Existence ($n=169$)	Absence ($n=74$)		
PTAI	Level 1: Negligible	>80	15 (6.2)	7 (2.9)	22 (9.1)	0.039†
	Level 2: Medium risk	60–80	129 (53.1)	57 (23.5)	186 (76.6)	
	Level 3: Severe risk	<60	25 (10.2)	10 (4.1)	35 (14.3)	
Total			169 (69.5)	74 (30.5)	243 (100)	

†Chi-square test.

organizational characteristics of nursing personnel were evaluated in two groups: with or without prevalence of LBP. The results showed that nurses with LBP were older and were male, and also had higher work experience, number of worked hours per week and BMI, and worked in day-shift (Table 2). No significant difference was found in terms of employment status, marital status and educational levels.

3.3. PTAI (Patient Transfer Assessment Index)

Results of PTAI index have shown that a large proportion of subjects (74.9%) were not fully aware of proper body posture during the work and a many of them (81.9 percent) described work arrangements as unsuitable (Table 3).

Based on the results of the evaluation of LBP risk by PTAI, 14.3% of nursing personnel were observed in severe risk levels (third level of PTAI) (Table 4). The Chi-square test also showed a significant correlation between the prevalence of MSDs in low back region and identified risk levels in PTAI index (Table 4). The results have shown that unavailable appropriate equipment for patient handling, lack of work organization and insufficient guidance in working posture had the most effects on increase of PTAI score. On the other hand, physical work environment factors had 0% of "not in order".

4. Discussion

The present study was conducted in order to determine the prevalence of LBP, assess risk of patient handling and the prior individual and organizational risk factors affecting the prevalence of LBP among nursing personnel. The following obtained results can help in choosing the ergonomic interventions that will help decrease the prevalence of LBP among nursing personnel.

Results of this study showed that the prevalence of LBP among 243 nursing personnel in five hospitals in Iran within the previous 12 months was 69.5%. According to Iranian studies on health and disease, the prevalence of MSDs in the lower back region of nurses was higher than among the public population [45]. Findings of this study on the high prevalence of LBP are consistent with the results of other studies [42, 46].

LBP in this study was lower than that in similar reports among nursing personnel in Greece (75%) [47], Nigeria (73.5%) [48] Egypt (79.3%) [49] and higher than the reported results in Nepal (67%) [50], Netherlands (62%) [47] and Portugal (60.9%) [18]. The prevalence of LBP among Iranian nurses has been 54.9–73.2% in recent studies [33, 51, 52].

In accordance with the results of this study, age, body mass index and gender (defined as demographic variables) and working hours per week, work shift, work experience (defined as organizational variables) are risk factors that increase the incidence of back pain among nursing staff.

Results of the present study showed a significant correlation between the variables of age and incidence of LBP ($P<0.05$), consistent with the studies by Sikiru et al., Munabi et al. and June et al. [48, 53, 54], and are contrary to the results of Tinubu's study in the southwestern part of Nigeria (on 128 nursing personnel) [55]. Also in a study by Karahan, an inverse relationship was observed between the age and incidence of LBP among nursing personnel, that their results are not consistent with the results of this study [42]. It should also be noted that the process of aging is naturally associated with subjects' weak muscle performance and physical capacity and that can cause pain as a result of MSDs. By aging, the subjects will suffer from muscle atrophy and muscle tension, followed by muscle weakness which ultimately leads to pains in the elderly [56, 57].

In this study, there was a significant relation between number of worked hours per week and the prevalence of LBP among nursing personnel ($P<0.05$). The issue discussed shows that the increase in working hours per week can result in physical and mental pressures on nursing personnel, and

can be counted as risk factors of the prevalence of LBP.

The results of this study are in line with studies conducted by Ovayolu, Trinkoff and Mehrdad [51, 58, 59] and in contrast with the results of Sadeghian's study on 246 nursing personnel (in Iran) [52].

Exposure time to risk factors affecting the prevalence of LBP (such as manual handling of patients) can be reduced by decrease in working hours per week as well as increase in the number of nurses in units as ergonomic interventions.

The results of Chi-square test showed a significant relationship between BMI levels and the prevalence of low back pain in nurses ($P < 0.05$). Karahan also showed that obesity was a serious risk factor of LBP, decrease in abdominal muscle strength and increase in lumbar lordosis [60]. Alexsopoulos also found that high BMI was significantly related to chronic LBP and absence of work due to low back and shoulder pains [61]. Maintaining a normal body weight reduces the pressure on the lower spine and excess abdominal weight pressure on the vertebrae that may lead to chronic spasms in the lower back region [62]. The results of the present study are in contradiction with Attarchi's study. In their study on 454 nurses of public hospitals (in Iran), no significant correlation was found between BMI and incidence of low back pain [63].

The results showed a significant correlation between the prevalence of LBP and work experience of subjects ($P < 0.05$). Yet, Yip, in a cross-sectional study in Hong Kong found no significant relation between work experience and the incidence of LBP among nursing personnel [64], and this is in contrast with the results of the present study.

Choobineh et al. have discussed the significant correlation between musculoskeletal disorders and work experience and recommended that the prevalence of the mentioned disorders was more probable in work-experienced people than workers with little work experience. They have suggested the sending of experienced workers from high work pressure units (such as emergency department, orthopedic and neurology) to less work pressure units as control measures [32].

In addition, Attarchi et al. have found a significant relation between work experience and the prevalence of LBP [63]. Their findings have shown increase in work experience and cumulative risk factors, there was an increase in prevalence of LBP. Nevertheless, people with high work experience are vulnerable to LBP and they should be considered by accurate treatments.

Also in this study, a significant correlation was observed between the gender and LBP ($P < 0.05$). The relation between the gender and the incidence of LBP can be due to anatomical, physiological and structural differences between men and women. Typically, on the basis of these differences, the incidence of mechanical disadvantage, LBP, sprain and strain in lower back region of women was higher than in men [48]. The results by Lorusso also showed that gender can be one of the most important risk factors for LBP, which increases the risk of LBP among women [46].

Results show that LBP was more prevalent among women than men. Thus, they should be more considered as high ergonomic risk factors. Since the number of female workers was higher than male workers, ergonomic interventions towards the reduction in LBP among female workers can be effective in order to decrease the prevalence of LBP among the nursing personnel.

The results of this study showed a meaningful relation between the incidence of LBP in nursing personnel and shift-work ($P < 0.05$).

Lack of nurse in shift-work especially at evening and night shifts can lead to increase in workload and can be discussed as an important risk factor in LBP.

Also, some other studies conducted by Demerouti [65] and that of Janssen [66] showed that the circadian rhythm disorder was affected by shift-work and night shift-work and caused MSDs in low back region of nursing personnel. Choobineh in his cross-sectional study also reported that the prevalence of LBP can be due to various risk factors such as shift-work [67]. Meanwhile, in a study by Eriksen, night shift-work was recorded as one of the most important factors for the Nurse's LBP [68]. It should be noted that a study by Takahashi in Japan on 111 nurses has found that a short rest during the night shift can reduce the incidence of LBP [69]. Work in unusual shift (night shift) was associated with the severity of LBP and nurses' leaving of work [68].

In ergonomic interventions, adequate number of nursing personnel in shift-work especially night shift can make a change in the distribution of workload that results in less exposure to LBP-related risk factors.

In the present study, there was no significant relation between prevalence of LBP, marital status and education level as demographic variables. Although in Attarchi et al.'s study there was a significant relationship between the education level and the occurrence of musculoskeletal disorders [63], in Abedini et al.'s study there was no significant relation between the education levels and the occurrence of

musculoskeletal disorders. Also, in Abedini et al.'s study there were no significant relation between marital status and the occurrence of musculoskeletal disorders [32].

According to the obtained PTAI factors, physical work environment had the most "order to" (68.3%) and the least "non-order to" (0%). It shows that the surveyed hospitals had the proper physical agents (temperature, wetness, and light) and the indoor air is suitable for medical treatments.

On the other hand, the use of mechanical hoist had the least number of "order to" (0%) and the most number of "not order to" (100%). It demonstrates that none of the handling equipment were used in the surveyed hospitals and it consequently increases the pressure on the nurse's waist and is a remarkable risk factor that affects the prevalence of LBP and also increases PTIA.

Grag et al. have surveyed the injuries that were caused by patient handling. They have classified them into 6 long term care facilities and one chronic care hospital at a mean interval of 38.9 months. They also equipped the hospital's units by patient handling equipment and they collected the information of patient handling twice in a mean interval of 51.2 months. Results showed that Post-intervention of patient-handling injuries decreased by 59.8%. Also, the number of work days lost, the number of task adjustment, and the worker's compensation expenses were decreased 86.7, 89.8%, and 90.6, respectively [70].

Schoenfisch et al. surveyed on 11545 nursing personnel to find the prevalence rate of musculoskeletal disorders before and after the interventions for 13 years in a medical center and community hospital. The interventions were including the patient handling equipment, and lifting the patient in "minimal manual lift environment" plan.

They found that there is no significant decrease in musculoskeletal disorders that were caused by manual lifting in medical center. Moreover, the decrease in 44% of the musculoskeletal disorders has been significant after confounding in the community hospital. According to their results from both hospitals, the improvement effect increased by the amount of lag time. Equipping the hospital's units by patient handling equipment had affected the results as it decreased the numbers of "days away" at both hospitals [71].

Studnek et al. studied on 706 emergency medical supply personnel and ergonomic interventions. They showed that the patient's transportation-related injuries have been significantly decreased after hydraulic stretchers for 104 weeks [72].

In addition, "feature of work environment" had the appropriate number of "order to" (46.9%) after "physical work environment". It shows that the equipment has been well-placed and services were well-used. Results showed that of 66.7% of nursing personnel with LBP, more than half (53.1%) had moderate risk levels with PTAI index between 60–80.

At this risk level, patient handling pressure was high. So, a solution should be provided to solve the identified problems in the work places. Only 10.2% of the occupants had low PTAI risk factor of less than 60%.

However, in the study by Abedini on 400 nursing personnel in 75 sectors, 87.5% of the subjects were observed in the third level of PTAI (severe risk) [44]. Abedini et al. in a research on MAPO, discussed that 83.5% of the participants were is moderate risk, and 20% were in high risk [32]. It needs to be mentioned that in both investigations, the prevalence of musculoskeletal disorder has been 88.2% during the last 12 months and that was more than the prevalence of LBP in the present study (69.7%). According to Chi-Square test, there was a significant correlation between the prevalence of MSDs disorders in the lower back region and risk levels of PTAI index ($P < 0.05$). It should be noted that the results of this study are in line with results by Abedini et al. that showed a significant correlation between the prevalence of LBP and PTAI indices. On the basis of this study, the risk of MSDs was increased with the increment of PTAI index, so that its risk of occurrence in level 2 was about 2.5 times higher than in level 1 and the risk for the third level was four times higher than for level 1 [44]. The key points of this study were: using a standardized questionnaire and a new method in manual patient handling assessment which was also included in the "ISO/TR 12296 : 2012 Ergonomics Standard" alongside a focus on LBP as a high prevalent pain among healthcare workers. The novel feature of the present study can be the identification of physical demands in patient-handling that developed LBP among healthcare workers such as nurse's aid and paramedics who were often neglected in the studies on LBP.

4.1. Limitations

It should be noted that the studied occupational group has a decisive role in the results of studies on MSDs, particularly when the studied population are nursing personnel. Tasks and risks of this group

of employees were influenced by many environmental, temporal and managing factors that affected the results of studies. Therefore, each of these factors can be a cause for inconsistent results as compared with the other studies. Other limitations of this study were unscaled questionnaire for determining the intensity of the reported pain, lack of reliable diagnostic tests for the exact diagnosis of LBP (such as electrodiagnosis) and reliance on the statements of the nursing personnel.

Results of the study showed a very high prevalence (69.5%) of MSDs in the low back region of nursing staff. A significant correlation was found between the incidence of LBP, demographic and organizational variables of nurses such as age, number of worked hours per week, work experience, BMI, gender, and shift-work. According to evaluations extracted from PTAI assessment index, most of the studied nurses (76.5%) were in the moderate risk level (the second level). In addition, a significant relationship was observed between the risk levels of this index and incidence of LBP among nursing personnel. It affirms the effectiveness of PTAI index in risk level classification and identifies the factors affecting on the incidence of LBP in nursing personnel who are responsible for patient handling. Therefore, in order to reduce the incidence of LBP in this occupational group, modification of the improper factors identified in this technique, including the use of advanced patient transfer equipment, increased guidance in work postures and work arrangements are recommended.

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Conflict of interest

The authors have no conflict of interest to report.

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