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Study of low back pain intensity and disability index among manual material handling workers of a tile and ceramic industrial unit, Iran (2016)

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Abstract

Background: The revised National Institute for Occupational Safety and Health (NIOSH) lifting equation (RNLE) is commonly used for risk assessment of manual handling, and can estimate low back pain (LBP) biomechanical stressors of lifting and/or lowering of loads. The aim of this study was to evaluate manual material handling by using the RNLE, LBP, and LBP disability index (LBPDI) among workers in a tile and ceramic industrial unit in Tehran, Iran.
Materials and Methods: A sample of 30 workers (manual workers) in a tile and ceramic production line was recruited. Low back pain prevalence and disability index were measured using body map questionnaire combined with visual analog scale and self-report Oswestry disability index (ODI), respectively. Statistical data analysis was done using SPSS software, version 22.
Results: According to results, composite lifting index was 14.77. Low back pain prevalence among workers was reported equal to 100%; also, Low back pain intensity was equal to 68.8 ± 17.8. The mean of Low back pain disability index among workers has been reported equal to 41.3 ± 17.1 (severe crippled).
Conclusions: The results show that composite lifting index value for these jobs exceeded 3, which means that there is a significant level of physical stress associated with these jobs for nearly all workers. Both strength and endurance for this job are high; therefore, job redesigning could decrease the physical demands, Low back pain prevalence, and Disability index, through modifying the job layout and work stations.

Keywords: Low Back Pain, Workers, Iran.

Introduction

Low back pain (LBP) is defined as pain and discomfort localized below the costal margin and above the inferior gluteal folds, with or without leg pain, which is one of the most prevalent forms of musculoskeletal disorders (MSDs) (1-3). LBP can affect the quality of life and has a significant economic impact (4-6). Annual LBP economic burden (direct and indirect costs) to society is estimated between 84.1 billion and 624.8 billion United States (US) dollars (6). According to annual statistics of the Health and Safety Executive (HSE), MSDs constitute three quarters of the occupational diseases, and are responsible for losing an average of about 17 work days per case (7, 8). In addition, LBP was the fifth most common reason for all office-based physician visits in the US (9). LBP risk factors include job physical factors, worker demographics, past LBP history, psychosocial factors, and hobbies and physical activities outside of work (5, 10). Low job satisfaction and work support, and high work have more association with LBP compared with other workplace psychosocial factors (11-13).

Manual handling is considered as the most stressful activity, because workers involve in repeated

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carrying or lifting heavy loads for a long period of time; thus, they are at risk of injury and pain (14-17). Manual handling is the second most commonly reported risk factor in workplaces (7). For risk assessment of manual handling of load, National Institute for Occupational Safety and Health (NIOSH) lifting equation can be used to estimate LBP biomechanical stressors. NIOSH lifting equation determines weight limits by using physiological, biomechanical, physical, psychological, and epidemiologic aspects of manual load lifting, that the majority of healthy workers can lift over a period of time (up to 8 hours) without adverse effects of load handling on the back (18). The revised NIOSH lifting equation (RNLE) combines seven biomechanical stressors including weight of the load, horizontal location (H), vertical location (V), vertical travel distance (D), asymmetry angle (A), frequency rate and duration of lifting (F), and coupling component (C), into a numerical scale to quantify biomechanical stressors. This numerical scale is called the lifting index (LI) for single task and composite LI (CLI) for multi-task.

Pain and limited movement of the spine has adverse effects on functional status, work activities, and quality of life, so it is essential that researchers use tools having acceptable validity and reliability to review the inability level and determine the consequences (19, 20). Measuring disability is an important component in the management of workers or patients with back pain, so that self-report Oswestry disability index (ODI) questionnaire is a very important evaluation tool for measuring permanent functional inability (21, 22). A significant relationship has been reported between the prevalence of LBP and manual handling (15-17, 23, 24). The present study aims to determine the prevalence of LBP and LBPDI among manual handling workers.

Materials and Methods

This cross-sectional study was carried out in a tile and ceramic industrial unit in Tehran, Iran, in 2016. All the employed workers were enrolled in this study by census (30 workers). All workers consented to participate in this study. The criteria for inclusion in the study included the work experience less than one year, as well as lack of a history of spinal surgery and traumatic orthopedic problems such as acute back and nerve problems, inflammatory diseases such as ankylosing spondylitis involving the spine, and congenital diseases such as scoliosis and hemivertebra; due to the mentioned factors, 5 workers were excluded from the study. To evaluate manual handling risk factors in one production line (packaging unit), the RNLE was used. Moreover, to evaluate prevalence and severity of LBP, body map questionnaire combined with a visual analog scale (VAS) was used, and LBPDI was evaluated by modified version of the ODI questionnaire. In the following, used questionnaires and tools are briefly introduced.

Figure 1: Loading tile packages, from conveyor to pallet

As shown in figure 1, in this production line dimensions (25 × 40 cm), weight of tile packages (14 kg), pallet height (10 cm), and conveyor height (80 cm) were reported. Respectively, 24 and 96 tile packages were placed on each tier and on each pallet. In addition, because this job was made up of 96 single tasks (due to changes in NIOSH equation parameters), multi-task lifting analysis procedure was used. Moreover, since all tasks required the controlling and repositioning of grip at the destination, analysis was performed at the origin and destination of lifting. The workers could freely

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walk on the pallet to get close to it. Workers had a continuous working model (8 hours/day). Moreover, this job did not involve a significant exposure to whole-body vibration (WBV).

To evaluate the risk factors of load lifting activities, the RNLE was used. In the first step, in the packaging unit and workers' station, parameters such as weight of tile packages, H, V, D, A, F, and C were measured for all workers. In the second step, based on the results of the first step, horizontal multiplier (HM), vertical multiplier (VM), distance multiplier (DM), asymmetry multiplier (AM), coupling multiplier (CM), and load constant (LC) were calculated. Based on the measured parameters, in each tier, one task was analyzed as the worst-case scenario (as marked in the figure, one task in each tier). Thus, frequency-independent recommended weight limit (FIRWL), single-task recommended weight limit (STRWL), frequency-independent LI (FILI), and single-task LI (STLI) at the origin and destination of lifting were calculated for these selected tasks, and at the end CLI was calculated for this lifting job according to the proposed formulas in the RNLE. It should be noted that in calculation of all mentioned parameters we used constant weight of handled tiles (not maximum or mean lifted weight).

To evaluate the prevalence of LBP, body map questionnaire was used. Moreover, to evaluate the severity of LBP, VAS was used. VAS is made up of a horizontal line with a length of 100 mm and has two labels including without discomfort and severe discomfort on both sides. To show the level of LBP, the subject specifies a point on the line that indicates the level of pain felt by him. Then, the severity of discomfort is recorded numerally from 0 to 100 using a millimeter ruler, and discomfort degree is interpreted as mild (0 to 20), moderate (21 to 40), severe (41 to 60), disabling (61 to 80), and severely disabling (81 to 100). Easy management, sensitivity, and ability to respond to statistical analysis can be noted as benefits of VAS (25). Saremi determined validity and reliability of the mentioned questionnaire among Shahed university dentists (26), and it has been used in Nadri et al. studies (27, 28).

A modified version of the ODI questionnaire has a high reliability and validity for the severity of the disability caused by LBP. The questionnaire consists of 10 sections: 7 sections for the activities of daily life, 2 sections for pain, and 1 section associated with the focus. This questionnaire or index examines the degree of disability resulted from LBP and its effect on daily activities of the person. In each section, the degree of disability in performance has been scored from zero (desirable performance and without pain) to five (disability in performance due to severe pain), and the total score is recorded in percentage. Therefore, disability degree is interpreted as mild (0 to 20 percent), moderate (21 to 40 percent), severe (41 to 60 percent), disabling (61 to 80 percent) and severely disabling (81 to 100 percent).

Statistical data analysis was done using SPSS (version 22.0, IBM Corporation, Armonk, NY, USA). Kolmogorov-Smirnov test (K-S test) was used to determine the normality of the data. To examine the relationship between demographic characteristics (marital status, gender, and exercise) with LBP and LBPDI, the chi-square test was used. To assess the relationship between pain intensity and disability with age, work experience, and body mass index (BMI), due to the absence of parametric conditions, the Spearman correlation coefficient was used ($P < 0.05$).

Results

About 86.7% of the subjects (26 workers) were married. According to the classification of BMI by health communities (33), 33.3% of the workers in this study were classified as normal weight, 60% overweight, and only 6.7% were obese. Therefore, the highest frequency of BMI belonged to the overweight class. Table 1 shows the demographic characteristics of the subjects.

Table 1: Distribution of workers' demographic characteristics (n = 30)

Variables	Mean ± SD	Range
Age (year)	35.5 ± 7.3	24.0-46.0
Experience (year)	11.3 ± 6.7	2.0-23.0
Height (cm)	172.1 ± 11.0	140.0-190.0
Weight (kg)	78.5 ± 10.6	52.0-96.0
BMI (kg/m^2)	26.5 ± 2.9	20.9-34.1
Regular working hours per day	8.1 ± 0.5	8.0-10.0

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Table 2: Computed frequency-independent recommended weight limit (FIRWL), single-task recommended weight limit (STRWL), frequency-independent lifting index (FILI), and single-task lifting index (STLI) for each task, and composite lifting index (CLI) for the job

Task No.		FIRWL*	FILI**	STRWL***	STLI #	CLI ##
1	Origin	12.49	1.12	6.87	2.04	14.77
	Destination	9.26	1.51	5.09	2.75	
2	Origin	12.11	1.16	6.66	2.10	
	Destination	5.78	2.42	3.18	4.40	
3	Origin	13.16	1.06	7.24	1.93	
	Destination	6.56	2.13	3.61	3.88	
4	Origin	13.16	1.06	7.24	1.93	
	Destination	6.53	2.15	3.59	3.90	

*** FIRWL:** Frequency-independent recommended weight limit
**** FILI:** Frequency-independent lifting index
***** STRWL:** Single-task recommended weight limit
 # STLI: Single-task lifting index
CLI: Composite lifting index

As shown in table 2, CLI was equal to 14.77. FILI and STLI values exceeded 1 for all tasks (with range of 1.06 to 2.42 and 1.88 to 4.40, respectively). In addition, FIRWL and STRWL values for all tasks were less than the weight of tile packages.

Table 3: Distribution of low back pain (LBP) intensity and LBP disability index (LBPDI) among workers (n = 30)

Variables	Mean ± SD	Minimum	Moderate	Severe	Crippled	Severe crippled
LBP*	68.8 ± 17.8	-	20.0	26.7	40.0	13.3
LBPDI**	41.3 ± 17.1	16.7	30.0	40.0	13.3	-

*** LBP:** Low back pain
**** LBPDI:** Low back pain disability index

The prevalence of LBP was reported equal to 100% among manual handling workers. LBP and LBPDI results and their classifications are shown in table 3. 40% of workers had crippled LBP intensity and 40% had severe LBPDI.

Table 4: Relationship between low back pain (LBP) intensity and LBP disability index (LBPDI) with workers demographic characteristics

Variables	Married (P)	Age (P)	Experience (P)	Exercise (P)	BMI*** (P)
LBP*	0.448	0.405	0.154	0.628	0.001
LBPDI**	0.400	0.390	0.118	0.583	0.001

*** LBP:** Low back pain
**** LBPDI:** Low back pain disability index
***** BMI:** Body mass index

There was no significant difference in the relationship between the LBP and LBPDI with marital status, age, work experience, and exercise ($P > 0.05$). However, LBP and LBPDI had a strong statistical relationship with BMI (Table 4).

Table 5: Average distribution of low back pain (LBP) intensity and LBP disability index (LBPDI) among workers' body mass index (BMI) classes

BMI*	Normal Mean ± SD	Overweight Mean ± SD	Obese Mean ± SD
LBP**	43.4 ± 10.1	66.6 ± 11.5	95.0 ± 7.0
LBPDI***	24.6 ± 9.4	46.8 ± 10.9	75.0 ± 7.0

*** BMI:** Body mass index
**** LBP:** Low back pain
***** LBPDI:** Low back pain disability index

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As shown in table 5, the mean of LBP and LBPDI in obese workers were greater than overweight and normal workers. Linear regression equation has shown that if BMI increases one unit, LBP and LBPDI have an increase equal to 5.29 and 5.01, respectively (Table 6).

Table 6: Linear regression between low back pain (LBP) and LBP disability index (LBPDI) with body mass index (BMI)

Variables	P	Adjusted R^2	Beta	Constant	Equation
LBP	0.001	0.733	0.861	-79.56	LBP = -79.56 + 5.29 BMI
LBPDI	0.001	0.712	0.849	-91.52	LBPDI = -91.52 + 5.01 BMI

*** LBP:** Low back pain
**** LBPDI:** Low back pain disability index
***** BMI:** Body mass index

Discussion

The RNLE has been introduced as a useful tool for the estimation of LBP incidence risk due to biomechanical stressors associated with manual lifting. In RNLE, LI is a scale of biomechanical stressors for LBP caused by lifting and lowering of loads in sub-tasks, and CLI is a scale of the stressors associated with all tasks. In fact, LI and CLI have shown a significant exposure response relationship for LBP (19-22). In our study, CLI value (14.77) exceeded 3 (high-risk); this means that the load lifting was very stressful, and there was an increased risk of LBP occurrence for all workers.

FIRWL reflects the compressive force and muscle strength demands for one task repetition; in this study, the FIRWL value in all tasks was less than tile packages' weight. FILI, regardless of the task's repetition frequency, determines the maximum biomechanical load imposed on the body and ability to identify different tasks with biomechanical requirements. Based on the results, FIRWL (with range of 5.78-13.16) and FILI (with range of 1.06-2.42) values, in all tasks considerable strength was required, although lifting frequency has not been considered in these parameters. It is clear that force is a problem in all tasks, because FILI values exceeded 1 in all cases. Thus, the total physical requirement of these jobs is primarily due to excessive force requirement rather than lifting frequency rate.

Since the STRWL is useful in determining the excessive physical stress of a separate task, in this study, STRWL (with range of 3.18-7.24) in all tasks was very less than the tile packages' weight. STLI can represent metabolic needs distributed among all tasks more accurately and is used to identify tasks with excessive physical requirement (leading to fatigue) and to prioritize tasks based on the amount of physical stress. In this study, STLI exceeded 1 in all tasks (with range of 1.93-4.40). Moreover, STRWL and STLI values showed that all tasks will be stressful when separately performed. Nevertheless, these values disregarded the combined effects of all tasks.

NIOSH equation has been used in many studies to evaluate manual handling of loads; their results were consistent with our study, and the values obtained were higher than the recommended limit (29, 30). These studies used their results for redesigning workstations for manual handling of loads (31, 32).

In this study, the prevalence of LBP among workers was reported equal to 100%, and LBP intensity evaluated by VAS was equal to 68.8 ± 17.8 (disabling pain). Some studies have reported a significant relationship between the risk of LBP prevalence, and LI or CLI of greater than 1.0 (33, 34).

ODI questionnaire evaluates the effects of pain on performance and how to do everyday activities. In other words, it examines the psychological status of a person's beliefs and attitudes about his inability to perform everyday activities, as the efficacy of this questionnaire has been reported in some studies (21, 35).

According to ODI results, LBPDI mean has been reported equal to 41.3 ± 17.1 (severe crippled). LBPDI in 30% of workers was placed in the moderate category of DI. The worker with moderate disability (although personal care, sexual activity and sleeping are not grossly affected), experiences more pain and difficulty with sitting, lifting, and standing, also travel and social life are more difficult and they may be disabled to work. Moreover, LBPDI in 40% of workers was placed in the severe category of DI. In these workers, pain remains the main problem and activities of daily life are affected; besides, they require a detailed investigation. In workers with crippled disability (13.3%), back pain affects all aspects of the workers' life, and their work requires positive intervention.

No significant difference was found between LBP and LBPDI with workers' demographic characteristics including marital status, age, work experience, and exercise (P > 0.05), that is aligned

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with the results of other studies (27,36,37). Although various studies have shown the effect of different exercises on reduction of the pain (28, 38, 39), some studies have not shown any relation between LBP and exercise, and are aligned with our finding (40, 41).

LBP and LBPDI had a strong statistical relationship with BMI. This finding was aligned with other studies that showed higher LBP and LBPDI in subjects with a higher BMI (28, 41). Further, Youdas et al. reported higher risk of developing LBP in women weighing more than 100 kg and in men with a height greater than 180 cm (42). Obesity is considered to be a risk factor for LBP; however, only weak associations between body weight and LBP have been revealed (43, 44).

Conclusion

The results of this study support the findings of other studies and show that biomechanical stressors play an important role in the development of LBP. The LI and CLI are useful metrics for estimating exposure to biomechanical stressors, and jobs should be designed to keep both of these metrics as low as possible to reduce the LBP risk. By redesigning the workstations and correction of all multipliers involved in calculating LI and CLI, including HM, VM, DM, AM, CM, frequency multiplier (FM), and LC, the LI and CLI value will be improved. On the other hand, by training and improving the condition of the BMI, we can take a positive step toward reducing the prevalence of LBP. Studies with a larger sample size are needed to clarify the exposure–response relationship between the LI and CLI with LBP.

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