A Comparative Assessment of Manual Load Lifting Using NIOSH Equation and WISHA Index Methods in Industrial Workers of Shiraz City

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Abstract

Background: Manual load lifting is the most common and stressful activity that imposes high biomechanical pressures on the body, particularly on the back. Diverse studies have shown that load lifting can cause work-related musculoskeletal disorders among workers. This study was conducted to assess manual lifting activity using NIOSH equation and WISHA index and compare the results of the two methods in workers with manual lifting activities.

Methods: This cross- sectional study was carried out among 120 workers with manual lifting activity in 7 industrial settings of Shiraz city. Nordic Musculoskeletal disorders Questionnaire (NMQ) and demographic questionnaire, as well as NIOSH lifting equation and WISHA index were used to gather the required data. Statistical analyses were performed using SPSS, 19.

Results: The results showed that back problems were the most frequent musculoskeletal disorders among the workers studied (68.3%). The results of lifting evaluation indicated that 79.2% of the individuals in the NIOSH method and 39.2% in WISHA index were at risk of back injuries. The kappa value was equal to 0.29, indicating a fair agreement between the results of assessment by the two methods.

Conclusion: The results of this study confirmed a fair correlation between these two assessment methods, so they might be used interchangeably.

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Introduction

Recent development of technology in working environment has not been able to obviate the need for manual material handling in industrial settings as it is supposed to.[1] Nowadays, in most industries, manual material handling forms a great portion of job activities.[2,3] Load lifting is the most common activity of manual material handling in the workplace[4] that imposes high biomechanical pressures on the body, particularly on the back. Diverse studies have shown that load lifting can cause work-related musculoskeletal disorders (WMSDs) among workers.[4,5] Musculoskeletal disorders are those which leave impacts on the musculoskeletal structures such as the nerves, muscle, tendon, and spine intervertebral discs.[6,7] One of the causes of these injuries is lifting and carrying heavy loads.[8] Low back pain is a common work-related musculoskeletal disorders caused by manual material handling particularly load lifting.[9-11] Heavy load lifting has been identified as a major risk factor for development of low back injuries.[12] Work-related back pain has been reported to be a reason for workers' disability and payment of compensations worldwide.[13]

In a study in the U.S., it was shown that about 2% of American workforces received compensations each year for work-related musculoskeletal disorders, particularly backache.[14]

Around 50% of backache cases are due to lifting, 10% pushing and pulling, and 6% handling loads.[15] There are different methods to evaluate manual load lifting and determine risk of back injury. Regarding the high prevalence of musculoskeletal disorders and especially back injury among the workforce, abundance of lifting activities in industrial and service sectors employees and also lack of risk level evaluation of manual lifting activities in Iranian industries, the present study was carried out to determine the prevalence of musculoskeletal back disorders, assess manual lifting activity using NIOSH lifting equation and WISHA index, and finally, compare the results of these two methods to introduce a more applicable evaluation method in 7 industries of Shiraz city, Iran.

Methods

This cross – sectional study was carried out in 2014 among 120 workers with manual lifting activity. The sample size was determined according to the previous studies.[12,16] The subjects were selected via easy sampling method among male workers employed in 7 industries of Shiraz city, Iran (i.e. cement, tiles, glaze, beverage, oil, rubber and dairy products). As the inclusion criteria, workers with at least one year of job tenure and nearly 8 hours of lifting activity per day without accidents affecting the musculoskeletal system were studied.

Data collection tools:

A) An anonymous self-administered questionnaire was used to collect the required data for each participant. The questionnaire consisted of two parts: a) demographic information including age, weight, height, marital status, job title, education, job tenure in the current job, daily working time, work schedule and intention to change the job; and b) the general Nordic questionnaire of musculoskeletal (NMQ) symptoms to examine reported cases of MSDs in different parts of the body among the study population.[17] The NMQ provides a mean to screen MSDs cases and to determine the prevalence of MSDs in epidemiological studies. NMQ reported musculoskeletal symptoms during the past 12 months. Each participant received the questionnaire in person in his workplace. The questionnaire was completed by workers during their work shifts.

B) NIOSH lifting equation to assess lifting activity in single and multi-tasks. This equation estimates the recommended weight limit to lift in a specific time period without causing any injuries to the spine.[18,19] In this equation, to calculate the recommended weight limit (RWL), 6 load lifting related parameters including Horizontal Multiplier (HM), Vertical Multiplier (VM), Distance Multiplier (DM), Asymmetric Multiplier (AM), frequency Multiplier (FM) and Coupling Multiplier (CM) are considered.[20,21]

After determining the parameters using the formulas and related tables, based on the following equation, RWL is calculated for the origin and the destination points of load lifting.

$$RWL=LC\times AM\times CM\times DM\times FM\times HM\times VM$$

Then, the lifting index (LI) is calculated according to the following formula:

$$LI = \frac{\text{Load Weight}}{\text{Recommended Weight Limit}} = \frac{L}{RWL}$$

If LI≤1, the risk of back injury would be low and if 1<LI<3, the risk of back injury would be moderate and if LI≥3, then the mentioned risk would be high.[22] In the current study, to compare the two methods, the risk level of back injuries created due to load lifting activities was categorized into two groups of low risk with LI≤1 and high risk with LI>1.

In investigating the multi-task in which there are significant differences in task variables between tasks, the composite lifting index (CLI) is computed. CLI represents the collective demands of the job. It is equal to the sum of the largest single task lifting index (STLI) and the incremental increase in the CLI as each subsequent task is added (ΣΔLI). The CLI for the job is computed according to the following formula:[19]

$$CLI= STLI_1+ \Sigma\Delta LI$$

C) Assessment of manual lifting activity by WISHA index method. The variables including the weight of the object lifted, the position of the hands at the origin of lift or lowering, the frequency of lifting per minute in a shift, and the twisting angle while lifting were considered to analyze the lifting operation. In this method, the acceptable load weight is determined and then the load lifted is compared with the acceptable weight. If the weight of the load lifted by the workers is higher than the WISHA acceptable weight, then there will be a possibility for back injuries.[23,24]

Data analysis was performed using SPSS software, version 19. To compare the prevalence of musculoskeletal disorders according to the quantitative variables, independent T-test was applied. In order to study the agreement between the results of the two assessment methods, Kappa coefficient was used. Values between 0 and 0.20 represent poor agreement, 0.21 and 0.40 fair agreement, 0.41 and 0.60 moderate agreement, and 0.41 and 0.80 substantial agreement. A value above 0.80 is considered as excellent agreement.[25-27]

Results

Table 1 presents demographic characteristics of the studied individuals. The majority of the workers (78.3%) had experienced some kind of musculoskeletal symptoms during the last 12 months prior to the study. The results showed that back problems were the most frequent musculoskeletal disorders among the workers studied (68.3%). In Table 1, the mean age, weight, height and job tenure of the subjects in the two groups of with and without MSDs symptoms are displayed. Statistical analysis revealed that the differences in the mean age (P=0.007) and job tenure (P<0.001) were significant between the two groups.

Based on the subjects' reports, 56% of the workers intended to change their jobs due to inappropriate working conditions. It is noteworthy that, the frequency of job change intention among workers with MSDs (95.6%) was significantly higher than that of workers with no MSDs symptoms (4.4%) (P<0.001).

The results of evaluation of the lifting activities by NIOSH equation showed that in 20.8% of the subjects LI index was ≤1 and in 79.2% of them it was >1.

The results of the evaluation of the lifting activities by WISHA index showed that 60.8% of the participants lifted loads lighter than allowable weight obtained by index WISHA and in 39.2% heavier than allowable limit. Comparison of the results of these two evaluation methods revealed that Kappa coefficient value was equal to 0.29; this indicated a significant fair agreement between the two methods (P<0.001).

Discussion

The age and the job tenure means of the studied workers was 31.7±7.4 and 4.9±4.8, respectively. According to the results of the Nordic questionnaire, the prevalence of the musculoskeletal disorders was reported to be 78.3%. The statistical analysis revealed that the age and job tenure means of the workers and also the frequency of the intention of changing jobs in those who suffered from musculoskeletal symptoms were more than those who did not report to have symptoms. This means that by increasing the above-mentioned variables the prevalence of the disorders increases as well. This finding is in agreement with the results of other studies.[16,28]

However, the results of this study showed that the difference in height and weight means between the two groups of with and without disorders was not significant. However, previous studies have shown that usually tall and heavier individuals were more likely to suffer from these kinds of disorders.[29,30]

As compared with the results of WISHA index, the results of the assessment of the lifting activities by NIOSH equation showed that a larger percentage of subjects are at risk of back injuries.

According to the obtained results from WISHA index, 73 individuals (60.8%) were not exposed to the risk of back injuries. This meant that the weight of the lifted load was lower than the allowed level. For 47 individuals (39.2%), there was a risk of back injury due to lifting loads heavier than the allowed weight limit.

The results indicated that there was a fair agreement between the results of the NIOSH equation and WISHA index assessment methods. Regarding this, it could be inferred that the two methods might be used interchangeably. The difference in the numbers and the types of the variables considered in these two assessment methods are possible reasons for fair but not complete agreement. Regarding the fact that WISHA index uses fewer parameters to assess the lifting activity as compared to the NIOSH method, it can be pointed out that it is a simpler and easier method and the procedure of the assessment is carried out in a shorter period of time. On the other hand, considering more variables of lifting conditions in the assessment model of NIOSH equation will produce more reliable and valid results.

Since the study was limited to male industrial workers, female employees were excluded from the study; thus, the data may underestimate the reported symptoms of musculoskeletal disorders.

Conclusion

In conclusion, the results of this study highlighted a fair correlation between these two assessment methods. The reasons for this could be the difference between

Table 1: Individual characteristics of the subjects in the two groups with and without MSDs symptoms (n=120)

Demographic Variables	Total (n=120)	MSDs		P value*
		Yes (94) (78.3%)	No (26) (21.7%)	
Age (yr) (mean±SD)	31.72±7.40	32.43±7.88	29.11±4.53	0.007
Weight (kg) (mean±SD)	74.49±10.03	74.58±10.28	74.15±9.25	0.847
Height (cm) (mean±SD)	174.06±5.88	174.09±5.96	173.92±5.69	0.895
Job tenure (yr)	4.92±4.76	5.6±5.04	2.44±2.22	<0.001

*Independent sample t- test between the two groups

the number and the types of variables included in the two assessment models. The WISHA index is a simpler and easier method, but the assessment model of NIOSH equation is more comprehensive and probably produces more reliable and valid results. Regarding the fair correlation found between the results of the two techniques, since the WISHA index is a simpler and more applicable one, it is suggested that in Iranian industries this evaluation method is applied to assess manual lifting activities. Further studies with larger sample size are required to achieve firmer and more reliable results. Also, investigation of the subject among female workers seems necessary.

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