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The Risk Assessment of Low Back Pain Based on Allowable Weight Limits for Manual Lifting in Iranian Women Workers

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Abstract

Background: Manual load lifting is one of the most important risk factors for musculoskeletal disorders, including occupational low back pain. These disorders are common in women workers who perform manual load lifting and displacement tasks at the workplace.

Objectives: To determine the level of musculoskeletal disorders and to evaluate the recommended limits of manual load lifting in women workers using WISHA checklist and ACGIH TLV, the recommended limits of Iran, and compare the results of two methods.

Methods: This cross-sectional study was conducted on 100 women workers who performed manual loading tasks in 2018. Nordic questionnaire was used to determine the prevalence of musculoskeletal disorders, and two methods, WISHA checklist and ACGIH TLV, were used to determine the recommended allowable limits for manual load lifting.

Results: The results of the prevalence assessment of musculoskeletal disorders showed that most of the musculoskeletal disorders were in the low back (55%) in the past 12 months. The results of the assessment of the allowable lifting limits also showed that 8% of women in the WISHA checklist method and 31% in the ACGIH TLV method were at risk for low back injuries. The kappa coefficient test (0.031) also showed that there is a poor and insignificant agreement between the two methods of WISHA checklist and ACGIH TLV in determining the allowable limits for manual lifting.

Conclusions: The results of this study showed a poor agreement between the WISHA checklist and ACGIH TLV in determining the allowable limits for manual lifting, which suggest that the two methods are not mutually exclusive. Hence, owing to the increasing presence of women in various occupations and raising the hand load-lifting and, naturally increasing occupational low back pain among them, it is necessary that in a comprehensive study, the allowable limits of lifting loads according to anthropometric and physiological characteristics of Iranian women, prepare and compile according to a comprehensive instruction.

Keywords: Load Lifting, WISHA Checklist, ACGIH TLV, Musculoskeletal Disorders, Women Workers

1. Background

Manual handling activities include lifting, lowering, pulling, pushing, which, despite extensive technological advances in various production processes and industries, and even in non-occupational and non-productive matters, have remained unchanged. Moreover, manual movement commodity and load lifting occur frequently (1, 2). Manual handling activities are of particular importance due to fatigue, musculoskeletal disorders, work losses, reduced productivity and safety, increased absenteeism, and increased work accidents. Musculoskeletal disorders caused by manual handling include acute and severe physical injuries in the low back, shoulder, and arm areas, which can cause long-term pain, disability, financial losses, etc. (3, 4). Manual load-lifting has been proven to be one of the occupational risk factors for low back diseases (5). According to the estimates by the National Institute for Occupational Safety and Health in the United States annually, about half a million workers suffer from varying degrees of low back injuries. In this regard, manual load lifting accounts for 60 percent of compensations caused by these injuries (6). In Iran, epidemiological and biomechanical studies show that the prevalence of low back pain in heavy and light occupations is high, and many studies have reported a prevalence of occupational low back pain between 60% and 70%, of which manual load lifting is one of the main reasons (7-12). Manual load lifting is a detrimental risk in the workplace for women who are involved in occupational or accidental handling activities in their work environment, which requires identifying, evaluating, and assessing the risk factors associated with it, and minimizing the effects and damage caused by it. A study in Canada re-

ported that 10% of the country's workforce was exposed to musculoskeletal disorders in the low back. The prevalence of low back pain in men was 7.6%, while in women, it was 11.3%, and this indicates a higher prevalence of these disorders in women than men (13). The main reasons for this difference are women's physical strength, anthropometric and physiological dimensions (14). Studies have shown that lower muscle strength, anthropometric dimensions, and hormonal changes make women more prone to musculoskeletal disorders than men (15). Various methods have been developed by various organizations to assess the allowable limits of manual lifting. Among the available methods, Washington Industrial Safety and Health Act (WISHA checklist) and American Conference of Governmental Industrial Hygienists Threshold Limit Value for manual lifting (ACGIH TLV) methods, the standards used in the manual load lifting regulations in Iran, have been introduced. The ACGIH TLV standard was used as the allowable manual load lifting limit Until 2017, and now the WISHA Checklist standard used.

2. Objectives

Owing to the high prevalence of occupational low back disorder among women workers and since no study has been conducted to assess the risk of manual load lifting according to Iranian standards among women, the present study aims to assess the overlap and reliability of the results of WISHA checklist and TLV ACGIH methods in estimating the risk of women's low back disorder were performed in manual load lifting activities.

3. Methods

This cross-sectional study was conducted on 100 women workers who were involved in manual load lifting in the chain stores in 2018. The research inclusion criteria included healthy women workers without age limit and having at least 1 month of working experience. The research exclusion was people with musculoskeletal problems or a history of lumbar surgery. The work environment and workstations of the workers were visited, and in addition to the interviews, their work situation was observed. Each worker worked at their workstation for 10 to 15 minutes, and the evaluation process was carried out.

3.1. Data Collection Tools

3.1.1. Nordic Questionnaire

This questionnaire was used to collect the required information from each participant and included two sections: (1) Demographic information, including age, weight, height, job position, level of education, marital status, tenure, duration of work shift, smoking, and chronic disease; (2) general prevalence of Nordic musculoskeletal disorders questionnaire (NMQ) to assess the prevalence of discomforts in different parts of the body (16).

3.1.2. ACGIH TLV

The recommended limit for manual load lifting in ACGIH TLV is for jobs whose workers are frequently exposed to manual load lifting for continuous days without causing pain in the low back and shoulder parts of the body. In this regard, there are some individual and organizational risk factors that increase the likelihood of low back pain and shoulder injuries at the workplace. This worksheet includes three tables in the weight zone in kg. It is used for works that are done manually only in the form of lifting similar loads, and the body deviates 30 degrees from its normal position when doing them. The allowable limit is defined in the form of tables that have been defined based on exposure durations for less than 2 hours per day and frequency or number of load-lifting per hour. To use these tables, vertical zones should be determined based on the position of the hands when lifting the load, and the horizontal zones should be determined by measuring the horizontal distance from the midpoint of the ankle bones to the midpoint of the two hands. Permissible limits are defined as tables based on periods for less than or more than two hours per day and repetition (number of load lifts per hour). To use these tables, we must do the work period, the number of times of lift the load, the vertical areas based on the position of the hands when lifting the load, and the horizontal areas by measuring the horizontal distance from the midpoint of the ankle bones to the point. Determine the middle of the two hands, then the allowable limits for weight lifted in kilograms are obtained using the horizontal and vertical areas of the table houses and based on the maximum duration and frequency of lifting the load. Load displacement should not begin and end in horizontal access more than 80 cm, 30 cm above shoulder level, or 180 cm above floor level. Also, the usual load-displacement should not be done for shaded parts of the table and is not allowed (17).

3.1.3. WISHA Checklist

WISHA technique has been introduced in recent years based on the allowable limit recommended for manual load lifting. This computational method is based on the recommendation of the Washington State Department of Labor and Industries known as WISHA. The needed variables include the desired load weight, position of hands relative to the load lifting site, the frequency in a minute, and the shift and bending angle. In this method, the acceptable weight of manual lifting is determined. Then, it is

compared with the desired weight of manual lifting. If the weight of the load lifted by an individual exceeds the acceptable value of WISHA, it means that the person is at risk for low back injury. If the load lifting activity involves lifting the load with different weights, the criterion for evaluating is the maximum load weight and the worst physical condition when lifting the load also the evaluation for the most repetitive mode and the most common working conditions. The steps for performing this method according to the checklist are as follows:

1) Determining the weight of the lifted load in kilograms.

2) Figure 1 of the checklist shows the area where the lifting and lowering of the load begins, and the appropriate weight is selected.

3) Owing to the frequency of lifting the load and the duration of the lifting activity during a shift, one of the coefficients of Table 1 of the checklist is selected.

4) If the person bends more than 45 degrees when lifting the load, the coefficient of 0.85; otherwise, the coefficient of 1 is considered.

5) The numbers obtained from steps 2, 3, and 4 are entered into the following formula, and the load lifting limit is obtained in kg:

Step number 2 × Step number 3 × Step number 4 = allowable weight for manual lifting.

The allowable weight is compared to the weight of the load. If the load lifted by the person is greater than the acceptable value of WISHA, it means that the person is at risk of lumbar injury (18).

3.2. Data Analysis and Statistics

The research data were analyzed using SPSS software, version 22. Independent *t*-test and kappa coefficient were used to compare the mean prevalence of musculoskeletal disorders based on quantitative variables. Kappa coefficient 0 - 0.2 poor agreement, 0.21 - 0.4 fair agreement, 0.41 - 0.6 medium agreement, 0.61 - 0.8 significant agreement and above 0.81 shows excellent agreement (19).

4. Results

The results obtained from the Nordic Questionnaire: Table 2 shows the demographic characteristics of the 100 women workers studied. Moreover, 66% of those who were surveyed had at least one symptom of musculoskeletal disorders in the past 12 months before the study began. The mean age, weight, height, tenure, and work time in the two groups with musculoskeletal disorders and without musculoskeletal disorders. Statistical analysis showed that there was a significant difference between the mean age (P = 0.015), weight (P = 0.033) and tenure (P = 0.00) in both groups ($P < 0.05$). However, no differences were observed between the mean height (P = 0.214), working time (P = 0.272), marital status (P = 0.156) and literacy level (P = 0.127) ($P > 0.05$).

Figure 1 shows the prevalence of musculoskeletal disorders in different areas. Low back disorders with a frequency of 55%, upper back with a frequency of 47%, and neck with a frequency of 31% had the highest frequency, respectively. According to the WISHA checklist, 8 % of all participants lift loads above the allowable weight of the WISHA and are at risk of low back injury, and 92 % of Participants lifting weights less than the allowable load (Figure 2). The TLV ACGIH results showed that 31% of all participants lifted unallowable weight and were at risk, and the other 69% lifted allowable loads. According to Table 1, there is a poor correlation and agreement (kappa coefficient = 0.031) between the results of the two ACGIH TLV and WISHA methods.

5. Discussion

The results of the present study showed that 66% of the women in the study reported symptoms of musculoskeletal disorders in the last 12 months, and the highest prevalence of these disorders was in the low back, upper back, neck, and shoulders. These results were consistent with the results of a study by Rahman and Zuhaidi (20), which examined the symptoms of musculoskeletal disorders and the ergonomic risks of male and female workers who work in the packaging of grocery stores. In this study, low back disorders with a frequency of 85.7%, upper back area with 71.4%, and neck with 50% had the highest prevalence among female workers (20). The results of statistical analysis showed that the age, weight, and tenure of women who are exposed to musculoskeletal disorders are higher than women without musculoskeletal disorders, so that with increasing age, weight, and tenure, the possibility of increasing low back pain in women studied had increased. These findings were in line with the findings of Kolgiri et al. (21) in 2018 on female workers who work in the Indian Power-Loom Industry, as well as Arghami et al. (22) in 2016 in female Workers in an Automobile Manufacturing Assembly Line in Iran where the age and tenure of influential factors were reported in the prevalence of musculoskeletal disorders (21, 22). It seems that in this study, in addition to demographic characteristics, other factors play a role in the prevalence of these disorders so that the weight of the external load that was lifted by women was between 3 and 20 kg. Heavy loads were often lifted from the ground floor, and according to observations, lifting loads with undesirable postures in the low back region and with a flexion angle of more than 90 degrees was performed. A

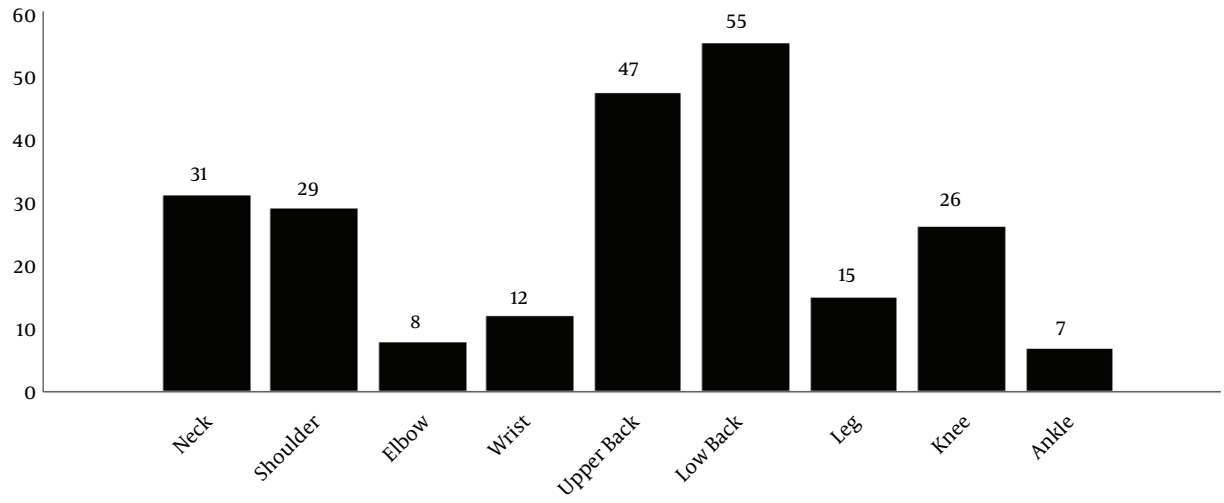

Figure 1. Prevalence of musculoskeletal disorders in the last 12 months in the studied women

Table 1. Kappa Coefficient Results Between ACGIH TLV and WISHA Methods[a]

	Value	Asymp. Std. Error[b]	Approx. T[c]	Approx. Sig.
Measure of agreement kappa	0.031	0.077	0.414	0.679

[a] Numbers of valid cases = 100.
[b] Not assuming the null hypothesis.
[c] Using the asymptotic standard error assuming the null hypothesis.

Table 2. Demographic Characteristics in Two Groups with Musculoskeletal Disorders and Without Musculoskeletal Disorders[a]

Demographic Characteristics	Total (N = 100)	Musculoskeletal Disorders		P Value[b]
		Yes (66%)	No (34%)	
Age, y	34.29 ± 9.79	37.15 ± 9.75	28.73 ± 7.23	0.015
Weight, kg	70.99 ± 11.40	73.92 ± 11.65	65.29 ± 8.46	0.033
Height, cm	163.55 ± 5.33	163.90 ± 4.93	162.85 ± 6.06	0.214
Job tenure, mo	35.59 ± 26.62	43.12 ± 28.43	20.97 ± 14.13	0.000
Work shift, h	8.41 ± 1.59	8.65 ± 1.39	7.94 ± 1.85	0.272

[a] Values are expressed as mean ± SD.
[b] Independent sample *t*-test between the two groups.

study by Vats and Devi et al. (23) in 2018 on women working in a tea factory in India reported an increase in musculoskeletal disorders due to lifting the load, raising the load at the top of the shoulder, and raising the load with one hand. The pressure and pulling weights were more than 25 kg, reported above (23). In another study, inappropriate postures and repetitive movements were reported as risk factors for musculoskeletal disorders (20). Comparison of manual load lifting risk assessment results using WISHA and ACGIH TLV methods shows that in the WISHA method, 8% of women and in ACGIH TLV method, 31% of women lift excessively allowed loads, and this means that the risk assessment of low back disorder in the WISHA method is less estimated than in the ACGIH TLV method. Based on statistical tests, the compliance power of the two methods in determining the allowable limits was negligible and showed that WISHA and ACGIH TLV manual load evaluation methods did not have the appropriate overlap in estimating the risk of load lifting and were not a suitable alternative for each other. The WISHA and ACGIH TLV methods are both derived from the NIOSH equation (24) but have fewer variables than the NIOSH equation method and are, therefore,

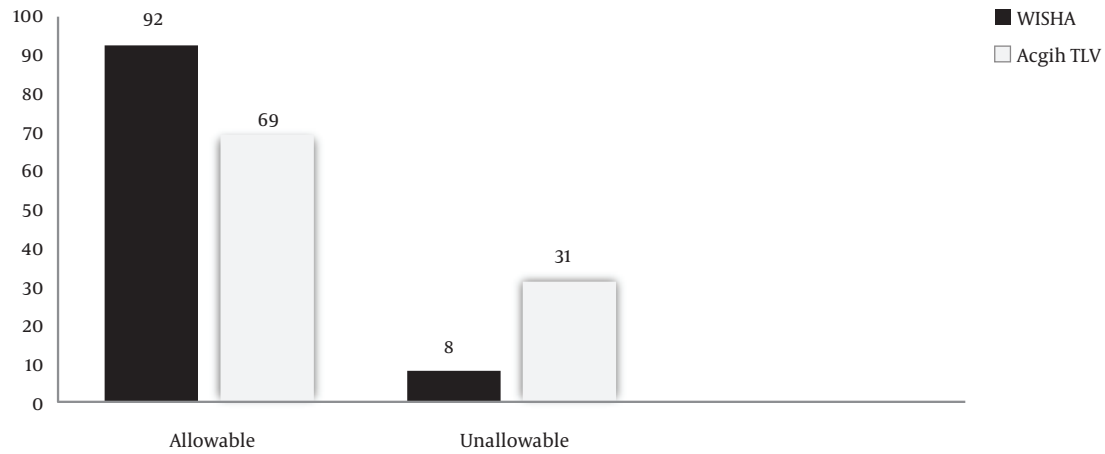

Figure 2. The frequency of allowable and unallowable cases is based on the evaluation method

easier and more convenient to assess and estimate the risk of manual load lifting. Although most of the variables measured in the two methods are similar, it seems that estimating the allowable limits in the ACGIH TLV method is more cautious than in the WISHA method. This could be because the WISHA method finally compares the allowable limits with the weight of the lifted load and then checks the safety of the load, while the ACGIH TLV method does not consider the load weight factor. In some cases, no safety limits have been considered due to lifting conditions. Studies that compare methods of manual load lifting have shown that the WISHA method is weaker than other methods in assessing the permissible limits of load lifting (24-26). In a study in 2005, Russell et al. (24) compared the results of five methods of analyzing manual load lifting (WISHA, ACGIH TLV, NIOSH, SNOOK, 3DSSPP) and concluded that the WISHA method underestimate the high risk obtained from ACGIH TLV, NIOSH methods. Asadi et al. (25) assessed 120 male workers from different industries in Shiraz, who were involved in the manual load lifting tasks using the NIOSH and WISHA methods. They found that 79.2% of people based on the NIOSH method and 39.2% of people based on WISHA checklist were at the risk of low back injury. The correlation coefficient of the two methods (kappa coefficient) was obtained at 0.29, indicating lower than average agreement between the results of the two methods (25). Panjali et al. (26) also compared the domestic and foreign standards of load-lifting in 2012. In this study, the results of the three methods of WISHA method, NIOSH equation, and MAC worksheet were compared. In this study, 54 % of the workstations in the WISHA method had an allowable load-lifting level, and it was less sensitive than the other two methods in risk assessment of low back pain (26). Considering the results obtained on the high prevalence of musculoskeletal disorders, especially low back disorders in women workers, it is necessary to perform risk assessments on manual load lifting tasks with valid methods based on anthropometric information and physiological characteristics. Salehi Sahl Abadi et al. (27), in a study in 2018 aimed at determining the changes in electromyographic indicators when measuring the maximum acceptable weight lifting load in Iranian students, concluded that if muscle activity is more than 70% of maximum voluntary muscle contraction. The weights in the SNOOK tables, which are one of the methods for evaluating manual load lifting, should be revised (27). Afshari et al. (28) in 2018, also examined the risk of occupational low back pain was also examined based on the measurable limits of lifting loads in Iran and concluded that the ACGIH TLV method requires further review based on Iranian anthropometric characteristics. Based on the results of the present study, the level of manual lifting risk obtained from WISHA and ACGIH TLV methods is different from each other and makes it difficult to decide on control methods to prevent low back disorders in the study population. Therefore, the need for a comprehensive laboratory study, the biomechanical and physiological details of the standard manual load lifting limits among Iranian women should be examined, and based on the laboratory findings, comprehensive instruction on manual load lifting limits for Iranian women should be prepared and presented.

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Footnotes

Authors' Contribution: Study concept and design, critical revision of the manuscript for important intellectual content, administrative, technical, and material support, and study supervision: AD and NM. Acquisition of data, analysis and interpretation of data, drafting the manuscript, and statistical analysis: MM.

Conflict of Interests: There is no scientific contradiction.

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Informed Consent: This study was done with complete consent of the samples and confidentiality of the information to the researchers.

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