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RESEARCH ARTICLE **OPEN ACCESS**

Prevalence and Associated Factors of Musculoskeletal Disorders (MSDs) among Greenhouse Workers

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Abstract:

Background: Musculoskeletal disorders (MSDs) are among the most common occupational health issues in agricultural work. Therefore, it is essential to assess the severity of these disorders among greenhouse workers to evaluate their health status and identify factors associated with these conditions.

Aim: This study aimed to investigate the prevalence of MSDs and identify associated risk factors among greenhouse workers.

Methods: This cross-sectional study examined 293 greenhouse workers in Jiroft City in 2023 through cluster sampling. Data were collected using the Nordic Musculoskeletal Questionnaire and analyzed in SPSS-24 employing independent t-tests, Pearson correlation, and ANOVA.

Results: This study included 293 greenhouse workers, with 261 (89.1%) being male and 32 (10.9%) female. The prevalence of MSDs was 89.3% among men and 10.7% among women. Over half of the participants were aged between 20 and 40 years. A total of 149 workers (50.9%) reported having MSDs, with 76 (25.9%) affected in one body area, 40 (13.7%) in two or three areas simultaneously, and 22 (7.5%) in all examined areas. The most common MSDs were back problems (36.2%, 106 cases), followed by shoulder pain (19.5%, 57 cases) and knee pain (17%, 50 cases). Ankle issues were the least frequent (7.5%, 22 cases). A significant correlation was found between physical activity and MSD prevalence ($p \leq 0.05$).

Conclusion: The high prevalence of MSDs underscores the urgent need for ergonomic interventions and workplace exercise programs. Promoting physical activity and healthy lifestyle practices among greenhouse workers is also essential to mitigate these occupational health risks.

Keywords: Musculoskeletal disorders (MSDs), Workers, Greenhouse, Trauma, Pain, Ergonomics, Occupational diseases.

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1. INTRODUCTION

MSDs are among the most common occupational diseases and leading causes of absenteeism, significantly reducing productivity [1, 2]. These disorders account for a major portion of occupational illnesses in work environments [3], resulting from damage to muscles, tendons, ligaments, joints, nerves, blood vessels, and soft tissues [4, 5]. MSDs represent one of the most prevalent work-related health issues worldwide, accounting for approximately 32% of all occupational diseases, according to 2014 data from the U.S. Bureau of Labor Statistics [6]. More recent statistics from the U.S. Department of Labor indicate that MSDs result in 1.6 cases of injury, illness, or fatality per 100 full-time workers [7]. MSDs account for 7% of all societal diseases, 14% of physician visits, and 19% of hospitalizations, with 62% of affected individuals experiencing movement restrictions, according to the International Institute's report. The American Occupational Health and Safety Organization ranks MSDs as the second most significant work-related disease in terms of frequency, severity, and progression potential [3]. In Iran, these disorders rank fourth for total disability [1], with Tehran's Social Security Organization Medical Commission reporting that 14.4% of disability-causing diseases are MSD-related [8]. Research indicates that MSDs cause over half of workplace absenteeism cases [9, 10], with back pain being the most prevalent manifestation affecting 50-90% of adults [2, 9-11].

The prevalence of these musculoskeletal discomforts leads to reduced work capacity and quality, increased medical costs, greater work time loss, and premature disability among workers [10, 12].

Chronic spinal pain leads to distressing psychological effects and serious complications, including limited mobility, disability, job changes, and the overuse of oral and injectable medications for treatment [13,14]. Despite advances in workplace automation, many jobs still involve physical tasks such as manual material handling and tool use, which place biomechanical stress on the body [15, 16]. These physical demands often result in pain and discomfort across multiple body regions. Both ergonomics and industrial psychology highlight the significance of workload-induced stress, which can lead to physiological changes (*e.g.*, increased heart rate), psychosocial effects (*e.g.*, irritability), and behavioral outcomes (*e.g.*, increased error rates) [17-19]. Excessive work pressure and poor posture, primary contributors to MSDs, remain central issues in workload-related investigations.

A study by Mostaghati *et al*. examining MSD prevalence and risk factors among agricultural machinery factory workers found MSD occurrence at 3.40%, with body-specific prevalence rates of 12.8% for back pain, 7.8% for knees, 6% for the neck, and 5% for shoulders [9]. The prevention of work-related MSDs has now become a national priority in many countries [18, 19]. Postural analysis serves as a powerful ergonomic assessment tool for work activities, where evaluating ergonomic risks associated with improper posture helps identify potential work-related MSDs [15, 20, 21]. The high prevalence across different body regions underscores the need for targeted ergonomic interventions in industrial settings. Agriculture represents one of the most physically demanding occupations, involving unavoidable risk factors for MSDs, such as heavy lifting, equipment handling, and sustained awkward postures, which contribute to conditions like osteoarthritis [22-24].

As one of the most prevalent occupational diseases, MSDs significantly reduce productivity, increase absenteeism, and may lead to permanent worker disability. Greenhouse workers are particularly vulnerable due to exposure to multiple ergonomic hazards, including repetitive motions, prolonged static postures, substantial weight-bearing, and insufficient recovery periods. The nature of greenhouse work, requiring frequent bending, kneeling, and transporting heavy loads in confined, humid environments, creates unique biomechanical stresses that elevate MSD risk. While previous research has documented MSD prevalence in general agricultural settings, greenhouse workers remain understudied despite facing compounded physical strain from microclimatic conditions. This study addresses this critical gap by investigating MSD patterns among greenhouse workers in Jiroft, a region known for intensive greenhouse farming. Our research aims to assess workers' health status and identify associated risk factors, responding to the urgent need for data on this high-risk occupational group. The findings will inform targeted interventions to protect this essential but vulnerable agricultural workforce.

2. METHODS AND MATERIALS

This cross-sectional study investigated 293 greenhouse workers in Jiroft city during 2023 using cluster sampling methodology. The sample size was determined through

Morgan's table for a population of 1,200 workers, achieving a 95% confidence level with a ±5% margin of error. Researchers identified 12 major greenhouse complexes across Jiroft and randomly selected 5 geographically representative clusters. Within each selected complex, all eligible available workers were enrolled until reaching the predetermined sample size, ensuring broad operational representation while maintaining practical implementation. The sampling framework specifically targeted population size (N)=1,200, sample size (n)=293, confidence level=95%, and margin of error=±5%. This methodological approach balanced statistical rigor with fieldwork feasibility while capturing diverse greenhouse working conditions across the region. The study included participants who met the following criteria: agriculture must be their primary occupation, they must be capable of participating in the study, have no history of musculoskeletal diseases, be aged 18 years or older, and provide informed consent. On the other hand, individuals who were non-professional or temporary workers, or those who provided incomplete questionnaire responses, were excluded from the study.

Data collection utilized a validated two-part questionnaire combining demographic characteristics with the Nordic Musculoskeletal Questionnaire (NMQ). The demographic section considered age, work experience, anthropometric measures (height/weight), and musculoskeletal history. The NMQ assessed symptoms across nine anatomical regions (neck, shoulders, upper/lower back, elbows, hands/wrists, thighs, knees, ankles, and feet). Previous Iranian validation studies confirmed the questionnaire's face validity, with excellent reliability metrics: standard error of measurement (SEM=0.56-1.76), intraclass correlation coefficients (ICC>0.70), and Kappa agreement coefficients (0.78-1.00) [25].

Data collection was carried out using two methods: literate workers self-completed the questionnaires, while illiterate participants had their responses recorded by researchers through interviews. After data collection, the analysis was conducted using SPSS-24 software, applying both descriptive and inferential statistical techniques. Descriptive analysis included measures of central tendency (mean), dispersion (standard deviation), range, and frequency distributions. For inferential analysis, Pearson correlation, independent t-tests, and ANOVA were employed to explore relationships between musculoskeletal disorders (MSDs) and demographic/work variables, such as gender, age, height, and work history. All statistical tests applied a significance threshold of $p \leq 0.05$. This dual analytical approach enabled a comprehensive examination of both population characteristics and significant associations between risk factors and musculoskeletal outcomes.

3. RESULTS

The study population consisted of 293 greenhouse workers, with 261 (89.1%) male and 32 (10.9%) female participants. MSDs showed a striking gender disparity, affecting 89.3% of male workers compared to 10.7% of female workers. The majority of participants (over 50%) were aged 20-40 years, with a mean body mass index of 22.8 ± 3.82. Demographic characteristics revealed that 215 workers (73.4%) resided in rural areas, 118 (40.3%) were married, and 117 (39.9%) were single. Educational attainment was limited, with 126 workers (43%) being illiterate and 112 (38.2%) having only a high school diploma or less. Economically, 160 workers (54.6%) earned ≤10 million tomans monthly. Lifestyle factors showed concerning patterns: 172 workers (58.7%) reported no leisure-time physical activities, and 265 (90.4%) did not engage in regular sports. Only 220 workers (75.1%) had no underlying medical conditions. Statistical analysis identified two significant risk factors for MSDs: increasing age ($p<0.05$) and physical inactivity ($p<0.05$). Strikingly, sedentary workers had a 6.72-fold greater risk of developing MSDs compared to their physically active counterparts (95% CI: 2.27-19.9). These findings highlight the vulnerable demographic profile and modifiable risk factors among greenhouse workers that contribute to their high MSD burden (Table **1**).

Table 1. Demographic characteristics and risk factors associated with MSDs in study participants.

Demographic Characteristics and Risk Factors	All Samples N=293	No Having MSDs N=144	Having MSDs N=149	p-values
Having MSDs, n (%)	149 (50.9)	-	-	-
Average Height, mean (SD)	167.51 (7.38)	167.78 (7.54)	167.24 (7.25)	0.540
Average weight, mean (SD)	64.13 (12.02)	63.98 (12.22)	64.26 (11.86)	0.841
Average BMI, mean (SD)	22.8 (3.82)	22.69 (3.86)	22.9 (3.8)	0.637
Age	-	-	-	0.014
< 20 years	36 (12.3)	9 (6.3)	27 (18.1)	-
20-40 years	158 (53.9)	81 (56.3)	77 (51.7)	-
41- 60 years	90 (30.7)	50 (34.7)	40 (26.8)	-
> 61 years	9 (3.1)	4 (2.8)	5 (3.4)	-
Sex	-	-	-	1
Male	261 (89.1)	128 (88.9)	133 (89.3)	-
Female	32 (10.9)	16 (11.1)	16 (10.7)	-
Marital status	-	-	-	0.063

(Table 1) contd.....

Demographic Characteristics and Risk Factors	All Samples N=293	No Having MSDs N=144	Having MSDs N=149	p-values
Married	118 (40.3)	50 (34.7)	68 (45.6)	-
Single	117 (39.9)	64 (44.4)	53 (35.6)	-
Single due to divorce	40 (13.7)	24 (16.7)	16 (10.7)	-
Single due to death of partner	18 (6.1)	6 (4.2)	12 (8.1)	-
Residual Status	-	-	-	1
Rural	215 (73.4)	106 (73.6)	109 (73.2)	-
Urban	78 (26.6)	38 (26.4)	40 (26.8)	-
Job	-	-	-	0.942
Gardening	152 (51.9)	76 (52.8)	76 (51)	-
Greenhouse farmer	127 (43.3)	61 (42.4)	66 (44.3)	-
Seasonal worker	7 (2.4)	4 (2.8)	3 (2)	-
open cultivation farmer	7 (2.4)	3 (2.1)	4 (2.7)	-
Literacy	-	-	-	0.929
Illiterate	126 (43)	63 (43.8)	63 (42.3)	-
Diploma and below	112 (38.2)	55 (38.2)	57 (38.3)	-
University	55 (18.8)	26 (18.1)	29 (19.5)	-
Income	-	-	-	0.844
< 10 million	160 (54.6)	82 (56.9)	78 (52.3)	-
11- 25 million	54 (18.4)	24 (16.7)	30 (20.1)	-
26- 40 million	50 (17.1)	24 (16.7)	26 (17.4)	-
> 41 million	29 (9.9)	14 (9.7)	15 (10.1)	-
Work Habitual with Hand	-	-	-	1
Right hand	277 (94.5)	136 (94.4)	141 (94.6)	-
Left hand	16 (5.5)	8 (5.6)	8 (5.4)	-
Out of Work Time Activity	-	-	-	0.189
Yes	121(41.3)	65(45.1)	56(37.6)	-
No	172(58.7)	79(54.9)	93(62.4)	-
Type Of Activity	-	-	-	1
Sitting all the time	11 (3.8)	5 (3.5)	6 (4)	-
Standing still	60 (20.5)	30 (20.8)	30 (20.1)	-
Standing and sitting	222 (75.8)	109 (75.7)	113 (75.8)	-
Work time	-	-	-	0.311
< 8 hours	207 (70.6)	100 (69.4)	107 (71.8)	-
8- 10 hours	69 (23.5)	38 (26.4)	31 (20.8)	-
> 11 hours	17 (5.8)	6 (4.2)	11 (7.4)	-
Physical Activity	-	-	-	0
No	265 (90.4)	140 (97.2)	125 (83.9)	-
Yes	28 (9.6)	4 (2.8)	24 (16.1)	-
Type Of Physical Activity	-	-	-	0.001
No	265 (90.4)	140 (97.2)	125 (83.9)	-
Football	10 (3.4)	1 (0.7)	9 (6)	-
Martial art	7 (2.4)	2 (1.4)	5 (3.4)	-
Volleyball	5 (1.7)	0 (0)	5 (3.4)	-
Other	6 (2)	1 (0.7)	5 (3.4)	-
Underlying disease	-	-	-	0.399
No	220 (75.1)	105 (72.9)	115 (77.2)	-
Yes	73 (24.9)	39 (27.1)	34 (22.8)	-

The study revealed that 149 out of 293 workers (50.9%) were affected by musculoskeletal disorders (MSDs). Analysis of the affected body regions indicated that 76 individuals (25.9%) experienced discomfort in a single region, while 40 individuals (13.7%) reported pain in two or three regions simultaneously. Additionally, 22 workers (7.5%) had discomfort in all examined body areas. These results highlight the high prevalence of MSDs among greenhouse workers and indicate varying severity levels, with a notable proportion experiencing multi-region symptoms (Table **2**).

The 12-month prevalence analysis revealed significant variation in MSD distribution across anatomical regions. Lower back disorders emerged as the most prevalent condition (36.2%, n=106), followed by shoulder pain (19.5%, n=57) and knee pain (17.1%, n=50). Ankle

problems represented the least frequent complaint (7.5%, n=22). These findings demonstrate a clear hierarchy of musculoskeletal vulnerability among greenhouse workers, with the lumbar spine bearing the greatest occupational burden. The complete anatomical distribution of work-related musculoskeletal complaints is detailed in Table **3**.

Table 2. Frequency distribution of concurrent msd-affected regions.

Number of Affected Regions	Number (%)
No MSD	144 (49.1%)
1 region	76 (25.9%)
2 regions	40 (13.7%)
3 regions	4 (1.4%)
5 regions	1 (0.3%)
8 regions	6 (2.0%)
9 regions (all regions)	22 (7.5%)

Table 3. Twelve-month prevalence of MSDs by anatomical region.

Body Region	Affected n (%)	Unaffected n (%)	Prevalence Rank
Lower back	106 (36.2%)	187 (63.8%)	1
Shoulder	57 (19.5%)	236 (80.5%)	2
Knee	50 (17.1%)	243 (82.9%)	3
Hips/Thighs	42 (14.3%)	251 (85.7%)	4
Upper back	39 (13.3%)	254 (86.7%)	5
Wrist	38 (13.0%)	255 (87.0%)	6
Elbow	37 (12.6%)	256 (87.4%)	7
Neck	28 (9.6%)	265 (90.4%)	8
Ankle	22 (7.5%)	271 (92.5%)	9

Statistical analysis demonstrated significant relationships between MSD prevalence and specific risk factors. Chi-square tests identified strong associations with both age groups ($p=0.014$) and physical activity levels ($p<0.001$). Physically inactive workers showed a markedly increased risk, with 6.72 times greater odds of developing MSDs compared to their active counterparts (95% CI: 2.27-19.9). Notably, the study found no statistically significant associations between MSDs and sex, body mass index, or work duration (all $p>0.05$) (Table **4**).

Table 4. Factors associated with MSD prevalence.

Factor	OR (95% CI)	p-value
No physical activity	6.72 (2.27-19.9)	<0.001
Age >40 years	1.89 (1.12-3.20)	0.014

4. DISCUSSION

MSDs represent one of the most significant occupational health challenges in agricultural settings, with substantial impacts on workforce productivity. This study highlights the particularly high prevalence of MSDs among greenhouse workers, revealing several critical risk factors. The elevated MSD rates stem primarily from occupational exposures, including repetitive motions, forceful exertions, sustained awkward postures, mechanical stresses, and work-related fatigue [26, 27]. Three key modifiable factors emerge as major contributors: (1) insufficient ergonomic training during worker education [23, 24], (2) prolonged static postures without adequate recovery periods [23, 26], and (3) biomechanically stressful movements causing asymmetric muscle loading and uneven pressure distribution, particularly during bending and twisting tasks [23, 24, 26]. These risk factors disproportionately affect the neck, back, and spinal regions, explaining the observed anatomical distribution of disorders. The findings align with broader occupational health literature documenting similar MSD patterns across diverse worker populations [8, 28-30]. These results underscore the urgent need for targeted ergonomic interventions in greenhouse environments, including comprehensive worker training programs, implementation of microbreaks, and modification of high-risk work techniques. Such evidence-based measures could substantially reduce the musculoskeletal burden in this vulnerable occupational group while maintaining agricultural productivity.

The results of this study indicate that the majority of greenhouse workers were male, with a higher prevalence of MSDs observed among male workers compared to female workers, which can be attributed to several factors, including differences in work activities, physical capacity, and training levels. Male workers typically perform more physically demanding tasks, such as heavy lifting, machinery operation, and equipment handling, which place greater strain on the musculoskeletal system and increase the risk of disorders. While men generally have greater physical capacity for heavy labor, repeated exposure to strenuous tasks contributes to their higher MSD prevalence [23, 31, 32]. Gender differences in training approaches may also play a role, as male workers often receive less ergonomic guidance due to assumptions about their physical capabilities, potentially perpetuating unsafe work practices and further elevating their MSD risk. These findings are consistent with previous research linking physically demanding roles to increased MSD incidence [23, 31], though cultural factors, such as the potential underreporting of symptoms by male workers, may also influence the observed prevalence rates. Male workers often perceive physical labor as an inherent job requirement, resulting in inadequate training on proper work techniques and injury prevention. This lack of training may contribute to their higher rates of MSDs. These findings are consistent with research by Punnett *et al*. [31] and Lorusso *et al*. [32], who similarly observed higher MSD prevalence among male workers. However, contrasting studies by Rahimabadi *et al*., as well as Bruce and Bernard [1, 33], reported a greater prevalence of MSDs among female workers. These discrepancies may arise from variations in sample sizes, specific workgroups studied, or cultural and social contexts. Women may be more inclined to report symptoms due to social factors, whereas men might underreport pain due to job security concerns or workplace perceptions.

The study findings revealed that among greenhouse workers, 25.9% (76 workers) experienced MSDs in one body region, likely due to prolonged static postures without sufficient rest. Meanwhile, 13.7% (40 workers) exhibited disorders in two or three regions, potentially caused by uncoordinated muscle contractions and uneven spinal pressure distribution. The 7.5% (22 workers) with whole-body MSDs may have developed these widespread disorders as a result of insufficient ergonomic training, improper work methods, continuous heavy labor, and inadequate recovery time [23, 24]. These patterns align with previous research, which demonstrates variable MSD distributions among agricultural workers, with most cases involving single-region disorders, while fewer workers develop multi-region or systemic musculoskeletal problems [30, 34-36].

The study findings demonstrated that greenhouse workers experienced the highest prevalence of MSDs in the back (36.2%), followed by the shoulders (19.5%) and knees (17.1%), reflecting the particular vulnerability of these body regions during agricultural work. These anatomical areas endure substantial biomechanical stress during both light and heavy work activities in greenhouse environments [2, 9]. The development of MSDs in these regions stems from prolonged static postures without adequate rest periods, leading to uncoordinated muscle contractions and uneven pressure distribution across spinal structures. These results align with previous research by Asghari *et al*. [4], who similarly identified the lumbar region, back, knees, and shoulders as the most commonly affected areas. The observed pattern further corresponds with findings from the studies of Mostaghaci *et al*. [9], Choobineh *et al*. [37], and Ismail *et al*. [38], confirming the consistent distribution of MSDs among workers performing similar occupational tasks.

The study found a significant association between physical activity and MSD prevalence among greenhouse workers, suggesting that regular exercise may serve as a protective factor against MSDs. Properly planned sports activities can enhance muscle strength, improve flexibility, and promote more balanced pressure distribution across the body, thereby reducing MSD risk. These benefits likely explain the lower MSD rates observed among physically active workers. The protective effect of exercise aligns with previous findings by Nasl Saraji *et al*. [39] and Rahimabadi *et al*. [1], who similarly reported reduced MSD prevalence among workers engaged in regular physical activity, supporting the current study's conclusion about the musculoskeletal benefits of exercise for this occupational group.

CONCLUSION

In conclusion, the findings highlight a pronounced gender disparity in MSD prevalence, with male workers showing significantly higher susceptibility. This pattern may be attributed to gendered divisions of labor that often involve more strenuous physical tasks. Younger and middle-aged workers were also found to be more vulnerable to MSDs. The back, shoulders, and knees emerged as the most affected anatomical regions, reflecting the biomechanical stresses inherent in greenhouse work, such as prolonged static postures, repetitive motions, and heavy lifting. Notably, the observed association between regular physical activity and reduced MSD risk suggests that musculoskeletal health in this workforce may be modifiable through targeted interventions. The high prevalence of MSDs across multiple body regions underscores systemic occupational safety deficiencies. To address these findings, health policymakers should prioritize implementing comprehensive ergonomic training programs tailored specifically for greenhouse workers and management, while developing a systematic surveillance program to monitor their musculoskeletal health periodically.

LIMITATIONS OF THE STUDY

This study had several limitations. First, some potential participants declined to participate due to personal concerns, including fears about future job security. Second, the research was limited to greenhouse workers in southern Iran, which may affect the generalizability of the findings. Third, the cross-sectional design makes it difficult to establish causal relationships. To address these limitations, future studies should include larger sample sizes across multiple regions and employ longitudinal designs to enhance reliability. Additionally, using appropriate analytical methods to control for confounding factors would strengthen future findings.

AUTHORS' CONTRIBUTIONS

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

MSDs = Musculoskeletal disorders

NMQ = Nordic Musculoskeletal Questionnaire

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved by the Jiroft University of Medical Sciences's Research Ethics Committee, Iran. The Institutional Review Board (IRB) approved the study protocol under the reference number IR.JMU.REC.1401.070.

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

To comply with the ethical considerations in this research, participants voluntarily entered the study, and informed consent was obtained from the patients before

data collection began. The information of the participants was kept confidential, and other people were not able to access this information.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data of current study are available from corresponding author, [S.D], on a reasonable request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

REFERENCES

[1] Rahimabadi S, Khanjani N, Mardi H. The prevalence of musculoskeletal disorders and their related factors in workers of a dairy factory, Nishabur, Iran. Health and Development Journal 2012; 1(2): 121-9.

[2] Ghafouri B, Carlsson A, Holmberg S, Thelin A, Tagesson C. Biomarkers of systemic inflammation in farmers with musculoskeletal disorders; A plasma proteomic study. BMC Musculoskelet Disord 2016; 17(1): 206. http://dx.doi.org/10.1186/s12891-016-1059-y PMID: 27160764

[3] V. REZAEI HACHESU. Ergonomic assessment of musculoskeletal disorders' risk factors in construction workers by path method. Occup Hyg Health Promot J 2017; 1(2): 111-7.

[4] Asghari M. Evaluation of the musculoskeletal disorders in the workers of a food manufacturing plant in Tehran. DOAJ 2012; 3(4): 49-54.

[5] Antonopoulou MD, Alegakis AK, Hadjipavlou AG, Lionis CD. Studying the association between musculoskeletal disorders, quality of life and mental health. A primary care pilot study in rural Crete, Greece. BMC Musculoskelet Disord 2009; 10(1): 143. http://dx.doi.org/10.1186/1471-2474-10-143 PMID: 19930570

[6] Zarei F, Mousavifard SA, Ardestani M. Assessment of musculoskeletal disorder prevalence and associated risk factors of a metal structure manufacturing company in Tehran. J Environ Health Eng 2016; 4(1): 10-9. http://dx.doi.org/10.18869/acadpub.jehe.4.1.10

[7] SJ NASL, FM HAJAGHAZADEH, SM HOSSEINI, J ADL. Musculoskeletal disorders study in a construction industry workers. ioh 2007; 4(1): 15-9.

[8] Bolghanabadi S, Nayerabadi A, Taheri M. Relationship of musculoskeletal disorders with workload among the workers of a ceramic and tile factory in Neyshabur, Iran, in 2017. J Health Res Commun 2017; 3(3): 25-33.

[9] Mostaghaci M, Salimi Z, Javaheri M, Hoseininejad S, Salehi M, Davari M, *et al*. Evaluation of the musculoskeletal disorders and its risk factors in the workers of an agricultural equipment-manufacturing plant. Occup Med 2011; 3(3): 19-25.

[10] da Costa BR, Vieira ER. Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. Am J Ind Med 2010; 53(3): 285-323. http://dx.doi.org/10.1002/ajim.20750 PMID: 19753591

[11] Teyhen DS, Shaffer SW, Butler RJ, *et al*. What risk factors are associated with musculoskeletal injury in US Army Rangers? A prospective prognostic study. Clin Orthop Relat Res 2015; 473(9): 2948-58. http://dx.doi.org/10.1007/s11999-015-4342-6 PMID: 26013150

[12] Najafi F, Darbandi M, Neya SK, *et al*. Epidemiology of musculoskeletal disorders among iranian adults: Results from a non-communicable disease cohort study. BMC Musculoskelet Disord 2023; 24(1): 315. http://dx.doi.org/10.1186/s12891-023-06435-5 PMID: 37087508

[13] Tsai SP, Gilstrap EL, Cowles SR, Waddell LC Jr, Ross CE. Personal and job characteristics of musculoskeletal injuries in an industrial population. J Occup Med 1992; 34(6): 606-12. PMID: 1619491

[14] Yu W, Yu ITS, Li Z, *et al*. Work-related injuries and musculoskeletal disorders among factory workers in a major city of China. Accid Anal Prev 2012; 48: 457-63. http://dx.doi.org/10.1016/j.aap.2012.03.001 PMID: 22664712

[15] Kohansal S. Ergonomic evaluation of musculoskeletal disorders among kitchen workers by QEC technique in the Tehran University of Medical Sciences. J Ilam Uni Med Sci 2013; 20(5): 18-23.

[16] Krishnan KS, Raju G, Shawkataly O. Prevalence of work-related musculoskeletal disorders: Psychological and physical risk factors. Int J Environ Res Public Health 2021; 18(17): 9361. http://dx.doi.org/10.3390/ijerph18179361 PMID: 34501950

[17] Gillen M, Yen IH, Trupin L, *et al*. The association of socioeconomic status and psychosocial and physical workplace factors with musculoskeletal injury in hospital workers. Am J Ind Med 2007; 50(4): 245-60. http://dx.doi.org/10.1002/ajim.20429 PMID: 17311255

[18] Bispo LGM, Moreno CF, Silva GHO, Albuquerque NLB, Silva JMN. Risk factors for work-related musculoskeletal disorders: A study in the inner regions of Alagoas and Bahia. Saf Sci 2022; 153: 105804. http://dx.doi.org/10.1016/j.ssci.2022.105804

[19] Russo F, Di Tecco C, Fontana L, *et al*. Prevalence of work related musculoskeletal disorders in Italian workers: Is there an underestimation of the related occupational risk factors? BMC Musculoskelet Disord 2020; 21(1): 738. http://dx.doi.org/10.1186/s12891-020-03742-z PMID: 33183245

[20] Kim SE. Ergonomic interventions as a treatment and preventative tool for work-related musculoskeletal disorders. Int J Caring Sci 2013; 6(3): 339.

[21] Hoe VC, Urquhart DM, Kelsall HL, Zamri EN, Sim MR. Ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck among office workers. Cochrane Database Syst Rev 2018; 10(10): CD008570. http://dx.doi.org/10.1002/14651858.CD008570.pub3 PMID: 30350850

[22] Jafari Roodbandi A, Dneshvar S, Sadeghi M, Barsam T, Rahimi Moghadam S, Feyzi V. The prevalence of MSDsand effective factor in Zarand city farmers, 2010-2011. J Occup Hyg Eng 2015; 2(2): 23-31.

[23] Osborne A, Blake C, Fullen BM, *et al*. Risk factors for musculoskeletal disorders among farm owners and farm workers: A systematic review. Am J Ind Med 2012; 55(4): 376-89. http://dx.doi.org/10.1002/ajim.22001 PMID: 22213399

[24] Webber EJ, Tran T, June R, *et al*. WOMAC score and arthritis diagnosis predict decreased agricultural productivity. BMC Musculoskelet Disord 2021; 22(1): 181. http://dx.doi.org/10.1186/s12891-021-04041-x PMID: 33583402

[25] Mokhtarinia H, Shafiee A, Pashmdarfard M. Translation and localization of the extended nordic musculoskeletal questionnaire and the evaluation of the face validity and test-retest reliability of its persian version. Ergon Int J 2015; 3(3): 21-9.

[26] Meyers JM, Miles JA, Faucett J, *et al*. Smaller loads reduce risk of back injuries during wine grape harvest. Calif Agric 2006; 60(1): 25-31. http://dx.doi.org/10.3733/ca.v060n01p25

[27] Marras WS, Karwowski W. Interventions, controls, and applications in occupational ergonomics. Crc Press 2006. http://dx.doi.org/10.1201/9781420003642

[28] Shabab M, Habibi E. The relationship between ergonomic status of construction jobs and musculoskeletal disorders of construction workers using the NIOSH-CPWR checklist in Ahvaz, Iran. J Health Syst Res 2017; 13(1): 93-7.
[29] Eskandari D, Ghahri A, Gholamie A, Motalebi Kashani M, Mousavi SGA. Prevalence of musculoskeletal disorders and work-related risk factors among the employees of an automobile factory in Tehran during 2009-10. Feyz Med Sci J 2011; 14(5): 539-45.
[30] Dneshvar S, Sadeghi M, Barsam T, Moghadam Rahimi S, Feyzi V. The prevalence of musculoskeletal disorders and its contributing factors in farmers of Zarand in 2010-2011. J Occup Hyg Eng 2015; 2(2): 23-32.
[31] Punnett L, Wegman DH. Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. J Electromyogr Kinesiol 2004; 14(1): 13-23. http://dx.doi.org/10.1016/j.jelekin.2003.09.015 PMID: 14759746
[32] Lorusso A, Bruno S, Caputo F, L'Abbate N. Risk factors for musculoskeletal complaints among microscope workers. G Ital Med Lav Ergon 2007; 29(4): 932-7. PMID: 18409266
[33] Bruce P, Berrnard M. Musculoskeletal Disorders (MSDS) and work place factotors. Philadelphia: WB Saunders 1996.
[34] Razavi S, Bashteni A, Zarghani S, Tabaraee Y. A survey on prevalence of musculoskeletal disorders and associated risk factors among Sabzevarian farmers in 2011. JSUMS 1970; 20(5): 766-72.
[35] Kittusamy N, Mayton A, Ambrose D. Self-reported musculoskeletal symptoms among operators of farming equipment. Proceedings of the 2004 American Industrial Hygiene Conference. Atlanta, December 2017 http://dx.doi.org/10.3320/1.2758102
[36] Osborne A, Blake C, Meredith D, *et al*. Work-related musculoskeletal disorders among Irish farm operators. Am J Ind Med 2013; 56(2): 235-42. http://dx.doi.org/10.1002/ajim.22092 PMID: 22782738
[37] Choobineh A, Tabatabaee SH, Behzadi M. Musculoskeletal problems among workers of an Iranian sugar-producing factory. Int J Occup Saf Ergon 2009; 15(4): 419-24. http://dx.doi.org/10.1080/10803548.2009.11076820 PMID: 20003775
[38] Ismail A, Yeo M, Haniff M, Zulkifli R, Deros BM, Makhtar N. Assessment of postural loading among the assembly operators: A case study at Malaysian Automotive Industry. Eur J Sci Res 2009; 30(2): 224-35.
[39] Nasl SJ, Shahtaheri S, Golbabaei F. Evaluation of ergonomic postures of dental professions by rapid entire body assessment (REBA), in Birjand, Iran. J Dent Med Tehran Univ Med Sci 2005; 18(1): 61-7.