

# Risk Assessment of Musculoskeletal Disorders among Gardening and Landscape Workers of Yazd Industrial Complex

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## ABSTRACT

**Aim:** Exposure to ergonomic risk factors in the workplace is one of the most common causes of Work-related MusculoSkeletal Disorders (WMSDs). Since gardeners and landscaping workers are exposed to WMSDs due to the different tasks they perform, this study aims to assess the risk of WMSDs prevalence among this group.

**Methods and Materials:** In this study, first, the job tasks of workers were analyzed using the Hierarchical Job Analysis (HTA) method. Then, the job postures of 100 gardening and landscape workers in one of the industrial complexes of Yazd province were assessed using the Rapid Entire Body Assessment (REBA) method. Finally, the Nordic Questionnaire (NQ) was used to estimate the prevalence of WMSDs. SPSS software version 22 was used for data analysis.

**Findings:** The REBA final score for the two activities of mowing (worst posture) and leaves collection (longest posture) were 8 (high) and 4 (medium), respectively. The highest prevalence of WMSDs was in the lower back and knee areas. A significant relationship was found between aging and the prevalence of WMSDs in the neck and wrist area. Furthermore, a relationship was found between severity of WMSDs in the elbow area and the type of work activity.

**Conclusion:** The working conditions of these workers should be examined and corrected from the ergonomic issues point of view. It is recommended that people be trained to understand the occupational ergonomics hazards and how to reduce the risk of developing WMSDs through the proper use of ergonomic principles.

**Keywords:** Gardening and Landscape Workers, Work-Related Musculoskeletal Disorders (WMSDs), Rapid Entire Body Assessment (REBA), Nordic Questionnaire(NQ), Hierarchical Task Analysis (HTA).

## Introduction

Today, Work-related MusculoSkeletal Disorders (WMSDs) are one of the most common problems faced by ergonomics professionals <sup>[1]</sup>. Musculoskeletal disorders are a wide range of inflammatory and destructive disorders that affect a person's muscles, tendons, joints, peripheral nerves, and blood vessels, and resulting from the accumulation of repetitive or severe harmful activity over a long period <sup>[2]</sup>. Musculoskeletal disorders usually occur as a result of risk factors such as repetitive activities, lifting heavy loads, inappropriate postures, intense work activities, etc., during a person's working professional

activity <sup>[2]</sup>. Depending on the type of activity performed by the individual and exposure to the ergonomic risk factors, the most important parts of the body that are affected by musculoskeletal disorders are the upper limbs, neck, lower back, and lower limbs <sup>[3]</sup>.

Work musculoskeletal disorders are estimated to be account for about 40% of the total compensation paid by the employer to workers in the world <sup>[4]</sup>. Studies show that more than half of work absences in the workplace are related to WMSDs <sup>[5, 6]</sup>. According to the International Labor Organization (ILO), WMSDs are one of the

main causes of 160 million occupational diseases and 300 million occupational accidents per year <sup>[7]</sup>. The U.S. Bureau of Labor mentioned in a report that in 2014, 32 percent of non-fatal occupational diseases and injuries were related to WMSDs, and also 65 percent of occupational disorders in the United States were related to WMSDs <sup>[8]</sup>. In China, the overall prevalence of WMSDs in one year is 86% and the most affected organs are the shoulder, neck, and lower back, respectively <sup>[9]</sup>. In the United States, repetitive movements, sudden movements, excessive force, etc. are estimated to cause more than 15.1 billion dollars of damage per year, which accounts for more than 25 percent of total compensation costs paid to workers <sup>[10]</sup>.

It has been argued that when work and the work environment contribute to the prevalence of musculoskeletal disorders, these disorders are called work-related musculoskeletal disorders (WMSDs) <sup>[11]</sup>. One of the main causes of WMSDs is the poor postures in a long time <sup>[12]</sup>. Other causes of such disorders include working in the wrong positions, sitting or standing for long time in shifts, lifting and moving heavy objects and equipment frequently and daily, exerting excessive force, etc <sup>[5, 13]</sup>. There are many individuals and employees around the world who deal with all the risk factors listed above, both occupationally and non-occupationally, and in particular, inappropriate job postures, which significantly increase their risk of developing WMSDs <sup>[14, 15]</sup>.

One of the groups that are seriously at risk for musculoskeletal disorders are people who perform tasks related to gardening, agriculture, and landscaping generally <sup>[7, 16]</sup>. People who perform these tasks are exposed to such disorders due to improper work postures, intense and prolonged activities, and improper use of ergonomic principles <sup>[7, 17]</sup>. Naeini et al. conducted a study on

gardeners. The results showed that 15% of gardeners and landscape workers suffer from injuries caused by the use of hand tools during gardening. About 62% of workers' postures require major corrections, and the highest prevalence of musculoskeletal disorders was in the lower back area <sup>[7]</sup>. A study conducted by Hildebrandt et al., found that 51% of workers suffered from low back pain (LBP) and the prevalence of WMSDs in the neck area was 35% <sup>[18]</sup>. In another study, 434 injuries were found among agricultural workers, and it was found that the use of hand tools is one of the main causes of injuries <sup>[19]</sup>. A study conducted by Houshyar et al. found that the main prevalence of disorders in gardeners are in the lower back, knee, and shoulder areas <sup>[20]</sup>. Another study conducted by Nandy et al., on gardeners and landscape workers, found that the highest prevalence of musculoskeletal disorders was in the lower back area, and these people were at risk for WMSDs <sup>[21]</sup>. Another study conducted by Momenia et al. on gardeners and farmers workers, showed that the highest prevalence of WMSD symptoms was related to the lower back, knees, and upper back respectively <sup>[16]</sup>. Since the postures of such workers are one of the main causes of WMSDs, in many methods of assessing the risk of musculoskeletal disorders, posture assessment is considered as the basis for evaluation and analysis <sup>[22]</sup>.

Among the postural assessment methods, one of the best and most valid methods is the Rapid Entire Body Assessment (REBA) method, which can be used to assess a wide range of WMSDs risk factors <sup>[5]</sup>. Hierarchical Task Analysis (HTA), which is used to identify the tasks, subtasks, and activities that make up a person's job, is one of the methods used to identify ergonomic problems in each of the tasks and subtasks that workers perform in the workplace <sup>[23]</sup>. Since, on the one hand, one of the occupational groups that

perform agricultural and gardening tasks in the workplace are landscape workers, and on the other hand, ergonomic problems, postural assessment, and job analysis have never been comprehensively reviewed in terms of the tasks, subtasks, and activities they perform, in this study, the physical postures of landscape workers was assessed using the REBA observation method and the prevalence of musculoskeletal disorders was assessed using the Nordic questionnaire. The main purpose of this study is to assess the risk of WMSDs among landscape and gardening workers in one of the industrial complexes of Yazd province.

### Method and Materials

The present study is a descriptive study that was conducted in 2021 on 100 workers in the landscape and gardening unit of one of the largest industrial complexes in Yazd province of Iran. Inclusion criteria was having more than one year of work experience and exclusion criteria were having congenital musculoskeletal disorders, questionnaire imperfect completion, and incomplete participation in the evaluation process.

Data collection tools in this study were the Nordic questionnaire and REBA postural assessment method. First, the study conditions were fully explained to the workers and then all individuals participated in the study voluntarily. Then, according to the HTA analysis method, after studying the general duties of landscape and gardening workers, their jobs were breakdown according to the tasks, subtasks, and activities they perform. As described above, HTA is a method of identifying and categorizing the tasks into subtasks and activities that make up a person's job. The HTA method identifies the set of activities required to achieve the ultimate goal of the job. According to the HTA method, a person's job breaks down to a set of goals, activities, and plans. At the top of

the HTA diagram is the overall goal of each overall task, then the overall goal breakdowns into a set of more detailed goals, and each more detailed goal breakdowns into a set of activities needed to achieve the job's goal<sup>[23]</sup>. Based on the HTA analysis, it was determined that the tasks that cause the worst posture and the longest posture in the landscape and gardening workers of this industrial complex are mowing and leaves collection, respectively. In this study, the REBA postural assessment observation method is used to determine the risk level of the worst and longest working postures. REBA method is one of the postural assessment methods which has high sensitivity, reliability, and validity due to its acceptable performance<sup>[24]</sup>. In the REBA method, the organs of the body are divided into two general categories, A and B. Group A includes the trunk, neck, and legs, and group B includes the arms, forearms, and wrists. Groups A and B create a combined 60 and 36 postures, respectively. Posture scoring of the organs of groups A and B and as well as determining their combined effect is done using relevant tables. Then the applying force points and the coupling of the hand with the load points are added to the combined points obtained from groups A and B, respectively. Finally, by combining the final score of A and B, the final score of C is obtained. By combining the C score with the activity score obtained from another table, the final posture of individuals is obtained, and by interpreting this score, the level of risk and priority of corrective action is determined<sup>[5]</sup>. As mentioned above, the tasks of mowing and leaf collection were chosen as the worst posture and the longest posture, respectively. After the postural assessment, the Nordic questionnaire was distributed among individuals, and the prevalence of WMSDs was determined among workers. Nordic questionnaire represents information such as demographic information such as

**Table 1)** Distribution of the prevalence of musculoskeletal disorders in different parts of the participants' body during the last 12 months and 7 days

Different parts of body	Last 12 months N (%)		Last 7 days N (%)	
	Pain	No pain	Pain	No pain
Neck	10 (10)	90 (90)	7 (7)	93 (93)
Shoulder	20 (20)	80 (80)	17 (17)	83 (83)
Elbow	12 (12)	88 (88)	7 (7)	93 (93)
Wrist	18 (18)	82 (82)	10 (10)	90 (90)
Upper back	9 (9)	91 (91)	8 (8)	92 (92)
Lower back	24 (24)	76 (76)	16 (16)	84 (84)
Hips and thighs	10 (10)	90 (90)	5 (5)	95 (95)
Knee	23 (23)	77 (77)	17 (17)	83 (83)
ankle	8 (8)	92 (92)	10 (10)	90 (90)

**Table 2)** Distribution of work related musculoskeletal disorders that caused work place leaving or limited activity during last 12 months

Different parts of body	Pain N(%)	No pain N(%)
Neck	1 (1)	99 (99)
Shoulder	7 (7)	93 (93)
Elbow	6 (6)	94 (94)
Wrist	7 (7)	93 (93)
Upper back	5 (5)	95 (95)
Lower back	11 (11)	89 (89)
Hips and thighs	4 (4)	96 (96)
Knee	13 (13)	87 (87)
Ankle	7 (7)	93 (93)

age, sex, weight, height, right or left hand, and as well as information about the prevalence of musculoskeletal disorders in 9 areas of the body (neck, shoulders, elbows, wrists, upper back, lower back, hips and thighs, knee, and ankle) [25]. For data analysis, SPSS software version 22 were used.

## Findings

In this study, 100 workers of the landscape

and gardening unit of one of the industrial complexes of Yazd province were studied. The mean age of the subjects was 38.71 years with a standard deviation of 10.05. Most of the participants were in the age range of 30 to 40 years, which indicates that the statistical population of this study is young. About 92% (N = 92) were married and 8% (N = 8) were single. Moreover, 8% of people (N = 8) who were all single, had secondary

**Table 3)** Final score of postural assessment by REBA method, risk level and priority of corrective action

Tasks	Final REBA score	Risk level	Corrective action priority	Necessity of corrective action
Mowing	8	High	3	Necessary (as soon as possible)
Leaf collection	4	Medium	2	Necessary

job activity outside the main job hours and 92% of people (N = 92) did not have secondary job activity. About 68% (N = 68), 25% (N = 25) and 7% (N = 7) of the subjects had sit-stand, standing and sitting work activities, respectively. About 48% (N = 48) and 52% (N = 52) of the subjects had 8 hours of daily working hours, and 10 hours or more, respectively. According to the findings of the study, only 20% (N = 20) of the people had sports activities. Table 1 shows the highest prevalence of musculoskeletal disorders during the last 12 months and 7 days.

Table 2 shows the prevalence of disorders that have forced people to rest, reduce daily activities, and leave work in the 12 months last. According to Table 2, musculoskeletal disorders of the lower back and knee organs have forced people to compulsory rest or stay home more than other organs in the last 12 months.

Table 3 shows the final score of REBA, the level of risk, and the priority of corrective actions for the worst (mowing) and the longest posture in terms of duration (leaf collection).

According to Table 3, workers who perform the task of mowing had REBA score of 8 with a high risk level, and workers who perform the task of leaf collection had a REBA score of 4 with a medium risk level.

## Discussion

In this study, job postures and the prevalence of WMSDs among 100 landscape and gardening workers in an industrial complex in Yazd province were studied. First, using the HTA job analysis method,

the individual job tasks were breakdown into tasks, sub-tasks, and activities. In the next step, the worst posture and the longest posture (in terms of duration) were selected from all work postures and their analysis was performed using the REBA method. The prevalence of WMSDs among individuals was also determined using the Nordic questionnaire. According to the results, the highest and lowest prevalence of WMSDs were related to the lower back and ankle, respectively. A study conducted by Mangale et al., on landscape and gardening workers, found that the highest prevalence of WMSDs was in the lower back area [26]. In another study conducted by Naeini et al. on gardeners found out that The highest prevalence of WMSDs was in the lower back area [7]. Another study conducted by Nandy et al. found that LBP was the most common musculoskeletal disorder among gardeners [21]. In another study conducted by Momenia et al., the highest prevalence of WMSDs was in the lower back area [16]. The results of the above four studies are completely consistent with the results of the present study. Reasons for low back pain in gardeners and landscape workers include incorrect body position, excessive bending, lifting, pulling, and pushing heavy loads many times, long-term static work positions as well as severe physical work.

In this study, knee pain after back pain ranked second in terms of the prevalence of WMSDs, which can be attributed to excessive knee flexion and high external pressure on the knee when performing work in the knee position, which exactly mentioned in some

other studies <sup>[16, 26, 27]</sup>. But in the other two studies mentioned above, the second most common pain in gardeners was pain in the wrists and thighs, respectively <sup>[7, 21]</sup>. Reasons for this difference include differences in strength and physical endurance, as well as differences in the performance of work and the use of different gardening tools, which in turn involve different parts of the body. According to the results of consistent and inconsistent studies with the results of the present study, it can be concluded that in general, despite the pain in different areas, the main pain in gardeners and landscape workers is low back pain, which shows the importance of ergonomic corrective measures in the lower back area and development and construction of tools to reduce pain and stress in the lower back area.

According to the results of the present study, WMSDs were more common in the lower back and knee areas than other areas which are due to improper postures, lifting heavy loads, standing for long periods, falling from heights, and performing static work. This means that paying attention to the risk factors of such disorders in these areas and eliminating them in the work environments of these workers is one of the effective measures to improve working conditions and prevent the prevalence of WMSDs <sup>[5]</sup>. Based on the results of the present study, a significant relationship was found between aging and increasing the prevalence of WMSDs in the neck and wrist areas. In other studies, the issue of aging and increasing the prevalence of disorders in some areas has been mentioned <sup>[16, 28]</sup>. However in another study, it was shown that there is not a significant relationship between decreasing age and increasing prevalence of WMSDs which is not consistent with the results of the present study <sup>[29]</sup>. This study also found a significant relationship between the increase

in WMSDs in the elbow area and the type of work activity (standing, sitting, stand-sit), which may be because gardeners, farmers, and landscape workers are often working at a height above elbow height. And another reason could be due to repetitive tasks. The study also found a significant relationship between exercise and increased prevalence of WMSDs in the ankle area. One of the reasons for that could be due to improper exercise and strenuous exercise, which leads to more vulnerable feet during Incidents related to the wrist.

According to the results of the study, no significant relationship was found between hours of work activity (8 hours and 10 hours or more) and WMSDs, one reason for this could be that fewer people are working more than 8 hours a day than people who are working 8 hours a week in this study. This study showed that a significant relationship between marital status and neck pain so that, married people had more neck pain, which could be due to musculoskeletal stress and double stress from family works and responsibilities. Based on the results of the postural assessment of individuals with the REBA observational method, the mowing task had the highest risk and based on the level of risk (high) and priority level of corrective action <sup>[3]</sup> is necessary (as soon as possible) to take ergonomic corrective action, and also for the task of collecting leaves, which was the longest posture in terms of duration, with a medium level of risk and a priority level of corrective action 2, is necessary to take corrective actions.

In general, according to the results of the consistent and inconsistent studies, people who perform gardening, agricultural, and landscaping tasks are exposed to many ergonomic risk factors, so that the risk of developing WMSDs in the lower back, knee, and shoulder areas is high, and such jobs must be seriously studied from the point of

view of ergonomic issues. Limitations of this study included difficult access to individuals and limitations due to non-cooperation due to COVID-19. It is suggested that in future studies, other postural assessment methods (such as OWAS and QEC) and other questionnaires related to musculoskeletal disorders (such as DMQ) for gardeners, farmers, and landscape workers be used, and the results compared with the results of the present study.

## Conclusion

In this study, an increase in the prevalence of work-related musculoskeletal disorders in the lower back, knee, and shoulder areas was observed in gardening, agricultural, and landscape workers in one of the industrial complexes of Yazd province. It was also concluded that the working conditions of these people should be examined and corrected from the point of view of ergonomic issues. It is recommended that such workers be trained to understand the occupational ergonomics hazards and how to reduce their risk of developing WMSDs, as well as the proper use of ergonomic principles.

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**Author Contribution:** MJSh reviews the literature and designed the study and wrote the first draft of the manuscript and final manuscript. HRSh analyses and interpret the data. FKHz collect data and fill out the questionnaires. OA supervised all stages of the study and finally confirmed all stages of the study. All authors read the manuscript and approved it.

**Conflict of Interests:** The authors declare that there is no conflict of interest for this study.

**Ethical Permission:** All Participants of ethics were considered in this study.

Participants were familiarized with aim, procedures of the study. They were satisfied to be studied and signed the consent form.

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