

# Analysis of Body Postures for Preventing Musculoskeletal Disorders among Tractor Drivers in Iran

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Received: 6 April 2017  
Revised: 12 May 2017  
Accepted: 20 June 2017

## Abstract

**Background:** Due to the high cost of advanced tractors in developing countries, their use with lower cost and technology has been further considered. Consequently, many of these machines in terms of ergonomics are in poor condition and cause musculoskeletal problems in the drivers. This study aimed to identify harmful postures causing musculoskeletal disorders in the tractor drivers in Iran.

**Methods:** The study was conducted in March 2018 among farmers in Golestan province. The tasks of tractor drivers are divided into three stages consisting of getting on, steering tractor, and getting off. Rapid Entire Body Assessment (REBA) method was used to assess the body postures. In REBA, different postures of the body regions such as the neck, wrist, hands and legs were assessed and finally the level of risk was determined. Then, the levels of ergonomic interventions were suggested based on the risk level.

**Results:** Based on the REBA analysis, most of the tasks performed by the tractor drivers had medium risk and they need prompt investigation and change. For the task of getting on and getting off the tractor, the highest scores were assigned to the arms, legs and trunk. For the task of steering tractor, the highest postural scores were related to the wrists, trunk and legs.

**Conclusion:** Ergonomic and posture conditions of Iranian tractors are not suitable. Therefore, it is necessary to implement ergonomic interventions to reduce the risk of developing musculoskeletal disorders.

Please cite this article as: Mokarami HR, Kalteh HO, Tajpoor A. Analysis of Body Postures for Preventing Musculoskeletal Disorders among Tractor Drivers in Iran. *J Health Sci Surveillance Sys*. 2017;5(3):100-106.

**Keywords:** Posture, Musculoskeletal diseases, Farmers, Ergonomic assessment

## Introduction

Musculoskeletal disorders (MSDs) are known as one of the most common occupational diseases and cause a lot of disability in industrialized and developing countries.<sup>1,2</sup> MSDs is defined as discomfort or strain in the musculoskeletal system that include inflammation, pain, etc.<sup>3</sup> Farming is the third harmful jobs in the world and farmers are exposed to many occupational diseases, especially musculoskeletal disorders.<sup>4-6</sup> The number of national and international studies in different countries

showed that farming tasks required high physical demands and that work activities could induce MSDs.<sup>7-9</sup> For example, low back pain is one of the disorders that have been mentioned in many studies and is caused by repetitive motions, lifting, manual material handling, and exposure to the whole body vibration.<sup>1,10</sup>

Many tasks related to farmers in planting and harvesting are carried out mechanically. With the advancement of technology, modern tractors are machines with more comfort and less strain on the human body. However, the use of these new tractors,

due to high cost in many developing countries, is limited and inexpensive tractors are preferred with lower technology. Working on these tractors requires more tasks by drivers. Examples of these functions include steering tractors and looking the back monitoring and control of the machines.<sup>11</sup> In addition to these cases, getting on and getting off the tractor, however, are carried out less frequently, but they require high attention.<sup>10</sup>

Based on these tasks and motions, body posture of driver has taken various situations and is exposed to a variety of situations during the work. Awkward postures can be a major contributor to musculoskeletal disorders.<sup>1</sup> This risk factor combined with whole body vibration provides a condition for the incidence of musculoskeletal disorders in tractor drivers and can cause disorders in regions such as the neck, back, legs and hands of the drivers. However, evaluation of working postures is required to identify the risk factors in tractor drivers.

Posture analysis methods to assess the musculoskeletal disorders risk factors are still the best methods due to the ease and low cost. Posture analysis methods are robust and efficient techniques to evaluate the job activities. Methods such as Ovako Working Analysis System (OWAS),<sup>12</sup> Rapid Upper Limb Assessment (RULA)<sup>13</sup> and Rapid Entire Body Assessment (REBA)<sup>14</sup> and many other methods of posture assessment have been used in many studies to determine the risk levels.<sup>15</sup> To the best of our knowledge, no study has been carried out to evaluate awkward postures causing musculoskeletal disorders among tractor drivers in Iran. The aim of this study was to determine and assess the awkward postures causing musculoskeletal disorders in the tractor drivers in Iran.

## Material and Methods

### *Procedure and Data Collection*

This cross-sectional study was conducted among the tractors drivers in Iran. The Ethics Committee of Mazandaran University of Medical Sciences reviewed and approved the ethical standards of this study. The study was conducted in March 2018 among tractor drivers in Golestan province. Farmers who spent more than 5 hours per day driving a tractor were selected to study. Before the beginning of the study, the goals of the research were described and written consent was received from them.

The highest used type of the tractor in Iran is shown in Figure 1. This type of tractor has no cabin and the driver is exposed to environmental conditions when working. The process of working with tractors is defined in three main sections. 1) Getting on; 2) Steering tractors; and 3) Getting off.

Given that repetition works in stage 1 or stage 2 are less than 3. Although monitoring devices like plows and planters that are installed on the tractor causes repetitive movements. To assess the ergonomics risk factors in the work with tractors, the working postures were photographed in different work activities. Observations and recording images were conducted in three sections of getting on, steering and getting. Photos were taken from various postures of the drivers. In the next step, the photos illustrating the most frequent and worst working postures were selected. Finally, the selected postures for each work subdivision were assessed in accordance with the Rapid Entire Body Assessment (REBA) instructions.



**Figure 1:** The highest used type of the tractor in Iran

### *Assessment of Body Posture*

In this study, REBA was used as a valid tool for body posture assessment. This method was developed by Hignett and McAtamney for measuring the angles of organs and assessing the body postures based on the amount of discomfort and exerted forces on the body.<sup>14</sup> This method is an observational and posture-based analysis method for assessment of working posture in different tasks. REBA focuses on the external load acting on the trunk, neck, and legs. Also, it focuses on the worker-load coupling in the upper limbs.

REBA method divides different body parts into two groups of A and B. group A consists of the postures of the trunk, neck and legs that include a total of 60 postures and group B comprise the postures of the arm, elbow and wrist, which include a total of 36 postures. A score has been devoted to interfering impact of force. Furthermore, gripping, static, and dynamic scores were separately calculated. Finally, the REBA score is obtained by calculating the scores and recording them in the scoring sheet, using

related tables. After calculation of the REBA scores, according to Table 1, the action level and risk level are determined and corrective action required.

**Results**






The results of the postural load risk assessment of

getting on the tractor and figures related to its stages (Figure 1A to Figure 5A) are shown in Table 2. The REBA score in the four task stages had medium risk (1A, 2A, 3A, and 5A) and the one task stage had a high risk (4A). The highest postural score was related to the arms, legs and trunk. Figure 4A illustrates the worst posture for the trunk (High risk). The results

**Table 1:** Risk levels and required control actions based on Rapid Entire Body Assessment (REBA) score

| REBA score | Action level | Risk level      | Action                             |
|------------|--------------|-----------------|------------------------------------|
| 1          | 0            | Negligible risk | No action required                 |
| 2-3        | 1            | Low risk        | Change may be needed               |
| 4-7        | 2            | Medium risk     | Further investigation, change soon |
| 8-10       | 3            | High risk       | Investigate and implement change   |
| 11-15      | 4            | Very high risk  | Implement change                   |

**Table 2:** Postural load risk assessment of getting on task in tractor operators

| Task stages | REBA final score | Risk level | Required actions                   | Photo   |
|-------------|------------------|------------|------------------------------------|---|
| 1A          | 5                | Medium     | Further investigation, change soon |    |
| 2A          | 4                | Medium     | Further investigation, change soon |  |
| 3A          | 5                | Medium     | Further investigation, change soon |  |
| 4A          | 8                | High       | Investigate and implement change   |  |
| 5A          | 4                | Medium     | Further investigation, change soon |  |

of the postural load risk assessment for the steering tractor task and figures related to its stages (Figure 1B to Figure 5B) are shown in Table 3. In this task, the highest postural scores were related to the wrists, trunk and legs. The maximum amount of force at this stage enters the hands. The results of the postural load risk assessment for getting off the tractor and figures related to its stages (Figure 1C to Figure 3C) are shown in Table 4. The highest postural score was related to the arms, legs and trunk. Among the tasks examined, this one had the lowest risk and had lower REBA scores.

However, it should be noted that due to the imbalance, the possibility of acute injury in this stage is high. Also, the whole body vibrations should be considered as an important factor in the development of musculoskeletal disorders

## Discussion




This study was conducted to examine the body postures for preventing musculoskeletal disorders among tractor drivers in Iran. The tractor selected for study was the mostly used one among Iranian farmers. These types of tractors, although less expensive, have many ergonomic problems. Due to the poor economic situation of the farmers, the use of advanced tractors is limited. For this reason, drivers of the tractor, due to awkward postures, are subject to ergonomic risk factors. Results from previous studies also indicate that there is a high prevalence of musculoskeletal disorders among tractor drivers, particularly in their hands, wrists, lower back, and knees.<sup>7, 16-18</sup> Davis et al. reported that on average 40% of tractor drivers are exposed to musculoskeletal disorders.<sup>19</sup> Davis estimates the incidence of LBP among

**Table 3:** Postural load risk assessment of steering tractor task in tractor operator

| Task stages | REBA final score | Risk level | Required actions                   | Photo   |
|-------------|------------------|------------|------------------------------------|---|
| 1B          | 4                | Medium     | Further investigation, change soon |   |
| 2B          | 4                | Medium     | Further investigation, change soon |  |
| 3B          | 4                | Medium     | Further investigation, change soon |  |
| 4B          | 4                | Medium     | Further investigation, change soon |  |
| 5B          | 2                | Low        | Change may be needed               |  |



**Table 4:** Postural load risk assessment of getting off task in tractor operators

| Task stages | REBA final score | Risk level | Required actions                   | Photo   |
|-------------|------------------|------------|------------------------------------|---|
| 1C          | 5                | Medium     | Further investigation, change soon |  |
|             |                  |            |                                    | Figure 5B   |
| 2C          | 5                | Medium     | Further investigation, change soon |  |
|             |                  |            |                                    | Figure 5B   |
| 3C          | 3                | Low        | Change may be needed               |  |
|             |                  |            |                                    | Figure 5B   |

tractor drivers between 20 and 75%.<sup>7</sup> Although there are fewer repetitive tasks in the tractor than other agricultural tasks, there are several risky ergonomic postures.

The analysis of the REBA results showed that most postures had poor or medium condition. Due to the fact that tractor equipment is not equipped with ergonomic requirements and dimensions are not based on Iranian anthropometric systems, it is not easy to get on and get off the tractor. Another problem is that due to reduced tractor production costs, steering systems are semi-hydraulic and power transmission levers are mechanically needed, which requires a high level of operational work. However, it is hard to make major changes to the tractor; it is possible to prevent musculoskeletal disorders by choosing more suitable users or minor changes in the layout of controls. For example, Mehta et al. developed a suspension system and tractor cabin using ergonomic evaluation facility based on Indian drivers.<sup>20</sup>

It is obvious that the access limit is not appropriate for all drivers. Therefore, drivers have to work with the tractor controls in awkward postures. For example, Figures 2B and 3B showed that the driver had to bend over and over to change the gear lever or pull the manual brake and had the highest trunk score in the REBA method. Kumar et al. reported this awkward posture among Indian tractor drivers who worked in similar conditions.<sup>21</sup> In this study, the driver stated that the foot accelerator pedal and the brake pedal were in a suitable distance and when using pedals, there was no

pressure on the legs. (Figure 5B). Of course, it should be noted that the driver's anthropometric measures were moderate compared to the Iranian workers, and if the short or tall drivers want to work with the pedals, the position of the natural posture in their knee and hip will change.<sup>22, 23</sup> Review studies have confirmed that knee and hip disorders in tractor drivers are more frequent.<sup>24</sup> Neck and waist problems and pelvic changes are common among the tractor users.<sup>24, 25</sup> The whole body vibration and the constant rotation of the workers' body are the main causes of musculoskeletal disorders in the lumbar region. The rotation of drivers to monitor the rear tractor extensions requires rotation of the waist and neck, which sometimes takes several seconds. Low back pain disorder is the most prevalent due to this conditions.<sup>26</sup>

The main limitation of this study was its cross-sectional nature. For a more detailed and precise assessment, the combined use of observational methods with electromyography is recommended. Also, such risk factors as heat, cold and vibration can also increase the risk of developing musculoskeletal disorders. These factors were not investigated in this study.

### Conclusion

It seems that using none-ergonomic tractors is inevitable in Iran. However, long-term use of these tractors increases the probability of musculoskeletal disorders. The whole body vibrations, non-ergonomic seats, use

of force to operate pedals and mechanical levers are major ergonomic risk factors. It should be noted that the risk level of awkward postures among tractor drivers is high and taking ergonomic interventional measures is mandatory. Intervention measures such as hydraulic systems for power transmission, ergonomic chairs and better access to controllers and levers are applicable.

### Acknowledgment

The authors of this study would like to express their gratitude and appreciation to the participants.

**Conflict of Interest:** None declared.

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