Title: Comparison and Agreement Assessment of WERA, QEC, and ART Methods in Evaluating Musculoskeletal Disorders Risk Among Urban Taxi Drivers in Tehran

Authors: Morvarid Mousavi[1], Amirhossein Montazeri[2], Mehrana Esnaaharieh[2], Neda Izadi[3], Mohsen Poursadeghi[4], Ali Salehi Sahlabad[2,5,*]

1. *Department of Occupational Health and Safety, University of Tarbiat Modares,Tehran, Iran.*
2. *Department of Occupational Health and Safety at Work, School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran.*
3. *Research Centre for Social Determinants of Health, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.*
4. *Social Determinants of Health Research Center, Ardabil University of Medical Sciences, Tehran, Iran.*
5. *Safety Promotion and Injury Prevention Research Center, Research Institute for Health Sciences and Environment, Shahid Beheshti University of Medical Sciences, Tehran, Iran.*

To appear in: ***Physical Treatments***

Received date: 2024/11/20

Revised date: 2025/01/04

Accepted date: 2025/01/20

First Online Published: 2025/08/04

Please cite this article as:

Mousavi M, Montazeri A, Esnaaharieh M, Izadi N, Poursadeghi M, Salehi Sahlabad A. Comparison and Agreement Assessment of WERA, QEC, and ART Methods in Evaluating Musculoskeletal Disorders Risk Among Urban Taxi Drivers in Tehran. ***Physical Treatments.*** Forthcoming 2025. DOI: http://dx.doi.org/10.32598/ptj.16.1.667.1

DOI: http://dx.doi.org/10.32598/ptj.16.1.667.1

Abstract

Introduction: Occupational musculoskeletal disorders (MSDs) are among the most common health problems in the taxi driver community. Considering the importance of the workforce and the variety of methods available for evaluating the risk of MSDs, this study aimed to assess musculoskeletal disorders and examine the agreement between the QEC, WERA, and ART methods among taxi drivers.

Method: This descriptive-analytical study was conducted in 2024 in Tehran on 140 urban taxi drivers. Additional information was collected using a demographic questionnaire and a body map to ensure a more comprehensive assessment. Selected samples should have at least 1 year of driving experience. On the other hand, people who had a history of musculoskeletal surgery were excluded from this study. Since participation in this study was voluntary, people who expressed their unwillingness to participate in the study could withdraw from the study. Specialists took photographs and recorded videos of participants in different postures while driving. Subsequently, the risk of musculoskeletal disorders among drivers was assessed using the WERA, ART, and QEC methods, and the results were analyzed with SPSS version 24.

Results: The highest severity of musculoskeletal disorders among taxi drivers was observed in the lower back and knees, respectively. No significant relationship was found between age and the occurrence of MSDs among participants ($p>0.05$). Risk assessments using the WERA and ART methods indicated that the studied population was at a medium risk level, while the QEC method results showed a low-risk level.

Conclusion: Prolonged sitting and repetitive clutch pedal use are significant contributors to increase lower-back and knee pain. The findings also revealed agreement between the WERA and ART methods in evaluating the risk of musculoskeletal disorders.

Keywords: WERA, QEC, ART, WMSDs

Highlights

1. Prolonged sitting and pressure on pedals cause back and knee pain in taxi drivers.
2. WERA and ART methods identified moderate risk for musculoskeletal disorders in drivers.
3. The most common musculoskeletal pain in taxi drivers was in the lower back and knees.
4. Increasing rest periods and reducing driving hours can help reduce pain and discomfort.
5. WERA is an effective tool for assessing musculoskeletal disorders in drivers' legs and lower back.

Plain Language Summary:

Musculoskeletal disorders (MSDs) are common problems that affect the muscles, joints, and bones of workers, and they can lead to pain and discomfort. Drivers, especially taxi drivers, are at high risk for developing these types of disorders because of long hours spent sitting and using their legs repeatedly to operate the vehicle. In this study, we looked at how often and how severe musculoskeletal disorders are among urban taxi drivers and how different methods can help assess the risk of these disorders.

We used three risk assessment tools to evaluate the drivers' posture and pain: the WERA method, QEC method, and ART method. Our findings showed that lower back and knee pain were the most common complaints among taxi drivers. Although some methods suggested that the overall risk was moderate, others showed lower risks. The study found that the WERA and ART methods gave similar results, pointing to a moderate risk for musculoskeletal disorders, especially in the back and knees.

This research is important because it helps identify the areas of the body most affected by driving and provides suggestions to reduce the risk of injury, such as increasing rest breaks and reducing driving hours. By using the WERA method, which specifically assesses the knees and lower back, we can better understand the risk of musculoskeletal disorders in taxi drivers and find ways to improve their working conditions and health.

Introduction

Musculoskeletal disorders (MSDs) are defined as any injury or disorder affecting the muscles, nerves, tendons, ligaments, joints, cartilage, spine, or blood vessels, often accompanied by pain and inflammation. However, poor working conditions can exacerbate these disorders [۱]. Work-related musculoskeletal disorders (WMSDs) are among the most serious and common problems among workers [۲]. According to NIOSH, after respiratory diseases, musculoskeletal disorders are the second most prevalent occupational health issue [۳]. Poorly designed workplaces that do not adhere to ergonomic principles may lead to accidents or incidents during work. Such accidents can result in physical harm to workers, as well as damage to both human and non-human resources[۴] . Studies have shown that musculoskeletal disorders lead to increased employee absenteeism and higher healthcare costs for nations[۵]. Driving is a significant occupation in today's society and plays a vital role in daily life [۶]. Drivers are exposed to various occupational hazards, such as job stress, chemical, physical, and ergonomic risk factors, throughout their workday [۷]. These risk factors can negatively affect their personal and professional lives [۸]. The results of studies have shown that the prevalence of musculoskeletal disorders among drivers has varied from 43.1% to 93%. This percentage shows that most of the drivers suffered from musculoskeletal disorders in their working life[9]. Working in different jobs and activities can cause musculoskeletal disorders in different parts of the human body. For example, the assessment of musculoskeletal disorders using the rapid upper limb assessment (RULA) and the occupational repetitive actions (OCRA) methods among manual block printing industry workers showed that these people suffer more from pain in the wrist and back areas[10].

The prevalence of spinal disorders (e.g., back and neck pain) has also been observed among professional drivers, which can lead to illness and early retirement [۱۱]. To maintain a stable driving position, these individuals must keep the muscles of their neck, back, shoulders, and arms in static tension for extended periods. Research has shown that this prolonged static posture leads to localized muscle fatigue accompanied by pain and discomfort [۱۲]. Studies indicate that driving in major cities—largely due to traffic congestion, poor road conditions, substandard vehicle designs, air, and noise pollution—exacerbates these disorders [۱۳]. A study by Mozaffari et al. in 2015 estimated the prevalence of WMSDs among truck drivers in Qom Province at 78.6%, with back and neck pain being highly common [۱۴]. Another study conducted in Zanjan on 89 drivers revealed that musculoskeletal disorders are widespread among this population [۱۵]. Such trends can lead to absenteeism, loss of work time, increased costs, and workforce injuries, all of which ultimately reduce productivity [۱۶]. A study by Borazgari et al. evaluated the risk of musculoskeletal disorders among drivers using the RULA method, finding a correlation between drivers' postures and their satisfaction [۱۷]. Many studies used closed-ended self-administered questionnaires and body map to gather data. Most questions were based on the Nordic Musculoskeletal Questionnaire (NMQ), which is commonly employed to examine work-related musculoskeletal symptoms in working populations [۱۸]. While these questionnaires are reliable and valid, they primarily focus on the prevalence of MSDs and do not examine the factors influencing these disorders or their risk levels. Factors such as working for a long time and lack of sleep and occupational stress of drivers cause many health problems such as cardiovascular diseases and metabolic syndrome among them [19-22]. Musculoskeletal disorders are one of the

disorders that can cause many health problems among drivers. Therefore, in this study, we investigated musculoskeletal disorders as one of the health problems among drivers. Musculoskeletal disorders in different work-related areas have led to the use of different musculoskeletal disorders assessment tools for each job and work environment. For example, in a study in the evaluation of musculoskeletal disorders among construction workers, RULA and Ovako Working Analysis System (OWAS) method was used[23]. For this research, specific questionnaires for WERA, QEC, and ART methods were used, and data on WMSDs among drivers were collected using a body map. A review of the relevant literature and keyword analyses indicated that ergonomic assessments of drivers using the WERA, QEC, and ART methods have received less attention in recent studies. In addition, in these 3 methods, attention has been paid to the parts of the body that are more active and used more while driving. Wera's method also considers other factors that affect the musculoskeletal system during driving, such as vibration and contact stress. In addition, the time of use of the musculoskeletal system, which can be a factor affecting the disorders of this area, is examined in all 3 types of this method. These methods may have been under-recognized due to less focus on this specific occupational group and the challenges of conducting research when assessing musculoskeletal disorders among drivers. This study is novel in its approach by combining WERA, QEC, and ART methods to evaluate ergonomic risks, offering a comprehensive perspective that has not been explored in previous research. Therefore, this study aimed to investigate the agreement between these risk assessment methods and to assess the risk and prevalence of musculoskeletal disorders among this occupational group.

Methods

This cross-sectional study was conducted in 2024, with a sample size of 146 participants determined using the formula for finite populations, based on a study by Motamedzadeh et al [۲۴]. The inclusion criteria were a minimum of one year of professional driving experience, while exclusion criteria included a history of musculoskeletal surgery or unwillingness to participate. Experts were present in taxi stations and then gave them the necessary information about the study by directly interviewing the taxi drivers. Then they were asked about their willingness or unwillingness to participate in this study. In the next step, the demographic questionnaire was completed by the participants to check the entry and exit criteria. Considering the nature of the job and its associated risk factors, the study employed tools such as body chart questionnaires to assess the severity of musculoskeletal disorders in the past year, demographic questionnaires to collect personal data (age, work experience, and working hours), and three risk assessment methods: WERA (Workplace Ergonomic Risk Assessment), QEC (Quick Exposure Check), and ART (Assessment of Repetitive Tasks). A body map questionnaire was also used to assess the location and intensity of pain, as it is critical for evaluating musculoskeletal risk factors [۲۵]. Initially, participants were asked to complete demographic questionnaires for personal data collection and then report their musculoskeletal pain intensity using the body map questionnaire. Postures of the drivers were captured using photography and videography, followed by a risk assessment of their postures using the three risk assessment tools. In the next step, every specialist who had more expertise, experience and mastery of each of the methods reviewed the images and videos and assessed the risk of musculoskeletal disorders in that method. Six participants who completed the demographic and body map questionnaires

expressed unwillingness to continue during posture documentation and were excluded from the study.

Tools Used in the Study

Body Map Questionnaire: This questionnaire was utilized to examine the exact location and intensity of participants' pain. Participants rated pain intensity for different body areas on a scale of 1 to 5, where 1 = no pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, and 5 = very severe pain [۲۶]. This self-reported tool focuses on evaluating pain in various body regions [۲۷]. Studies have demonstrated that body map assessments correlate with reported outcomes and have sufficient reliability and validity for use in research [۲۸].

Workplace Ergonomic Risk Assessment (WERA): WERA is an ergonomic risk assessment tool that evaluates six ergonomic risk factors: awkward postures, contact stress, repetitive work, whole-body vibration, work duration, and applied force. Postures of the shoulder, wrist, back, neck, and legs are independently assessed, as these are closely related to musculoskeletal risk. The final score is categorized into three risk levels: low risk (18–27, acceptable), moderate risk (28–44, requiring further investigation), and high risk (>45, unacceptable risk). Corrective actions are prioritized based on the final score. Studies have shown that WERA has acceptable reliability and validit [۲] . Another study indicated that WERA effectively identifies work-related musculoskeletal disorders across a wide range of occupations [۲۹].

Quick Exposure Check (QEC): QEC is an observational tool used by occupational health professionals to assess musculoskeletal risk factors. It evaluates four body regions—back, wrist, neck—and includes psychosocial factors [4]. Scores for the back, shoulder, and wrist range from

10–56, with corresponding risk levels: low (10–20), moderate (21–30), high (31–40), and very high (41–56). For the neck, scores range from 4–18: low (4–6), moderate (8–10), high (12–14), and very high (16–18). Whole-body exposure scores are expressed as percentages and categorized into four levels: below 40% (acceptable), 41–50% (further investigation required), 51–70% (corrective actions needed soon), and above 70% (unacceptable exposure). Studies indicate that QEC provides reliable assessments of musculoskeletal risk factors [٣٠].

Assessment of Repetitive Tasks (ART): This method is suitable for evaluating repetitive tasks, particularly those involving upper limbs. It assesses postures of the head, neck, back, arms, wrists, and fingers, as well as psychosocial factors that influence the final score. Scores related to force, posture, rest time, and additional activities, combined with the duration of the task, generate the final score. Final scores are categorized as low risk (<11), moderate risk (12–21), and high risk (>22) .Studies have validated ART as a suitable tool for evaluating repetitive occupational tasks[٣١] .

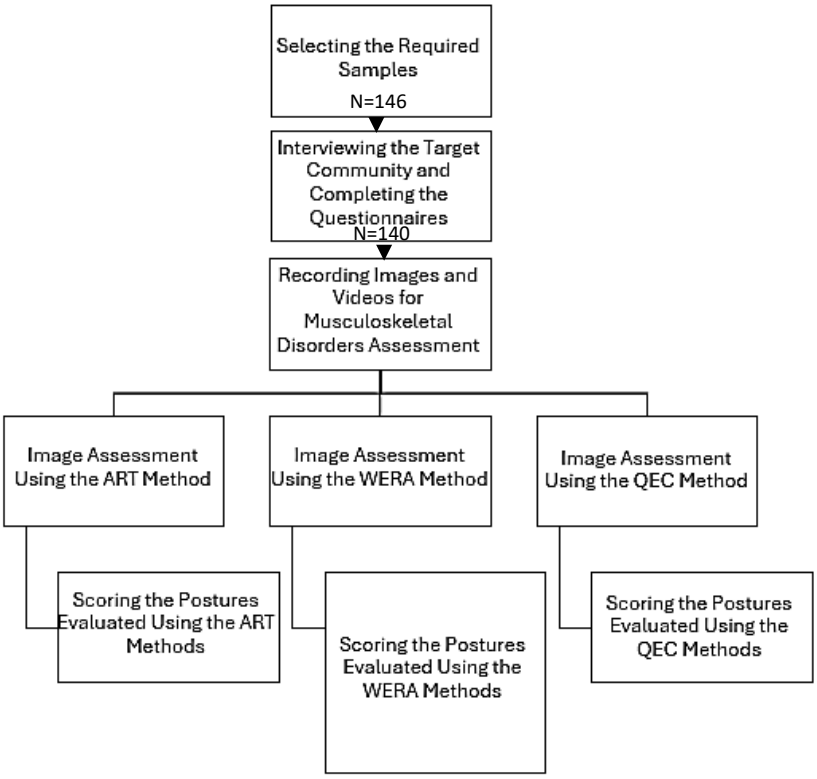

Figure 1: Flowchart of the Work Method

Data from 140 taxi drivers were collected by three occupational health experts, all fully trained in the methods used in this study. The experts photographed the drivers in various postures using cameras and completed the questionnaires through direct interviews with participants. At the end of the data collection phase, the experts independently evaluated the photographs and questionnaires. Demographic information, posture assessment scores from the photographs, and questionnaire results were analyzed.

Statical analysis

The statistical analysis of the musculoskeletal disorder risk levels was conducted using SPSS software version 24. Statistical tests were the t-test for finding out the relationship between age

and MSD_S and the relationship between age and the results of our questionaries, with a significance level set at $p<0.05$ for assessing.

Results for quantitative variables were used with Mean (Standard Deviation) and for Qualitative variables were used with Number (Percentage).

Ethical Considerations

The research protocol was reviewed and approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences - School of Public Health and Neuroscience Research Center, under the ethical code IR.SBMU.PHNS.REC.1403.078.

All participants were informed about the objectives and procedures of the study, and their consent was obtained through signed informed consent forms. Participants were assured that their information would remain completely confidential and would only be used for research purposes.

Results

The mean age of the 140 participants in this study was 51.50 ± 9.53 years, and their average work experience was 18.31 ± 9.22 years, with the highest percentage belonging to taxi drivers with over 20 years of work experience. All drivers were male, and none had a history of musculoskeletal surgeries.

Table 1: Demographic Characteristics of the Studied Taxi Drivers

Variable	Number (Percentage)	95% Confidence interval	
		Lower	Upper
Age (Years)*	(9.53) 51.50	49.87	53.15
Marital Status			
- Married	(95.7) 134	91.4	98.4
- Single	(4.3) 6	1.6	8.6
Education Level			
- Primary School	(11.4) 15	5.5	16.4
- Middle School	(5.26) 35	18	34.4
- High School	(57.6) 76	50.8	67.2
- Diploma	(4.5) 6	1.6	8.6
Work Experience (Years)*	(9.21) 18.32	16.71	19.80
Working Hours (Hours per Week) *	(19.37) 71.63	68.46	75.11
Body Mass Index (kg/m²) *	(27.98) 4.23	27.09	28.4

Note:

* Quantitative variables = Mean (Standard Deviation)

- Qualitative variables = Number (Percentage)

The analysis of musculoskeletal disorder (MSD) severity using the Body Map questionnaire revealed that lower back pain had the highest prevalence, with a mean score of 2.77 ± 1.64, followed by left knee pain, with a mean score of 2.58 ± 1.45. Participants predominantly reported musculoskeletal discomfort in these regions (Figure 1).

Additionally, the results showed no significant correlation between age and musculoskeletal pain in any body region, as the severity of pain in the knees and lower back was consistent across both groups: participants aged ≤50 years and those aged >50 years ($p > 0.05$). However, individuals aged ≤50 years reported greater pain severity in the left knee (2.58), right knee (2.36), neck (2.58) and lower back (1.92) they reported lowest pain severity in back (1.14). On the other hand, participants aged >50 years experienced more pronounced pain in the lower back and left knee (2.58), right knee(2.46) and lower back(2.67), while they experienced less pain in forearms(1.27) (Table 2).

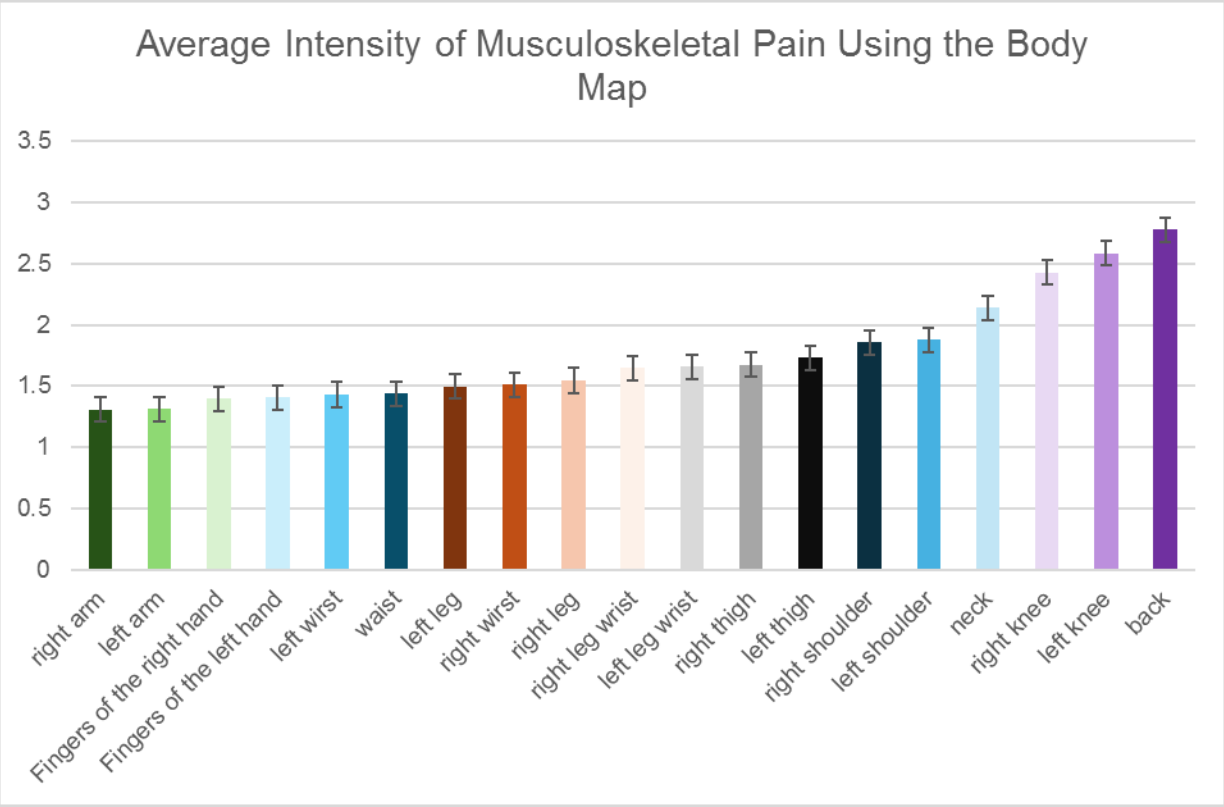

Figure 2: Average Intensity of Musculoskeletal Pain Among Taxi Drivers According to the Body Map Questionnaire

Table 2: Average Intensity of Musculoskeletal Pain in Individuals Aged ≤50 Years and >50 Years

Body Part	Mean Pain Intensity (Age >50)	Mean Pain Intensity (Age ≤50)
Neck	(1.28) 2.03	(1.43) 2.29
Right Shoulder	(1.25) 1.85	(1.23) 1.85
Left Shoulder	(1.24) 1.85	(1.23) 1.90
Right Forearm	(0.73) 1.27	(0.86) 1.36
Left Forearm	(0.73) 1.25	(0.86) 1.36
Right Wrist	(0.76) 1.32	(1.06) 1.81
Left Wrist	(0.76) 1.32	(1.09) 1.60
Right Fingers	(0.93) 1.40	(0.93) 1.38
Left Fingers	(0.93) 1.40	(0.95) 1.41
Right Thigh	(1.21) 1.67	(1.33) 1.67
Left Thigh	(1.27) 1.77	(1.33) 1.67
Right Knee	(1.50) 2.46	(1.50) 2.36
Left Knee	(1.45) 2.58	(1.47) 2.58
Right Calf	(0.94) 1.45	(1.21) 1.69
Left Calf	(0.87) 1.36	(1.21) 1.69
Right Ankle	(1.02) 1.51	(1.32) 1.85
Left Ankle	(1.05) 1.54	(1.32) 1.81
Back	(0.93) 1.46	(0.95) 1.14
Lower Back	(1.68) 2.67	(1.59) 1.92

Mean (Standard Deviation)

Risk assessments for musculoskeletal disorders (MSDs) using the WERA method revealed that 98.6% of participants fell into the moderate-risk category, while 1.4% were classified as low-risk. The WERA risk scores ranged between 25 and 35, indicating an overall moderate risk of developing MSDs. Additionally, this method identified the knees as the body region with the highest risk for MSDs among taxi drivers. Conversely, the QEC method classified all participants within the acceptable risk range, as the final risk scores were 40% or lower, signifying a tolerable risk level. The risk percentage for taxi drivers ranged between 30% and 40%. Risk evaluation using the ART method showed that all participants were in the moderate-risk category, with scores ranging from 13 to 21. In summary, the WERA and ART methods identified participants as being in the moderate-risk category, whereas the QEC method indicated that participants were in the low and acceptable-risk range (Table 3).

Table 3: Results of Musculoskeletal Disorder Risk Assessment Using WERA, QEC, and ART Methods

Method/Risk Level	Acceptable (Low)	Requires Further Investigation (Medium)	Unacceptable Risk (High)
WERA	2 (1.4%)	138 (98.6%)	--
QEC	140 (100.0%)	--	--
ART	--	140 (100.0%)	--

Table 3 shows that both the WERA and ART methods indicate a moderate level of risk in the studied population. In contrast, assessments using the QEC method suggest that the risk of musculoskeletal disorders among drivers falls within the low-risk range. This finding indicates that the WERA and ART methods show a higher level of agreement with each other. According

to Table 4, individuals over 50 years old received higher risk scores in the WERA and QEC methods compared to those under 50. On the other hand, the average risk score for individuals over 50 in the ART method was lower than that of individuals under 50. However, the results of the t-test showed that these differences were not statistically significant ($p>0.05$).

Table 4. Comparison of Risk Assessment Scores Between Individuals Aged ≤50 Years and >50 Years

Method	Age Range	Mean Score	Sig	F
WERA	≤50	(1.56) 25.29	0.44	0.57
	>50	(1.73) 65.29		
QEC	≤50	(5.00) 05.35	0.88	0.02
	>50	(5.00) 52.34		
ART	≤50	(3.23) 10.16	0.40	0.7
	>50	(3.11) 81.15		

Mean (Standard Deviation)

Discussion

The present study aimed to evaluate the risk of musculoskeletal disorders (MSDs) among urban taxi drivers. In this study, the risk of MSDs was assessed using three methods: WERA, QEC, and ART, and the level of agreement between these methods was also evaluated. Our results showed that the highest levels of pain and discomfort, according to the body map questionnaire, were reported in the lower back region, with 51% of participants attributing a pain score of 3 or higher to this area. However, the results from the musculoskeletal risk assessments using all three methods indicated that the posture of the participants' backs was at a low-risk level, as the back was supported, and there was no opportunity for rotation. However, the postures were static, and

the prolonged sitting throughout the day led to most of the participants experiencing pain in the lower back.

The results of a study conducted by Moradpour et al. among taxi drivers in Shahrood aligned with our findings. This study, using the MFA and CMDQ methods, showed that the highest levels of fatigue and musculoskeletal discomfort were in the lower back region. Their results, obtained through different methods, further support our findings. .[۳۲] A study conducted on 382 taxi drivers using the QEC method also revealed that the overall score for back posture was low. Therefore, it can be concluded that long hours of sitting and repetitive tasks contribute to musculoskeletal discomfort in the lower back area among taxi drivers. Furthermore, based on the risk assessment using the QEC method, it can be noted that vibration from vehicle movement could also be considered as a contributing factor to the pain experienced in the back. Although this vibration is minimal, due to the continuous and prolonged exposure of taxi drivers to it, it leads to increased fatigue, stress, and reduced energy levels. .[۳۳]A 2024 review that examined 1,606 studies on musculoskeletal disorders among taxi drivers concluded that the highest prevalence of musculoskeletal disorders among taxi drivers was in the lower back region [۳۴]. A study conducted in 23 different countries across 14 types of transportation vehicles showed that the lower back was the most common area affected by musculoskeletal pain. Following that, the neck, back, shoulders, knees, thighs, wrists, feet, and elbows were also at risk for musculoskeletal pain [۳۵]. In the present study, musculoskeletal disorders were most common in the lower back and knees, with less severe pain reported in the shoulder and hand regions. According to the results of this study, the second most affected area among taxi drivers was the left knee. This body part was particularly stressed due to the pressure applied on the clutch, making it the second area that caused discomfort among taxi drivers. The musculoskeletal risk

assessment using the WERA method also showed that the knee scores were high due to prolonged and severe bending, which aligns with the body map questionnaire results indicating that most participants reported pain and discomfort in their knees.

Another study by Mazlomi et al. clearly demonstrated a significant difference in the perceived discomfort in body areas involved in clutching before and after using the clutch. The highest levels of discomfort were reported in the lower back and knees, which aligns with our findings [۳۶].Additionally, another study showed that the highest prevalence of occupational musculoskeletal disorders among taxi drivers was in the lower back, while the lowest prevalence was found in the elbow region [۳۷]. These results further confirm the findings of the present study.

Another study that examined drivers of eight different types of vehicles showed that long driving hours, poor posture, long working hours, alcohol consumption, and sitting in uncomfortable positions were factors that contributed to musculoskeletal disorders [۳۸]. Therefore, by examining the physical condition of drivers and assessing the risk level of musculoskeletal disorders in their working postures, it is possible to identify the body parts most at risk. Subsequently, through the implementation of necessary training and management interventions, these disorders can be reduced in the long term.

On the other hand, inappropriate seating is one of the factors that not only impacts musculoskeletal disorders but also decreases job satisfaction [۳۹].

In conclusion, it can be stated that prolonged sitting during taxi driving and the pressure exerted when using the clutch leads to significant musculoskeletal pain, particularly in the lower back. Although taxi drivers maintain a proper back posture with support from the chair, the extended

periods of sitting eventually result in musculoskeletal discomfort in the lower back. Additionally, the knees remain in a bent position for extended periods during driving, which leads to improper posture. The continuous bending and pressure applied during clutching contribute to additional strain on the knees. It can be suggested that increasing rest periods and reducing working hours for drivers could reduce the pressure on the back and knees. Furthermore, appropriate exercises aimed at strengthening the back and leg muscles can help support the spine and knees.

Our study showed that there was agreement between the WERA and ART methods, as both indicated a moderate risk for musculoskeletal disorders. The WERA method assesses shoulders, wrists, back, neck, knees, load handling, vibration, and contact stress, while the ART method focuses more on the upper body, evaluating arms, wrists, fingers, and load handling. Although the ART method does not assess knees, its results aligned with those of WERA. But the knees are one of the body parts that are used a lot in driving. Also, our results showed that the average intensity of pain in the drivers' knees according to the body map questionnaire was the highest, after the back. Therefore, in the evaluation of musculoskeletal disorders of drivers, a method that evaluates the legs and especially the knees should be used. Based on this, although the results of the Wera method and ART were close to each other, the Wera method is a more reliable method for studying the assessment of musculoskeletal disorders in the driver community.

In the QEC questionnaire, posture assessment is limited to the shoulders, wrists, neck, and back. Although factors such as load handling, vibration, visual demands, and stress are self-reported by participants in the second questionnaire, this self-reporting has lower reliability compared to evaluations performed by experts. Although the QEC method can be considered as a complete assessment of musculoskeletal disorders, because it examines both physical and psychological factors, the self-report part of this questionnaire can directly affect the final risk assessment[33].

that this part may be affected by the individual's condition and as a result the assessment of the risk of musculoskeletal disorders may be on the wrong path. Therefore, although the QEC method is one of the proposed methods for evaluating musculoskeletal disorders, as a single method, it is not completely accurate and efficient as a method and does not provide a completely reliable report. This statement was fully demonstrated in our results as the Wera and Art methods report more similar results than the QEC method.

This study has some limitations that may affect the findings. Due to the limited sample of urban taxi drivers, the results may not be fully representative of all drivers, as weather conditions and traffic vary by region. Because weather changes such as snow and rain, as well as working on busy roads, make the route longer and thus drive more, and can cause more musculoskeletal disorders. Furthermore, because of the busy and impatient nature of the target group, the study only included 140 drivers, which may not be enough to draw definitive conclusions. The sample size was small due to limited access to participants. Because urban taxi drivers often work long and irregular hours, and attracting a sufficient number of people in the time frame made the study to be conducted with a minimum number of samples.

Conclusion

The results of the assessment using WERA, ART, QEC risk evaluation methods, and the body map chart questionnaire indicated that the highest risk of musculoskeletal disorders occurred in the **lower back** and **knees**, with participants reporting greater pain intensity in these areas. Since prolonged sitting and pressure on pedals increase the severity of pain in the lower back and knees, increasing rest periods and reducing working hours can help alleviate these issues. In

addition, since both WERA and ART methods showed a medium level of risk, but the QEC method showed a low risk level, it can be concluded that the two WERA and ART methods are more consistent with each other. Based on the evaluation results and the body areas assessed by each method, it can be inferred that, given the high prevalence of musculoskeletal disorders in the lower back and lower extremities among taxi drivers, a method focusing on these areas is of greater importance. Also, contrary to the QEC method, the Wera method lacks a self-reporting section, which can have a negative effect on the main result of assessing the risk of musculoskeletal disorders. Based on this, it can be said that the Wera method is a more acceptable method for examining musculoskeletal disorders in the drivers' community. Since the WERA method includes an assessment of legs and knees, using the WERA method for evaluating musculoskeletal disorders among drivers can be considered both effective and practical.

Also, since our results showed that musculoskeletal disorders in knees and back are more among drivers, it is suggested that drivers keep their knees in a straight position during rest. Also, using standard pillows can support drivers' backs. It is recommended to avoid uninterrupted driving. Using a rhythm of rest and intermittent work can help reduce musculoskeletal pain in this occupational group.

Acknowledgment

This study was conducted among taxi drivers in Tehran with the approval of Shahid Beheshti University of Medical Sciences, under the ethical code IR.SBMU.PHNS.REC.1403.078. We express our sincere gratitude to the Research Deputy of Shahid Beheshti University, the Occupational Health Department of Shahid Beheshti University of Medical Sciences, and all participants in this research for their valuable contributions.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' contribution

Conceptualization: ASS.MP

Methodology: MM,ASS

Software: NI

Validation: ASS

Formal Analysis: NI

Investigation: MP

Resources:MP

Data Curation:NI

Writing – Original Draft Preparation: AM

Writing – Review & Editing: ME

Visualization:MS

Supervision:ASS

Project Administration:3245667

Funding Acquisition:SBMU

REFERENCE

.۱ Laal, F., et al., *Relationship between musculoskeletal disorders and anthropometric indices among bus drivers in Zahedan city.* Int J Occup Saf Ergon, 2018. **24**(3): p. 431-437.

.۲ Rohani, J.M., et al., *The inter-rater and intra-rater reliability analysis of workplace ergonomic risk assessment.* Jurnal Teknologi, 2018. **80**(1): p. 53-59.

.۳ SheikhMozafari, M.J., et al., *Investigating the prevalence of musculoskeletal disorders and its relationship with physical and psychosocial risk factors among an automotive industry employees: Validating the MDRF questionnaire.* Journal of Health and Safety at Work, 2024. **13**(4): p. 714-735.

.۴ Mufti, D., A. Ikhsan, and T.M. Putri. *Workplace Ergonomic Risk Assessment Toward Small-Scale Household Business*. in *IOP Conference Series: Materials Science and Engineering*. 2019. IOP Publishing.

.۵ Hamed Yarmohammadi, S.H.N.S., Sudabah Yarmohammadi, Alireza Khomer, Hossein Mari Eriad and M.P. *, *Investigating the prevalence of skeletal and muscular disorders in drivers: a systematic review and meta-analysis.* 2019.

.۶ Khandan Mohammad, S.Z., Alireza hiking, *Investigating the incidence of musculoskeletal disorders and investigating its relationship with the occupational stress of truck drivers in Iran.* Iran's work health bimonthly, 20.۱۶

.۷ Bahrami, F., et al., *Study of Pain and Disabilities in Musculoskeletal System among Urban Bus Drivers with Respect to Body Postures, Job Satisfaction, and Individual Factors.* Journal of Occupational Hygiene Engineering, 2024.

.۸ Sadri, G., *A MODEL OF BUS DRIVERS.* 2002.

.۹ Joseph, L., et al., *Prevalence of musculoskeletal pain among professional drivers: A systematic review.* J Occup Health, 2020. **62**(1): p. e12150.

.۱۰ Kamble, R., S. Pandit, and A. Sahu, *Occupational ergonomic assessment of MSDs among the artisans working in the Bagh hand block printing industry in Madhya Pradesh, India.* International Journal of Occupational Safety and Ergonomics, 2023. **29**(3): p. 963-969.

.۱۱ Okunribido, O.O., M. Magnusson, and M. Pope, *Delivery drivers and low-back pain: a study of the exposures to posture demands, manual materials handling and whole-body vibration.* International Journal of Industrial Ergonomics, 2006. **36**(3): p. 265-273.

.۱۲ Maduagwu, S.M., et al., *Work-related musculoskeletal disorders among occupational drivers in Mubi, Nigeria.* Int J Occup Saf Ergon, 2022. **28**(1): p. 572-580.

.۱۳ Benstowe, S.J., *Long driving hours and health of truck drivers.* 2008.

.۱۴ Mozafari, A., et al., *Work-related musculoskeletal disorders in truck drivers and official workers.* Acta Med Iran, 2015. **53**(7): p. 432-8.

.۱۵ Arghami, S., K. Kamali, and M. NasabAlhosseini, *A Survey on Musculoskeletal Pain in Suburban Bus Drivers.* Journal of Occupational Hygiene Engineering, 2015. **2**(2): p. 72-81.

.۱۶ Bevan, S., *Economic impact of musculoskeletal disorders (MSDs) on work in Europe.* Best Practice & Research Clinical Rheumatology, 2015. **29**(3): p. 356-373.

.۱۷ Mohammad Ali Barzegari Bafghi, A.S.S., Mahmoud Mokhlisi, Qasim Tori, Engineer Shahram Votoghi, *Examining the work status of 0457 bus drivers of a single company using the RULA method and its compliance with the Body Map questionnaire.* The fourth nationwide conference on professional health of Iran, 2004.

.۱۸ Kuorinka, I., et al., *Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms.* Applied ergonomics, 1987. **18**(3): p. 233-237.

.۱۹ Salehi Sahlabadi, A., et al., *Evaluation of health risk experienced by urban taxi drivers to whole-body vibration and multiple shocks.* Noise & Vibration Worldwide, 2024. **55**(6-7 :(p. 296-303.

.۲۰ Soltaninejad, M., et al., *The prevalence of metabolic syndrome in drivers: A meta-analysis and systematic review.* Work, 2020. **67**(4): p. 829-835.

.۲۱ Karchani, M., et al., *Association of Subjective and Interpretive Drowsiness with Facial Dynamic Changes in Simulator Driving.* J Res Health Sci, 2015. **15**(4): p. 250-5.

.۲۲ Biglari, H., et al., *Relationship between occupational stress and cardiovascular diseases risk factors in drivers.* Int J Occup Med Environ Health, 2016. **29**(6): p. 895-901.

.۲۳ Palikhe, S., et al., *Ergonomic Risk Assessment of Aluminum Form Workers' Musculoskeletal Disorder at Construction Workstations Using Simulation.* Sustainability, 2022. **14**(7): p. 4356.

.۲۴ Motamedzade, M., M. Mohammadian, and J. Faradmal, *Comparing of four ergonomic risk assessment methods of hal-tlv, strain index, ocra checklist, and art for repetitive work tasks.* Iranian journal of health, safety and environment, 2019. **6**(3): p. 1303-1309.

.۲۵ Escalante, A., et al., *A method for scoring the pain map of the McGill pain questionnaire for use in epidemiologic studies.* Aging Clinical and Experimental Research, 1995. **7**(5): p. 358-366.

.۲۶ Zare, M., et al., *Prevalence of Musculoskeletal Disorders in Primary School Students in Abu Musa Island.* Journal of Preventive Medicine, 2022. **9**(3): p. 268-279.

.۲۷ Brummett, C.M., et al., *Preliminary validation of the Michigan Body Map.* PAIN, 2016. **157**(6): p. 1205-1212.

.۲۸ Foxen-Craft, E., et al., *Pain location and widespread pain in youth with orthopaedic conditions: Exploration of the reliability and validity of a body map.* European Journal of Pain, 2019. **23**(1): p. 57-65.

.۲۹ Abdol Rahman, M.N., *Development of an ergonomic risk assessment tool for work postures*. 2014, Universiti Teknologi Malaysia.

.۳۰ Li, G. and P. Buckle, *A Practical Method for the Assessment of Work-Related Musculoskeletal Risks - Quick Exposure Check (QEC).* Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 1998. **42**(19): p. 1351-1355.

.۳۱ Hosseini, M.H., *Ergonomic evaluation of working conditions using QEC and ART methods and the prevalence of musculoskeletal disorders in a tile industry.* Occupational Medicine Quarterly Journal, 2024. **16**(1): p. 43-52.

.۳۲ Moradpour, Z., et al., *Study of Correlation Between Muscle Fatigue Assessment and Cornell Musculoskeletal Disorders Questionnaire in Shahroud Taxi Drivers in 2017: A Descriptive Study.* Journal of Rafsanjan University of Medical Sciences, 2019. **17**(11): p. 1031-1042.

.۳۳ Bulduk, E.Ö., et al., *Assessing exposure to risk factors for work-related musculoskeletal disorders using Quick Exposure Check (QEC) in taxi drivers.* International Journal of Industrial Ergonomics, 2014. **44**(6): p. 817-820.

.۳۴ Rezaei, E., et al., *Musculoskeletal disorders among taxi drivers: a systematic review and meta-analysis.* BMC Musculoskeletal Disorders, 2024. **25**(1): p. 663.

.۳۵ Joseph, L., et al., *Prevalence of musculoskeletal pain among professional drivers: A systematic review.* Journal of Occupational Health, 2020. **62**.(۱)

.۳۶ Shirmohammadi, A.M.Z.K.S.A.M.M.H., *Ergonomic evaluation of the clutch pedal in several models of common cars in taxi lines in Tehran.* 2018.

.٣٧ Ahmad, I., et al., *Occupational musculoskeletal disorders among taxi industry workers in Jeddah, Saudi Arabia.* Biosciences Biotechnology Research Asia, 2017. **14**(2): p. 593-606.

.٣٨ Sharma, G., et al., *Risk factors Assessment of Musculoskeletal disorders among Professional Vehicle drivers in India using an Ordinal Priority Approach.* Mathematics, 2022. **10**(23): p. 4492.

.٣٩ Joseph, L., et al ,.*Causal Relationship Between the Risk Factors and Work-Related Musculoskeletal Disorders Among Professional Drivers: A Systematic Review.* Human Factors, 2023. **65**(1): p. 62-85.