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Research Article

Measurement Of Intensive Care Nurses' Musculoskeletal System Disorders with Quick Exposure Check Method

Selma KAYMAZ[1*], Muharrem ÜNVER [1]

[1]Karabuk University Faculty of Engineering Department of Industrial Engineering, 78050, Karabuk, TÜRKİYE

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Abstract

Musculoskeletal disorders are long-term health problems that individuals experience long-term while performing their professions. These problems are caused by repetitive work or incorrect positions. Ergonomists or occupational health and safety specialists have developed various methods to identify and address employee ailments. One such method is the quick exposure check (QEC). This method detects workplace deficiencies by measuring employees' exposure to different body parts and work stress. It is both fast and reliable. The scale was applied to intensive care nurses in this study due to societal awareness of the heavy workload healthcare workers face.

Additionally, it is believed that these workers play an important role in human health, making it crucial to measure their stress levels. In this context, the scale was applied to a group of 19 individuals, 2 of whom were male, with an average age of 31.7, all healthy nurses working in the intensive care unit of an educational research hospital. The reliability test of the survey was conducted, and items with low internal consistency were removed. The Cronbach's alpha value was found to be 0.643. The results showed that the exposure levels of nurses' neck and stress levels were very high. According to the QEC method, the risk was found to be high for the neck, shoulder/arm, wrist/hand regions, and the work pace factor. The effects of independent variables (age, gender, and smoking status) on exposure levels were analyzed using linear regression in the SPSS 25 statistical package program. The results indicated that gender significantly affects exposure levels. According to the Durbin-Watson test results, smoking status does not show a high variation effect in the model of shoulder/arm pain, work pace, and stress levels in nurses. Recommendations were made to reduce workload based on these findings.

Keywords

"Quick Exposure Check (QEC), Intensive Care Units (ICUs), Intensive Care Nurses, Musculoskeletal Disorders (MSD)"

**** Corresponding Author:** kaymazselma@outlook.com*

1. Introduction

Risk assessments are an essential tool for identifying the risks to which employees are exposed as they work. These tools emphasize the need to carry out risk assessments regularly to prevent exposure to potentially harmful work environments (Oliv et al., 2019). Work-related musculoskeletal disorders are among the painful conditions addressed by ergonomic evaluations. These assessments evaluate hazards that can damage muscles, nerves, and/or joints. They assess physical load by analyzing body movements in one or more postures and examining repetitive, strenuous activities over time. This approach helps prevent musculoskeletal disorders or physiological impairments through ergonomic analysis and evaluation (Korkmaz & Unver, 2024). Significant improvements are needed in the healthcare sector. It is well known that doctors, nurses, caregivers, dentists, and support staff, such as those responsible for cleaning hospitals, work under heavy workloads. These healthcare professionals dedicate considerable time and effort to focusing on patients' health without interruption. This dedicated team performs critical tasks, including meeting patient needs, managing treatment processes, and maintaining a clean and safe hospital environment, all of which significantly contribute to public health. Despite these challenging conditions, they continue to provide essential services that play a vital role in promoting community well-being. Nurses working in intensive care units (ICUs) have a job description that includes physically demanding activities such as lifting, moving, prolonged walking and standing. Many ICU nurses are required to work under workloads that often exceed the World Health Organization's recommended 10,000 steps per day (Fijačko et al., 2024). This workload and the nurse's posture in the workplace sometimes lead to occupational diseases or cause permanent damage to certain parts of the body.

Significant improvements are needed in the healthcare sector. It is well known that doctors, nurses, caregivers, dentists, and support staff, such as those responsible for cleaning hospitals, work under heavy workloads. These healthcare professionals dedicate considerable time and effort to focusing on patients' health without interruption. This dedicated team performs critical tasks, including meeting patient needs, managing treatment processes, and maintaining a clean and safe hospital environment, all of which significantly contribute to public health. Despite these challenging conditions, they continue to provide essential services that play a vital role in promoting community well-being.

Nurses working in intensive care units (ICUs) have a job description that includes physically demanding activities such as lifting, moving, prolonged walking and standing. Many ICU nurses are required to work under workloads that often exceed the World Health Organization's recommended 10,000 steps per day (Fijačko et al., 2024). This workload and the nurse's posture in the workplace sometimes lead to occupational diseases or cause permanent damage to certain parts of the body. It is crucial to take preventive measures in workplaces to protect employees from musculoskeletal disorders. Tools that measure and mitigate musculoskeletal exposure levels should be available across all sectors, from construction to agriculture. One such tool is the QEC Scale. This scale was developed to meet the needs of ergonomists and specialists. It involves both the observer and the worker being observed in the evaluation process. It assesses the worst positions for different body postures, the frequency of movements performed per minute, and the exposure levels for weight and duration. These factors are then compiled and summarized in a scoring table for each body part, vibration, and work-related stress (Oliv et al., 2019). Initially developed by occupational health and safety experts for the healthcare sector, this method has gradually been extended to other sectors where employees work under ergonomic risks. Known for addressing all body parts and worker stress, this method is widely used across various industries due to its ease of use and the ability to conduct quick assessments to identify musculoskeletal disorders.

In the introduction, musculoskeletal exposure of healthcare workers was briefly discussed, and the workload of ICU nurses was highlighted. Additionally, the QEC, which will be utilized in this study, was briefly introduced. The subsequent sections include a literature review focusing on the QEC method, an explanation of the scale, and the application of this scale to ICU nurses, with the results presented accordingly.

Symbols and Abbreviations

β	Unstandardized Regression Coefficient
t	t-Value
p	p-Value
R	The Multiple Correlation Coefficient
CNC	Computer Numerical Control
ICU/ICUs	Intensive Care Unit/Intensive Care Units
MQ	Musculoskeletal Questionnaire
MSD	Musculoskeletal Disorders
OCRA	Occupational Repetitive Actions
OWAS	Ovako Working Posture Analysing System
QEC	Quick Exposure Check
REBA	Rapid Entire Body Assessment
RULA	Rapid Upper Limb Assessment

2. Literature Review

In this part of the study, QEC studies in the literature were analyzed. The reviewed studies are presented in Table 1.

Table 1. Quick Exposure Check Studies in the Literature

Author/Authors	Year of Publication	Publication Name (Original Name)	Published in Journal/Institution	Participant Group	Number of Participants	Identified Risk Factors
Mirmohamadi, M., Seraji, J. N., Shahtaheri, J., Lahmi, M., Ghasemkhani, M.	2004	Evaluation of Risk Factors Causing Musculoskeletal Disorders Using QEC Method in a Furniture Producing Unite	Iranian Journal of Public Health	14 Workers Group	500	Wrist/Hand Neck
Özcan, E., Kesiktaş-Sakar, N., Alptekin, H. K., Özcan, E. E.	2007	Mesleki Kas Iskelet Risklerinin Değerlendirilmesinde QEC Olceginin Turkçe Uyarlamasının Guvenilirligi	Istanbul Tip Fakultesi Dergisi	Cleaning Workers in the Hospital	20	Back Wrist/Hand Stress Work pace
David, G., Woods V., Li, G., Buckle, P.	2008	The Development of the QEC For Assessing Exposure to Risk Factors For Work-related Musculoskeletal Disorders	Applied Ergonomics	Quantitative Methodological Study		
Chiasson, M.-È., Imbeau, D., Aubry, K., Delisle, A.	2012	Comparing the Results of Eight Methods Used to Evaluate Risk Factors Associated with Musculoskeletal Disorders	International Journal of Industrial Ergonomics	567 Worker Groups with Job Descriptions Working in 18 Different Facilities	516	Wrist/Hand
Comper, M. L. C., Costa, L. O. P., Padula, R. S.	2012	Clinimetric Properties of the Brazilian-Portuguese Version of the QEC	Brazilian Journal of Physical Therapy	2 Different Worker Groups from the Manufacturing Sector	99	All body areas are at moderate risk.
Ericsson, P., Björklund, M., Wahlström, J.	2012	Exposure Assessment in Different Occupational Groups at a Hospital Using QEC – A Pilot Study	Work	Personnel Working in the Healthcare Field (Nurse, cleaner, secretary…)	23	Neck Shoulder/Arm
Sukadarin, E. H., Deros, B. M., Ghani, J. A., Ismail, A. R., Mokhtar, M. M., Mohamad, D.	2013	Investigation Of Ergonomics Risk Factors For Musculoskeletal Disorders Among Oil Palm Workers QEC	Advanced Engineering Forum	Oil Palm Harvest Workers	7	Back Shoulder/Arm Wrist/Hand
Bulduk, E. Ö., Bulduk, S., Süren, T., Ovalı, F.	2014	Assessing Exposure to Risk Factors for Work-related Musculoskeletal Disorders Using Quick Exposure Check (QEC) in Taxi Drivers	International Journal of Industrial Ergonomics	Taxi Drivers	382	Shoulder/Arm Wrist/Hand Back
Mert, E. A.	2014	Ergonomik Risk Değerlendirme Yöntemlerinin Karşılaştırılması ve Bir Çanta İmalat Atölyesinde Uygulanması	T.C. Çalışma ve Sosyal Güvenlik Bakanlığı, Ankara, Türkiye.	Group of Workers with Different Job Descriptions in the Bag Manufacturing Industry	6	It was concluded that there is no risk and no action is required.

Table 1. (*continued*)

Bidiawati, J. R. A., Suryani, E.	2015	Improving the Work Position of Worker's Based on Quick Exposure Check Method to Reduce the Risk of Work Related Musculoskeletal Disorders	Procedia Manufacturing	Group of Workers Working in the Manufacturing Process of Bricks and Well Rings	-	Back Shoulder/Arm Wrist/Hand Neck
Park, H.-S., Kim, J., Roh, H.-L., Namkoong, S.	2015	Analysis Of The Risk Factors Of Musculoskeletal Disease Among Dentists İnduced By Work Posture	Journal of Physical Therapy Science	Dentists with more than 10 years of experience	3	Neck Vibration
Bozkurt, S., Demirsoy, N., Günendi, Z.	2016	Risk Factors Associated With Work-Related Musculoskeletal Disorders In Dentistry	Clinical and Investigative Medicine	Dentists	164	Back
Ulutaş, İ. B., Gündüz, T.	2017	Otomotiv Kablo İmalatında Ergonomik Risk Analizi	Uludag Universitesi Muhendislik Fakultesi Dergisi	L Form Latch Tables Operators	-	Back Shoulder/Arm Neck Work Pace Stress
Inalçuk, E.	2019	Investıgatıon Of Ergonomıc Rısks In Manufacturıng Sector Usıng Quıck Exposure Check Method.	Middle East Technical University, Ankara, Türkiye.	CNC Operators	47	Back Shoulder/Arm Neck
Kâhya, E., Söylemez, S.	2019	Jant Sektöründe QEC ve REBA Yöntemleriyle Ergonomik Risk Değerlendirmesi	Karaelmas Journal of Occupational Health and Safety	Workers Working on 4 Different Looms in Wheel Production	4	Weight
Oliv, S., Gustafsson, E., Baloch, A. N., Hagberg, M., Sandén, H.	2019	The Quick Exposure Check (QEC) — Inter-rater reliability in total score and individual items	Applied Ergonomics	Workers with 51 Job Tasks on the Construction Site	14	It was concluded that there is no risk and no action is required.
Karimi, A., Dianat, I., Barkhordari, A., Yusefzade, I. ve Rohani-Rasaf, M.	2020	A Multicomponent Ergonomic İntervention İnvolving İndividual And Organisational Changes For İmproving Musculoskeletal Outcomes And Exposure Risks Among Dairy Workers	Applied Ergonomics	Group of Male Workers Working in a Dairy Products Facility	48	Shoulder/Arm Back Neck
Dalkılınç, T.	2021	Fiziksel Ergonomik Risk Faktörlerinin İş Yükü Algısı ile İlişkisi: Tekstil Sektörüne Yönelik Bir Uygulama.	Izmir University of Economy, Izmir, Türkiye.	Group of Workers Working in a Single Production Line in a Factory	60	Shoulder/Arm Wrist/Hand Neck
Akpınar, C. V., Mandıracıoğlu, A.	2022	Associatıon Between Work-Related Musculoskeletal Dısorders And Quıck Exposure Check Results In Dentısts	Nobel Medicus	Dentists	200	Stress Wrist/Hand Back Neck Vibration
Celestino, J. C., Peña, C. S., Ramos, J. M. H., Jiménez, V. L.	2022	Evaluación Ergonómica con QEC para la detección de Trastornos Musculoesqueléticos	Revista Ingeniería y Gestión Industrial	Operator Group from the Pipe Manufacturing Sector	70	Back
Esmaeili, R.,Shakerian,M., Esmaeili, S. V., Jalali, M., Pouya, A. B., Karimi, A.	2023	A Multicomponent Quasi-Experimental Ergonomic İnterventional Study: Long-Term Parallel Four-Groups İnterventions	BMC Musculoskeletal Disorders	Male Labourers From the Foundry Industry	117	Shoulder/Arm Stress Back

Scientific studies in the literature using the QEC scale were examined in chronological order. These reviews are presented in detail below.

In their study conducted by Mirmohammadi et al. (2004), the system was successful in detecting 500 personal muscle structure disorders from 14 working groups in a company operating in the furniture sector in Tehran. QEC performance and the Nordic MQ Scandinavian Musculoskeletal System Questionnaire were started on these potential personnel. With quick exposure check, it was revealed that 90% of the results contained high and very high risk (Mirmohammadi et al., 2004).
In their study conducted by Özcan et al. (2007), it was aimed to test the Turkish adaptation of the QEC method. In this context, the method was applied to 20 cleaning personnel working at Istanbul Faculty of Medicine and the reliability of the method was rated as moderate-good (Özcan et al., 2007).

In their study conducted by David et al. (2008), checked and analysed the modifications made to the quick exposure check scale. In this context, the scale was tested by 206 practitioners in various sectors. As a result of the trial for the new version, the scale was found reasonable for use in various business activities (David et al., 2008).

In the study conducted by Chiasson (2012), 8 different scales developed for musculoskeletal disorders were tested. In this context, 224 workstations including 567 tasks were evaluated with the QEC Scale, REBA, RULA, OCRA, JSI, HAL, FIOH, EN 1005-3 standard methods. As a result of the study, the QEC method proved to be less stringent in assessing the overall risk and classified 35% of the workstations as high risk compared to RULA. OCRA and QEC agreed 57% of the time for all risk categories (Chiasson, 2012).

In their study conducted by Comper et al. (2012) aimed to test the Portuguese version of the quick exposure check scale. In this context, the method was applied to 107 workers working in the textile sector. As a result of the study, the Portuguese version of the scale showed practicality, applicability and satisfactory results in accordance with its features and application conditions (Comper et al., 2012).

In the study conducted by Ericsson et al. (2012), the quick exposure check scale was tested in different occupational groups. In this context, the method was applied to a total of 23 people, including 5 operating theatre nurses, 5 medical secretaries, 5 equipment attendants, 4 hospital cleaners and 4 biomedical analysts. The study concluded that the scale was sufficiently sensitive to capture exposure differences both between occupations and between workers in the same job (Ericsson et al., 2012).

In their study conducted by Sukadarin et al. (2013), a quick exposure check scale was applied to 7 personnel working in an oil palm plantation in Kuala Selangor to measure the musculoskeletal exposure of workers harvesting oil palm. As a result of the study, a very high degree of risk was found in the shoulder/arm and wrist/hand region (Sukadarin et al., 2013).

In their study conducted by Bulduk et al. (2014), quick exposure check scale was applied to 382 taxi drivers in Ankara in order to determine the risk factors related to musculoskeletal disorders of taxi drivers. As a result of the study, the exposure levels of the drivers for shoulder, hand and neck were found to be very high risk (Bulduk et al., 2014).

In the study conducted by Mert (2014), OWAS, PLIBEL, ManTRA, REBA quick exposure check method was applied to 6 employees in order to determine ergonomic risks in a bag manufacturing workshop and to compare the scales. As a result of the study, it was determined that OWAS, REBA and QEC scales gave the best results. The quick exposure check score was determined as 64%. 11 improvements were suggested for the job description (Mert, 2014).

In their study conducted by Bidiawati and Suryani (2015), it was aimed to determine the risk factors related to musculoskeletal disorders of workers working in brick production and well ring manufacturing by quick exposure check method. As a result of the study, 100% of the workers working in brick production were found to have low back disorders, and wrist and neck areas were considered 80% risky (Bidiawati and Suryani, 2015).

In their study conducted by Park et al. (2015), quick exposure check scale and RULA were applied to three dentists with more than 10 years of clinical experience and without orthopedic or neurological problems in the last three years in order to ergonomically evaluate the working postures of dentists. As a result of the study, it was revealed that dentists had the worst posture in second molar treatments. This made the risk of neck problems and vibration high in dentists (Park et al., 2015).

In their study conducted by Bozkurt et al. (2016), a quick exposure check scale was applied to 164 dentists working at Gazi University in order to identify the musculoskeletal risk areas for dentists. It was determined that the region where the physicians were exposed to the highest risk level was the back with a rate of 66.9%. The risk level was higher in women and research assistants compared to others. In dentists who do regular sports, quick exposure check scores were lower than other groups (Bozkurt et al., 2016).

In their study conducted by Ulutaş and Gündüz (2017), it was aimed to determine musculoskeletal disorders in a company where automotive electrical cable systems are made in order to create a new line. In the study where quick exposure check and REBA scales

were used, risk exposure was found to be high with both methods in the in-line welding section. For the L-form latch tables quick exposure check scale, work tempo was too high, back, neck, shoulder, stress was found to be at a high level (Ulutaş & Gündüz, 2017). In the study conducted by Inalçuk (2019), the quick exposure check scale was applied to 47 CNC operators in a factory to measure musculoskeletal exposure. As a result of the scale evaluation, high risk was found in the back, shoulder/arm, neck of most of the employees. At the same time, it is emphasised that the development of automation systems is important for ergonomic risk (Inalçuk, 2019).

In their study conducted by Kâhya and Söylemez in 2019, quick exposure check scale and REBA scales were applied to 4 workers working in 4 different workbenches in order to determine the musculoskeletal disorders of workers working in wheel production and to make improvements. As a result of the study, it was concluded that the ergonomic risk level of workers working in washing and press should be reduced according to the QEC method (Kâhya & Söylemez, 2019).

In their study conducted by Oliv et al. (2019), conducted a risk assessment for the Swedish language QEC scale by ergonomists. Within the scope of the study, 102 assessments were made for 51 work tasks at a construction site in Western Sweden. The number of workers involved in the analysis was 14. As a result of the study, the evaluated work tasks were in the range of mild to moderate risk level and no body part was evaluated in the highest risk category (Oliv et al., 2019).

In the study conducted by Karimi (2020), QEC and Cornell musculoskeletal disorders assessment method were applied to 48 male workers working in Isfahan milk centre in order to optimise the ergonomic training and exercise programme to be given to the workers working in the dairy plant. As a result of the study, it was observed that shoulder, back and neck disorders were common in milking workers. The level of risk exposure decreased with the application of the results obtained by QEC to the intervention programme (Karimi, 2020).

In the study conducted by Dalkılınç (2021), QEC and NASA-TLX scales were applied to 60 people working on a production line in a factory in order to determine ergonomic risk levels and evaluate workload perception. As a result of the study, it was found appropriate to evaluate that the perception of workload was high and that especially shoulder/arm, wrist/hand and neck exposure levels should be emphasised (Dalkılınç, 2021).

In their study conducted by Akpınar and Mandıracıoğlu in 2022, QEC and Nordic MQ Scandinavian Questionnaire were applied to 200 dentists in order to identify the areas at musculoskeletal risk for dentists. It was revealed that the percentage of physicians having musculoskeletal disorders was very high, 92.1% (Akpınar & Mandıracıoğlu, 2022).

In their study conducted by Celestino et al. (2022), aimed to measure the risk exposure levels of 70 operators working in a pipe production and manufacturing plant. As a result of the study, it was concluded that 'Workers are likely to develop Traumatic Musculoskeletal Infection in the back areas' (Celestino et al., 2022).

In their study conducted by Esmaeili et al. (2023), QEC and Cornell musculoskeletal disorders assessment method were applied to measure the musculoskeletal exposures of 117 male workers in the foundry industry. The results showed that the interventions applied as a result of high exposure at the shoulder/arm, back and stress level were effective (Esmaeili et al., 2023).

As a result of the literature search, it is seen that the QEC scale has been applied in various sectors and in various job tasks. The literature does not provide guidance when determining the sample for the scale. The differences between the sample sizes in the studies may reflect certain difficulties in the literature on how the QEC scale is applied in various sectors and job tasks. While small sample sizes in some studies (Park et al. 2015; Kâhya & Söylemez, 2019) allow for in-depth and detailed analyses, large sample sizes in other studies (Chiasson et al. 2012; Bulduk et al. 2014) offer the opportunity to make generalisations and generalise results to a wider audience. The reasons for these differences may depend on factors such as the purpose of the studies, the topics they focus on and the available resources. It is also understood that the scale was applied to more than one professional group at the same time in the studies. Pooling data from different occupational groups provides important clues as to how the scale can be adapted to a wide range of job tasks and working conditions. This study aims to deepen existing knowledge and provide a more comprehensive understanding of the effectiveness and importance of musculoskeletal testing in clinical practice. The use of a sample of 10 participants in our study allows for an in-depth and detailed analysis. This small but carefully selected sample allows us to obtain rich and detailed data by focusing on healthy nurses in an intensive care unit and with the same job role. In this way, we were able to develop a more in-depth understanding of the effectiveness and applicability of the QEC scale.

3. Material and Method

In this section, the QEC scale, which will be used to assess the musculoskeletal disorders of nurses and the risks they are exposed to in the workplace, is presented in detail.

Quick exposure check

The QEC scale was started to be developed in 1998-1999 (Li and Buckle, 1998) to measure musculoskeletal disorders of healthcare workers. The scale was used for a while and was revised in 2005 (David et al., 2005). After this process, an update was needed. In this context, worker questions and scoring systems were changed. At the same time, observer and worker questions were combined on a single page and vibration factor was added to the assessment (David et al., 2008). The QEC is a standardized scale designed to assess the task risk of a job at a single time. It is known that the scale was designed by occupational health and safety practitioners to meet the needs of both ergonomists and specialists. The scale includes both the observations of the observer and the assessments of the worker in the scoring. It assesses the lower back, shoulder/arm, wrist/hand, neck and the stress, work pace, vibration and driving exposures the worker is exposed to at work. These assessments are summed into total scores in the score table (Oliv et al., 2019). Observers and workers are needed to apply the QEC scale. In order to answer the scale reliably and accurately, the observer is expected to be familiar with the job description and the QEC scale. For this reason, the observer should be assessed by experts before assessing the employee.

Table 2. Quick Exposure Check Scale Completed by the Observer

BACK	**A**	**Select the nurse's back position angle while working.**
	1	The nurse's bending angle is less than 20 degrees.
	2	The nurse's bending angle is between 20 and 60 degrees.
	3	The nurse's bending angle is more than 60 degrees.
	B	**Evaluate the frequency of back movements for lifting, pushing-pulling, and carrying tasks for the employee.**
	3	The nurse's back movement frequency is 3 or fewer within 60 seconds.
	4	The nurse's back movement frequency is 8 within 60 seconds.
	5	The nurse's back movement frequency is 12 or more within 60 seconds.
SHOULDER /ARM	**C**	**Select the worst hand position the nurse is exposed to while working.**
	1	At or below back level.
	2	At chest level.
	3	At shoulder level or above the shoulder.
	D	**Select the worst shoulder/arm movement the employee performs while working.**
	1	The nurse moves the arm rarely.
	2	The nurse's arm pauses occasionally but otherwise is in motion.
	3	The nurse's arm is constantly moving.
WRIST/HAND	**E**	**Select the worst wrist position the nurse is exposed to while working.**
	1	The wrist angle is less than 15 degrees of flexion or extension.
	2	The wrist angle is more than 15 degrees of flexion or extension.
	F	**Number of similar repetitive movements:**
	1	The nurse’s repetitive movement occurs 10 or fewer times within 60 seconds.
	2	The nurse’s repetitive movement occurs 11-20 times within 60 seconds.
	3	The nurse’s repetitive movement occurs 20 or more times within 60 seconds.
NECK	**G**	**Select the worst neck position the employee is exposed to while working.**
	1	The nurse's neck bending/rotation angle is less than 20 degrees.
	2	The nurse's neck bending/rotation exceeds 20 degrees for less than 70% of the working time.
	3	The nurse's neck bending/rotation exceeds 20 degrees for more than 70% of the working time.

The first part of the QEC scale is intended for the assessor. The assessor should tick the levels observed to assess the risk of the worker's back, shoulder/arm, wrist/hand and neck task. In the second part, the assessor asks the worker standard questions about the weight used during the task, hand strength, time spent on the daily task, visual attention needs of the task, use of tools, use of vibrating tools, difficulty keeping up with the work and work stress. According to the instructions for the QEC, the worst case and worst positions are expected to be assessed. For example, when assessing the neck region, the neck should be assessed in the time period when the neck is excessively bent. The scale completed by the observer is given in Table 2.

In the second part, the evaluation is made by taking the employee's opinions. This evaluation includes weight, time, visual attention, force, vehicle, vibration, work tempo and stress exposures. Table 3 shows the employee evaluation section of the scale.

Table 3. Quick Exposure Check Scale Completed by the Observer

TIME	**J**	**On average, how much time do you spend performing your profession daily?**
	1	I spend less than 2 hours.
	2	I spend between 2 and 4 hours.
	3	I spend more than 4 hours.
FORCE	K	**What level of force do you apply with your hands while performing your tasks?**
	1	Less than 1 kg.
	2	Between 1 and 4 kg.
	3	I apply more than 4 kg of force.
VISUAL ATTENTION	**L**	**Select the required visual attention level for nurses.**
	1	Not high.
	2	High (It is important to see details.)
	If high, please specify the details.	
TRANSPORTATION	**M**	**Do you use a vehicle while performing your job? If yes, what is your daily vehicle usage time?**
	1	I do not use a vehicle or use it for 1 hour per day.
	2	I use a vehicle for 1-4 hours during each shift.
	3	I use a vehicle for more than 4 hours during each shift.
VIBRATION	**N**	**What is your daily exposure level to vibrating tools?**
	1	Never or for 1 hour during each shift.
	2	For 1 or 4 hours during each shift, I am exposed to these tools.
	3	For more than 4 hours during each shift, I am exposed to these tools.
WORK PACE	**P**	**Do you experience difficulty while performing your job?**
	1	My job is not difficult.
	2	I experience difficulty occasionally.
	3	I always experience difficulty while performing my job.
	If you marked P3, please specify the details.	
STRESS FACTOR	**Q**	**How stressful do you think your job is?**
	1	Not stressful.
	2	Slightly stressful.
	3	Moderately stressful.
	4	Extremely stressful.
	If you marked 3 or 4, please specify the details.	

While preparing the scale, questionnaires of Turkish studies in the literature were utilised. After the scales are filled in by the observer and the worker, the scores are calculated separately for each body part by scoring the combinations of certain factors in the score table by the experts. The calculated scores are evaluated according to exposure value ranges. Quick exposure value ranges are given in Table 4.

Table 4. Quick Exposure Value Ranges (Inalçuk, 2019).

	Low	Medium	High	Very High
Back	10-20	21-30	31-40	41-56
Shoulder/Arm	10-20	21-30	31-40	41-56
Wrist/Hand	10-20	21-30	31-40	41-56
Neck	4-6	8-10	12-14	16-18
Driving	1	4	9	-
Vibration	1	4	9	-
Work Pace	1	4	9	
Stress Factor	1	4	9	16

When the exposure value ranges are evaluated in percentages, it is mentioned that values of 70% and above are very high and immediate changes should be made. In cases where the value range is 51-70%, it is expected that the exposure level is high, the work environment should be examined and changes should be made in the work environment in a short time. When it is 41-50%, the exposure level that needs further examination is acceptable when it is below 40% (McCabe, 2002).

4. Implementation

In this section, the QEC scale to be used within the scope of the study is applied to intensive care nurses working in the intensive care unit of a training and research hospital in Ankara. Our inputs are information about body exposure levels that we collect from nurses within the scope of the QEC questionnaire. As an output, it aims to identify the body parts where nurses are exposed to the most damage/weight and to measure its relationship with environmental factors.

Intensive care units are units where patients with severe conditions are observed by doctors, nurses and staff for 24 hours (Kıraner & Terzi, 2020). These severe patients; cardiovascular, respiratory, etc. They are admitted to intensive care for inadequacy in life functions and organ support treatment for reasons (Aydın & Gürsoy, 2017).

In the intensive care unit where the study was conducted, there are 20 nurses, 1 of whom is in charge. It is known that 15 of them are bachelor's degree graduates, 2 of them are associate degree graduates and the rest are graduates of health vocational high school. The nurse in charge is generally responsible for the administration and planning of the department. Accordingly, she works during working hours. Other nurses work 8-hour shifts, 16-hour shifts and 24-hour shifts. The nurse in charge prepares which nurse will work and how long they will work and their leaves by creating a monthly work schedule. When the shift schedule is analysed, it is seen that between 5-7 nurses work 8, 16 or 24 hours a day and 24-hour shifts are predominant. Nurses have leave rights such as post-shift leave, administrative leave, death leave, annual leave, prenatal leave and postnatal leave. It was found that the number of beds in the department was 10. The daily care time per patient is approximately 90 minutes in the morning, lunch and evening. This situation varies according to the patient and the care process. In general, the nurses were informed that it was done faster in the afternoon and slower in the morning. At the same time, it was learnt that the care time of the patient with a bad wound was longer. In addition to morning, lunch and evening, additional care is provided when necessary.

The sample size of the study was 19 because the nurse in charge was mostly concerned with administrative tasks. 9 people were not subjected to the scale, and the study was evaluated over 10 intensive care nurses without health problems. It is known that 2 of them were male nurses. The average age of the nurses was 31.7 years. It is known that 4 of the 10 nurses participating in the study smoked. Exposure was calculated for 4 body parts of each nurse, i.e. a total of 40 body parts. For each of the 10 nurses, 8 factors, i.e. 80 work factors in total, were observed. The entry of civilians into the intensive care unit is inconvenient due to security, health problems and hospital procedures. For this reason, direct observations were carried out by the intensive care nurse trained by the author. The observer nurse took detailed notes of the nurses' thoughts about intesnsive care and workload. She carried out her observations during 30-minute patient care processes. In other words, the observations lasted 30 minutes for each nurse.

The observer nurse preferred every other day shifts in order to observe her colleagues after counselling. She observed 3 nurses on Tuesday 9 January 2024, 4 nurses on Friday 12 January 2024 and 3 nurses on Monday 15 January 2024. After the observer nurse filled in the A, B (mobile waist), C, D, E, F and G parts of the scale, she informed and asked her colleague to fill in the H, J, K, L, M, N, P and Q parts. The author transferred the completed scales to the score table and calculated the total scores.

5. Findings

In this section, total scores were calculated by transferring the data collected from the nurses with the scale to the score table in accordance with the method. Table 5 was created with the calculated scores. In the table where the score totals of 10 nurses are given, female nurses are indicated as and male nurses are indicated as.

Table 5. Total Exposure Points Calculated in Nurses' Scoreboard

	Back	Shoulder/Arm	Wrist/Hand	Neck	Driving	Vibration	Work Pace	Stress Factor
1	46	38	38	14	1	1	4	9
2	22	30	32	16	1	1	4	9
3	28	36	36	18	1	1	4	9
4	44	32	42	16	1	1	4	9
5	38	46	36	18	1	1	4	9
6	46	38	40	16	1	1	4	9
7	32	36	42	16	1	1	9	16
8	18	18	10	8	1	1	4	4
9	34	40	20	12	1	1	9	16
10	38	34	36	16	1	1	4	9

After collecting the questionnaire data, Cronbach's Alpha test was applied in SPSS 25 statistical programme to measure the reliability of the questionnaire and the compatibility of different items with each other. As a result of the test, it was noticed that the internal consistency of the questionnaire items 'Select the degree of lumbar position of the nurse while working' and 'Select the worst shoulder/arm movement of the employee while doing the job' was low. After these items were removed, the Cronbach's Alpha value of the questionnaire was found to be 0.643. With this value, which is acceptable in the literature, the data collected from items A and D in the questionnaire were removed from the list in order to make the inferences in the rest of the study reliable.

After summing the scores in the score table, the mean and standard deviations of the scores of the nurses were calculated for each of the back, shoulder/arm, wrist/hand, neck, work tempo and stress factors. The results were evaluated according to the exposure value ranges in the literature. Exposure levels of nurses regarding body parts, work tempo and stress were determined. Table 6 shows the scores and exposure levels. Since the nurses were not exposed to vibration and driving or were exposed very little, these factors were not evaluated.

Table 6. Exposure Levels of Nurses

	Back	Shoulder/Arm	Wrist/Hand	Neck	Work Pace	Stress Factor
Exposure Score	18,2±7,91	18,8±5,89	33,2±10,34	15±3,02	5±2,11	9,9±3,57
Level	Medium	Medium	High	Very High	High	Very High

When the exposure levels of the nurses were evaluated according to the quick exposure value ranges in the literature, it was found that their necks and stress levels were at 'very high' risk, while the wrist/hand and tempo factors were at 'high' risk.

It is known that 2 of the 10 nurses who completed the scale were male. The low scores of male nurses in the score table drew attention. Accordingly, the exposure rates (%) of male and female nurses were compared. The comparison is given in Table 7.

Table 7. Percentage of Exposure of Intensive Care Nurses by Gender

	Male (%)	Female (%)
Back	24%	61%
Shoulder/Arm	29%	62%
Wrist/Hand	46%	79%
Neck	67%	88%
Work Pace	44%	58%
Stress Factor	41%	67%

As a result of the comparison, the exposure rate for all body parts and stress was higher in women than in men. Wrist/hand exposure levels are very high in women, with the neck being in the first place.

In order to increase the reliability of the survey results, the effect of independent variables (gender, smoking status and age) on dependent variables (back, neck, shoulder/arm...) is examined by using linear regression model in SPSS 25 statistical package programme. The dependent variables in the table are the variables that we examined in our study and wanted to measure the effect of independent variables (age, gender, smoking status). Independent variables are the variables that we think are likely to have an effect on the dependent variable. Beta coefficient (β) is the coefficient showing the effect of the independent variable on the dependent variable. It can be positive or negative. Standard error is the standard error of the estimated coefficient β. A lower standard error indicates that the coefficient is more reliable. Beta; shows the effect of the independent variable on the dependent variable on a standardised scale. It is used to compare the effects of different variables. t value is obtained by dividing β coefficient by its standard error. It tests whether the variable has a significant effect on the dependent variable. p-value; indicates whether the effect of the independent variable on the dependent variable is statistically significant. Generally, values less than 0.05 are considered significant. The results of the linear regression analysis are given in Table 8

Table 8. Linear Regression Analysis Results

Dependent Variable	Independent Variable	β	Standard Error	Beta	t-Value	p-Value
Back	(Constant)	-9,442	13,877		-,680	,522
	Gender	12,392	5,553	,660	2,232	,067
	Smoke	-,001	4,939	,000	,000	1,000
	Age	,168	,355	,153	,474	,652
Neck	(Constant)	9,667	6,011		1,608	,159
	Gender	3,835	2,405	,536	1,595	,162
	Smoke	1,125	2,139	,193	,526	,618
	Age	-,106	,154	-,254	-,691	,515
Shoulder/Arm	(Constant)	3,997	8,389		,476	,651
	Gender	11,388	3,357	,813	3,393	,015
	Smoke	-,351	2,985	-,031	-,118	,910
	Age	-,162	,215	-,197	-,754	,479
Wrist/Hand	(Constant)	7,514	18,161		,414	,693
	Gender	15,260	7,267	,622	2,100	,080
	Smoke	6,178	6,463	,309	,956	,376
	Age	-,368	,465	-,256	-,792	,459
Work Pace	(Constant)	1,753	4,480		,391	,709
	Gender	1,136	1,793	,227	,633	,550
	Smoke	1,907	1,594	,467	1,196	,277
	Age	-,058	,115	-,199	-,508	,629
Stress Factor	(Constant)	,146	6,057		,024	,982
	Gender	4,010	2,424	,473	1,655	,149
	Smoke	3,930	2,155	,568	1,823	,118
	Age	-,118	,155	-,238	-,763	,474

Detailed interpretation of all dependent and independent variables is given below:

Back Exposure: Gender has a significant and positive impact on back exposure (B=12.392, Beta=0.660, t=2.232, p=0.067), whereas smoking exhibits almost no effect (B=-0.001, Beta=0.000, t=0.000, p=1.000). Age demonstrates a low and non-significant effect on low back exposure (B=0.168, Beta=0.153, t=0.474, p=0.652).

Neck Exposure: The positive effect of gender on neck exposure is low and not significant (B=3.835, Beta=0.536, t=1.595, p=0.162). Similarly, the effect of smoking is low and not significant (B=1.125, Beta=0.193, t=0.526, p=0.618). The negative effect of age on neck exposure is also low and not significant (B=-0.106, Beta=-0.254, t=-0.691, p=0.515).

Shoulder/Arm Exposure: The positive effect of gender on shoulder/arm exposure is high and significant (B=11.388, Beta=0.813, t=3.393, p=0.015). The negative effect of smoking on shoulder/arm exposure is low and not significant (B=-0.351, Beta=-0.031, t=-0.118, p=0.910). Similarly, the negative effect of age on shoulder/arm exposure is low and not significant (B=-0.162, Beta=-0.197, t=-0.754, p=0.479).

Wrist/Hand Exposure: The positive effect of gender on wrist/hand exposure is high and approaches significance (B=15.260, Beta=0.622, t=2.100, p=0.080). The positive effect of smoking on wrist/hand exposure is low and not significant (B=6.178, Beta=0.309, t=0.956, p=0.376). The negative effect of age on wrist/hand exposure is low and not significant (B=-0.368, Beta=-0.256, t=-0.792, p=0.459).

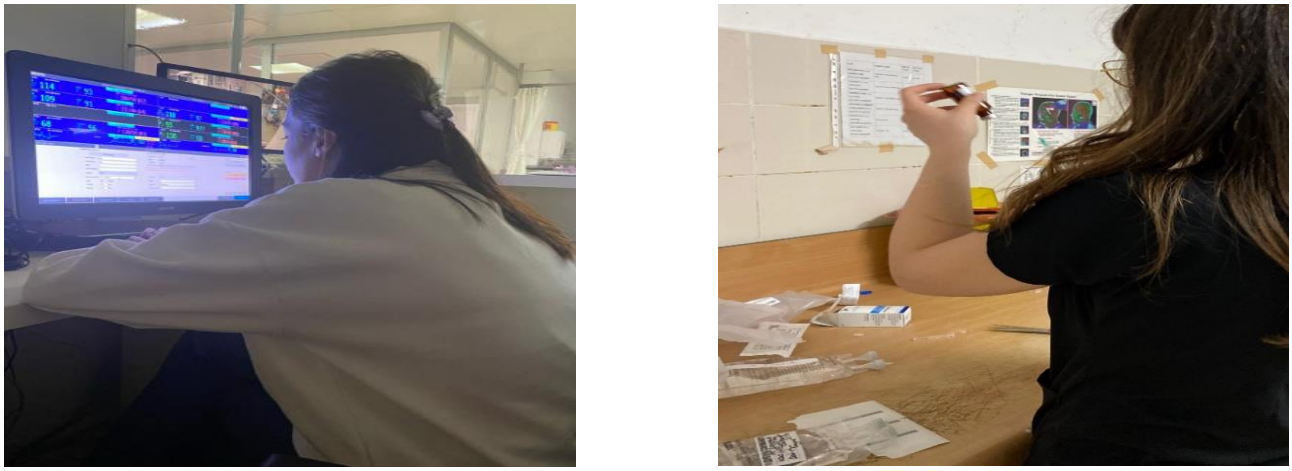
Work Pace: The positive effect of gender on work pace is low and not significant (B=1.136, Beta=0.227, t=0.633, p=0.550). The positive effect of smoking on work pace is moderate but not significant (B=1.907, Beta=0.467, t=1.196, p=0.277). The negative effect of age on work pace is very low and not significant (B=-0.058, Beta=-0.199, t=-0.508, p=0.629).

Stress Factor: The positive effect of gender on the stress factor is high and approaches significance but is not significant (B=4.010, Beta=0.473, t=1.655, p=0.149). The positive effect of smoking on stress is moderate and also approaches significance but is not significant (B=3.930, Beta=0.568, t=1.823, p=0.118). The negative effect of age on the stress factor is low and not significant (B=-0.118, Beta=-0.238, t=-0.763, p=0.474).

The correlation value of the model was found to be R=0.696. This value indicates a moderate to high positive relationship between the dependent and independent variables. In other words, increases in the independent variables tend to cause increases in the dependent variable. While nurses' gender has a significant effect on shoulder/arm exposure (p=0.015), it shows borderline statistical significance for lumbar exposure (p=0.067), wrist/hand exposure (p=0.080) and stress (p=0.149). Gender does not appear to have a significant effect on other types of exposure or work tempo. The smoking habits of nurses have no statistically significant effect on any dependent variable (p>0.05). Similarly, nurses' age has no statistically significant effect on the dependent variables (p>0.05).

The findings suggest that gender may have a distinct effect on some ergonomic risk factors, but the effects of smoking and age are generally limited. Such analyses are important for better understanding ergonomic risk factors and improving workplace conditions. Autocorrelation between smoking habits and exposure levels was examined using the Durbin-Watson test to check the assumptions of the regression model. According to the test results, positive autocorrelations indicate that the effect of smoking on specific pains or conditions is continuous and progresses in the same direction. For example, it was observed that nurses who smoke tend to have an increased likelihood of experiencing lumbar, neck, and wrist/hand pain. Negative autocorrelations, on the other hand, indicate that the effect of smoking on certain pains or conditions is fluctuating and progresses in the opposite direction. Smoking habits do not show a high variation effect in the models for shoulder/arm pain, work pace, and stress levels in nurses. As is well known, the autocorrelation value for independent variables in a regression model is expected to be 0. Values close to 1 or -1 are undesirable. In such cases, it would indicate that some independent variables should be excluded from the model. This approach helps achieve simplicity in the model.

During and after completing the survey, additional insights were gathered from the nurses. In their evaluations, nurses emphasized that attention to visual details is critical in their profession. They noted that a nurse must carefully monitor vital health measurements of patients, as this is crucial for patient safety. In Figure 1 (a), a nurse in the intensive care unit is photographed while monitoring vital signs. Regular tracking of these signs increases the chance of early intervention in potential complications. Therefore, intensive care nursing requires a job definition that demands a high level of visual attention. In Figure 1 (b), a nurse in the intensive care unit is shown adjusting medication dosage. This image highlights the importance of the visual attention factor in nurses' job descriptions. Continuous monitoring of patients at screens carries a long-term risk of lumbar and neck disorders.



a) b)

Figure 1. **(a)** Monitoring Vital Signs; **(b)** Preparation of Drug Dosages

In the intensive care unit where the research was conducted, the moment when the nurse lifted the patient during patient care hours is shown in Figure 2. The nurses stated that their bodies, especially their back and neck, were exposed to a lot of load while carrying the patient and changing the bed. Based on the visual, it can be said that the nurse's back and neck exposure is high. Exposure levels may vary depending on the patient's weight.

Figure 2. Nurse's Leaning Angle While Lifting a Patient

Nurses state that constantly facing death causes psychological strain but also makes them composed. They view this as an advantage in their professional lives but a disadvantage in their personal lives. Nurses also experience difficulties in accessing materials and resources in the hospital. Since the material storage is located far away, they face significant challenges in reaching the required supplies. This situation creates problems during patient emergencies and limits the nurses' time. In the intensive care unit in question, not only access to materials but also material shortages are prominent issues. There are occasional shortages of equipment such as creams and wound care dressings used in patient care. Additionally, the number of pillows available is insufficient.

Despite the challenges they face in their profession, nurses also encounter factors that are satisfying and motivating. One of the advantages for nurses working in the intensive care unit is the absence of the wide variety of patients typically seen in general wards. Nurses in intensive care units usually focus on a specific group of patients. This allows them to provide closer and more individualized attention to these patients. It also enables nurses to better understand the medical histories and treatment plans of their patients, resulting in more effective care.

Positive feedback from patients and their families increases nurses' commitment to their work and reduces their stress levels. Such feedback creates a more motivating work environment for them. Nurses take pride and satisfaction in serving their country while performing their duties. The emotional gratification of contributing to patient health enhances their respect for and commitment to their profession. This sense of pride helps nurses maintain high levels of motivation and contributes to their ability to perform their duties more effectively.

6. Result

Healthcare workers are known to have a high workload due to both the physical demands of their jobs and the nature of their work involving human health. In intensive care units (ICUs), the workload increases further as healthcare workers care for more critically ill patients. This study conducted an ergonomic risk assessment for musculoskeletal disorders among nurses in ICUs. According to the scale's value ranges, the risk level and stress levels for the neck region of the nurses were found to be very high. In the scoring table, neck assessments are measured using factors such as neck angle, time, and visual attention. Nurses frequently work long shifts on their feet, performing tasks like lifting and moving patients or changing beds. Additionally, tasks such as monitoring vital signs, creating care plans, and adjusting medication doses are risky and require visual attention, which becomes particularly challenging during sleepless shifts. Several factors contribute to the very high stress levels observed among nurses. Constant exposure to critically ill patients and frequent encounters with death in ICUs naturally lead to elevated stress levels.

Furthermore, nurses at the hospital where the study was conducted cited several other factors contributing to psychological strain, including: Mobbing, sleeplessness during shifts, high nurse-to-patient ratios, violence from patient relatives, inadequate salaries, insufficient resources and materials, alternate day shifts, lack of motivation sources, poor and inadequate nutrition, communication issues within the team, urgency and stress factors. Nurses also expressed concerns about their physical and mental health, which supports the results of the scale. They noted that their bodies, especially their lower back and neck, endure significant strain when lifting patients or changing beds.

The very high exposure levels for the neck region indicated by the scale align with the nurses' complaints, demonstrating the scale's accuracy. It was also observed that exposure levels were higher among female nurses compared to their male counterparts.

Regression analysis revealed that gender significantly affects exposure levels in the lower back and shoulder/arm regions. Similar findings were observed in a previous study conducted on dentists (Akpınar & Mandıracıoğlu, 2022). These studies suggest that women are more prone to musculoskeletal disorders compared to men. This difference may stem from women having less muscle mass than men and taking on more roles in their social lives.

To minimize musculoskeletal disorders among ICU nurses, reducing workload and lowering the nurse-to-patient ratio is essential. This could be achieved by hiring more healthcare staff. To address mobbing and communication issues within teams, job descriptions should be clearly defined and consistent. Additionally, locating storage areas closer to the nurses would enable quicker and less physically demanding access to equipment and medical supplies. Hospital administrations should adopt lean management principles and other optimization tools to address these issues. Such measures could help prevent time loss during patient emergencies. Future studies could explore solutions for material and storage issues based on this scale. In addition to the QEC method, ergonomic risk assessment methods incorporating environmental factors, rest periods, and anthropometric data could be integrated to create a hybrid model. This model could enable practical improvements in ICU units.

This study does not require ethics committee approval or any special permission. The authors confirm that there is no data revealing the identities or personal information of individuals or institutions, nor any data that could create an ethical conflict. All responsibility in this regard rests with the authors.

References

Akpınar, C. V. & Mandıracıoğlu, A. (2022). Association Between Work-Related Musculoskeletal Disorders and Quick Exposure Check Results In Dentists. Nobel Medicus, 18(3), 187-193.

Aydın, A. & Gürsoy, A. (2017). A Voice in the Intensive Care: ‘I’m here’. Journal of Academic Research in Nursing. doi:10.5222/jaren.2017.097.

Bidiawati, J. R. A. & Suryani, E. (2015). Improving the Work Position of Worker’s Based on Quick Exposure Check Method to Reduce the Risk of Work Related Musculoskeletal Disorders. Procedia Manufacturing, 4(2015), 496-503. doi:10.1016/j.promfg.2015.11.068.

Bozkurt, S., Demirsoy, N. & Günendi, Z. (2016). Risk Factors Associated With Work-Related Musculoskeletal Disorders In Dentistry. Clinical and Investigative Medicine, 39(6), 192-196. doi:10.25011/cim.v39i6.27527.

Bulduk, E. Ö., Bulduk, S., Süren, T. & Ovalı, F. (2014). Assessing Exposure To Risk Factors For Work-Related Musculoskeletal Disorders Using Quick Exposure Check (QEC) In Taxi Drivers. International Journal of Industrial Ergonomics, 44(6), 817-820. doi:10.1016/j.ergon.2014.10.002.

Celestino, J. C., Peña, C. S., Ramos, J. M. H. & Jiménez, V. L. (2022). Evaluación Ergonómica Con Quick Exposure Check (QEC) Para La Detección De Trastornos Musculoesqueléticos. Revista Ingeniería y Gestión Industrial, 1(1), 28-37. doi:10.29105/revig1.1-8. Chiasson, M.-È., Imbeau, D., Aubry, K. & Delisle, A. (2012). Comparing The Results Of Eight Methods Used To Evaluate Risk Factors Associated With Musculoskeletal Disorders. International Journal of Industrial Ergonomics, 42(5), 478-488. doi:10.1016/j.ergon.2012.07.003.

Comper, M. L. C., Costa, L. O. P. & Padula, R. S. (2012). Clinimetric properties of the Brazilian-Portuguese version of the Quick Exposure Check (QEC). Brazilian Journal of Physical Therapy, 16(6), 487- 494. doi:10.1590/S1413-35552012005000049.

Dalkılınç, T. (2021). The Relationship Between Physical Ergonomic Risk Factors and Perceived Workload: an Application in the Textile Industry. (Master's Thesis), Izmir University of Economics, Izmir, Türkiye.

David, G., Buckle, P., & Woods, V. (2005). Further Development Of The Usability And Validity Of The Quick Exposure Check (QEC). Health & Safety Executive.

David, G., Woods, V., Li, G. & Buckle, P. (2008). The Development Of The Quick Exposure Check (QEC) For Assessing Exposure To Risk Factors For Work-Related Musculoskeletal Disorders. Applied Ergonomics, 39(1), 57-69. doi:10.1016/j.apergo.2007.03.002.

Ericsson, P., Björklund, M. & Wahlström, J. (2012). Exposure Assessment in Different Occupational Groups at a Hospital Using Quick Exposure Check (QEC) – A Pilot Study. Work, 41(1), 5718-5720. doi:10.3233/WOR-2012-0929-5718.

Esmaeili, R., Shakerian, M., Esmaeili, S. V., Jalali, M., Pouya, A. B. & Karimi, A. (2023). A Multicomponent Quasi-Experimental Ergonomic Interventional Study: Long-Term Parallel Four-Groups Interventions. BMC Musculoskeletal Disorders, 24(1), 107. doi:10.1186/s12891-023-06220-4.

Fijačko, N., Masterson Creber, R., Metličar, Š., Gosak, L. & Štiglic, G. (2024). Nurses' Occupational Physical Activity And Workload İn A Perioperative İntensive Care Unit İn Slovenia. Preventive Medicine Reports, 37, 102543. doi:10.1016/j.pmedr.2023.102543.

Inalçuk, E. (2019). Investıgatıon Of Ergonomıc Risks in Manufacturing Sector Using Quıck Exposure Check Method. (Master's Thesis), Middle East Technical University, Ankara, Türkiye.

Kâhya, E. & Söylemez, S. (2019). Ergonomic Risk Assessment By Using QEC and REBA Methods in Rim Sector. Karaelmas Journal of Occupational Health and Safety, 3(2), 83-96. doi:10.33720/kisgd.644584.

Karimi, A., Dianat, I., Barkhordari, A., Yusefzade, I. & Rohani-Rasaf, M. (2020). A Multicomponent Ergonomic İntervention İnvolving İndividual And Organisational Changes For İmproving Musculoskeletal Outcomes And Exposure Risks Among Dairy Workers. Applied Ergonomics, 88, 103159. doi:10.1016/j.apergo.2020.103159.

Kıraner, E. & Terzi, B. (2020). The Role of the Intensive Care Nurse in the COVID-19 Pandemic Process. Izmir Kâtip Çelebi Faculty of Health Sciences Journal, 24, 83-88.

Korkmaz, Ö. A., & Ünver, M. (2024). The ergonomic posture assessment by comparing REBA with RULA & OWAS: A case study in a gas springs factory. Sigma Journal of Engineering and Natural Sciences, 42(6).

Li, G., & Buckle, P. (1998). A Practical Method For The Assessment Of Work-Related Musculoskeletal Risks-Quick Exposure Check (QEC). In Proceedings Of The Human Factors And Ergonomics Society Annual Meeting 42(19), 1351-1355.

McCabe, P. T. (2002). Contemporary Ergonomics 2003. CRC Press.

Mert, E. A. (2014). Ergonomik Risk Değerlendirme Yöntemlerinin Karşılaştırılması ve Bir Çanta İmalat Atölyesinde Uygulanması. (Occupational Health and Safety Specialization Thesis), Republic of Turkey Ministry of Labor and Social Security, Ankara.

Mirmohamadi, M., Seraji, J. N., Shahtaheri, J., Lahmi, M. & Ghasemkhani, M. (2004). Evaluation of Risk Factors Causing Musculoskeletal Disorders Using QEC Method in a Furniture Producing Unite. Iranian Journal of Public Health, 33(2), 24-27.

Oliv, S., Gustafsson, E., Baloch, A. N., Hagberg, M. & Sandén, H. (2019). The Quick Exposure Check (QEC)—Inter-Rater Reliability İn Total Score And İndividual İtems. Applied Ergonomics, 76, 32-37. doi:10.1016/j.apergo.2018.11.005.

Özcan, E., Sakar, K. N., Alptekin, H. K., & Özcan, E. E. (2007). The Reliability Of Turkish Translation Of Quick Exposure Check (QEC) For Risk Assessment Of Work Related Musculoskeletal Disorders. Istanbul Tıp Fakultesi Dergisi, 70(4), 98-102.

Park, H.-S., Kim, J., Roh, H.-L. & Namkoong, S. (2015). Analysis Of The Risk Factors Of Musculoskeletal Disease Among Dentists İnduced By Work Posture. Journal of Physical Therapy Science, 27(12), 3651-3654. doi:10.1589/jpts.27.3651.

Sukadarin, E. H., Deros, B. M., Ghani, J. A., Ismail, A. R., Mokhtar, M. M. & Mohamad, D. (2013). Investigation of Ergonomics Risk Factors for Musculoskeletal Disorders among Oil Palm Workers Using Quick Exposure Check (QEC). Advanced Engineering Forum, 10, 103-109. doi:10.4028/www.scientific.net/AEF.10.103.

Ulutaş, İ. B. & Gündüz, T. (2017). Ergonomic Risk Analysis in Production of Automotive Wire. Uludağ Üniversitesi Mühendislik Fakültesi Dergisi, 22(2), 107-120. doi:10.17482/uumfd.336440