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Research Article

Evaluation of Ergonomic Risks Among Factory Workers in Different Sectors

Farklı Sektörlerdeki Fabrika Çalışanlarının Ergonomik Risk Açısından Değerlendirilmesi

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ABSTRACT

Purpose: This research was conducted to assess the ergonomic risks of factory workers in different sectors. **Material and Methods:** The study was carried out with 97 participants from three different sectors in the province of Gaziantep. A sociodemographic data form was used to collect demographic information about the participants, and the Quick Exposure Check (QEC) was applied to assess the risk factors. **Results:** A total of 97 participants were included in the study: 21 from the heavy industry sector, 17 from the food sector, and 59 from the textile sector. Of the participants, 34% were between 20-30 years old, 44.3% were between 31-40 years old, and 21.6% were between 41-50 years old. Based on the action category of the QEC, 1 participant was in the first category (<40%=acceptable), 4 in the second category (41-50%=investigate further investigation), 75 in the third category (51-70%=investigate further and change soon), and 17 in the fourth category (>70%=investigate and change immediately). Except for gender, smoking and education level, the groups were similar in terms of factors such as age, marital status, and alcohol use. Although the proportions of the QEC categories were more similar among heavy industry and textile workers than among food workers, there was no significant difference between the groups (p=0.153).**Discussion:** As a result of the risk assessments of workers in three different factories in Gaziantep, although there is no significant difference between individuals in different sectors in terms of ergonomic risk, in general, the majority of workers are at medium-high level ergonomic risk. Different parts of the body of factory workers are affected by risk factors at different rates.

Keywords: Ergonomics; Occupational health; Risk assessment.

ÖZ

Amaç: Bu araştırma, farklı sektörlerdeki fabrika çalışanlarının ergonomik risklerinin değerlendirilmesi amacıyla gerçekleştirildi. **Gereç ve Yöntem:** Çalışma, Gaziantep ilinde bulunan üç farklı sektörden toplam 97 katılımcı ile gerçekleştirildi. Katılımcıların demografik bilgileri için sosyodemografik veri formu ve risk faktörlerinin değerlendirilmesi için Hızlı Maruziyet Değerlendirilme Ölçeği kullanıldı. **Sonuçlar:** Ağır sanayi sektöründen 21 kişi, gıda sektöründen 17 kişi ve tekstil sektöründen 59 kişi olmak üzere toplamda 97 kişi dâhil edildi. Katılımcıların %34'ü 20-30 yaş, %44,3'ü 31-40 yaş ve %21,6'sı 41-50 yaş aralığında idi. Hızlı Maruziyet Değerlendirme Ölçeğinin eylem kategorisine göre katılımcıların 1'i ilk kategoride (kabul edilebilir), 4'ü ikinci kategoride (daha fazla incelenmeli), 75'i üçüncü kategoride (kısa zamanda değişiklik yapılmalı) ve 17'si dördüncü kategoride (derhal değişiklik yapılmalı) idi. Gruplar cinsiyet, sigara kullanımı ve eğitim seviyesi haricinde; yaş, medeni durum, vs. etkenler açısından benzerdi. Hızlı Maruziyet Değerlendirme Ölçeğinin kategorileri ağır sanayi ve tekstil işçilerinde gıda sektöründekilere kıyasla daha benzer oranlara sahip olmasına rağmen, gruplar arası karşılaştırmada anlamlı bir fark bulunmamıştır (p=0,153).**Tartışma:** Gaziantep ilinde yer alan üç farklı fabrikadaki işçilerin risk değerlendirmeleri sonucunda farklı sektörlerdeki bireylerin arasında ergonomik risk açısından anlamlı bir fark bulunmamakla birlikte, genel olarak çalışanların büyük çoğunluğu orta-yüksek düzeyde ergonomik risk altındadır. Fabrikada çalışan bireylerin vücutlarının farklı bölümleri, risk faktörlerinden farklı oranlarda etkilenmektedir.

Anahtar Kelimeler: Ergonomik; İş sağlığı; Risk değerlendirmesi.

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The term ergonomics, derived from the Greek words ergon (work) and nomos (law), was adapted into Turkish as "ergonomi" by the Turkish Language Association. It is defined as the scientific field or discipline that examines human-machine characteristics and the harmony between these characteristics (Sabancı and Sümer, 2015). Factors such as work style, work duration, equipment used during work, and the work environment contribute to musculoskeletal problems in the workplace. Consequently, ergonomics has become a crucial cornerstone for worker health and productivity in industry (Yalçın ve Ayvaz, 2018).

It is important for employees to work in ergonomically suitable environments. In industry, there is a prevailing notion that a relationship exists between health, illness, and work in the context of providing working conditions that are compatible with human physiological characteristics (Berry, 2009). The primary advantage of an ergonomically appropriate work environment is that it helps protect employee health, prevents workday losses due to discomfort or illness, and avoids negative impacts on work capacity, thereby enabling more efficient work. Ergonomic adjustments in a well-organized work environment significantly reduce potential workplace accidents and allow employees to work in a healthy and productive setting (Berry, 2009).

Evaluating work processes from an ergonomic perspective supports employees in working in a suitable and safe environment, helping to protect them from musculoskeletal disorders. This is essential as deformations in the human body can lead to an increase in workplace accidents. Ergonomics aims to minimize these negative effects (Akay, Dağdeviren ve Kurt, 2003). According to the Occupational Health and Safety Law, risk assessment is defined as “the necessary procedures conducted to identify existing or potential external hazards in workplaces, to analyze and grade the factors causing these hazards to transform into risks, and to determine control measures to manage these risks” (Korkmaz ve Avsallı, 2012). The primary goal of conducting risk assessments is to ensure the ongoing health and safety of personnel. Additionally, risk assessment seeks to protect both the workplace and the surrounding environment, which could potentially be harmed by workplace activities (Akpınar, Çakmakkaya and Batur, 2018).

Risk factors for Work-Related Musculoskeletal Disorders (WRMDs) include working in poor posture, inappropriate positioning, stress, vibration, repetitive movements, heavy lifting, force exertion, pushing and pulling actions, prolonged work hours, equipment incompatibility, tasks involving intense movements, and lack of attention to ergonomics (Akbal, Eroğlu, Yılmaz et al., 2012). Therefore, ergonomic risks are critical for employees' health and working life. These ergonomic risks directly impact employee health, productivity, and job satisfaction. Such risk factors can increase not only physical stress but also mental stress in the workplace, leading to injuries and workforce loss (Bazaluk, Tsopa, Cheberiachko et al., 2023). Reducing ergonomic risks lowers costs associated with workplace accidents and illnesses, ultimately reducing long-term costs for companies (Statistics, 2015). Additionally, it enhances employees' job satisfaction and their commitment to the workplace (Dul and Neumann, 2009). Therefore, identifying ergonomic risk factors in the workplace is an essential step for both employees and employers.

Based on this information, our study aims to analyze ergonomic risks among factory workers in different sectors and to identify differences in ergonomic risk levels across sectors.

MATERIALS AND METHODS

Participants

The study was conducted in September 2023 and involved voluntary participants from three distinct sectors: food, textile, and heavy industry, all situated in Gaziantep. Prior to the commencement of the research, ethical approval was obtained from the relevant committee, and the study adhered to the principles outlined in the Helsinki Declaration. The participants were thoroughly informed about the study's objectives, and written consent was secured from each individual. Eligibility criteria included individuals aged 18 to 65 who were proficient in Turkish and voluntarily agreed to participate. Exclusion criteria comprised those utilizing assistive devices, those with a history of surgical interventions, and those presenting with pre-existing orthopedic and/or neurological conditions.

Assessment Tools

Sociodemographic Data Form: Information regarding participants' age, gender, place of residence, social security, marital status, alcohol use, smoking habits, housing situation, education level, income level, and chronic illnesses was collected using a sociodemographic data form.

Quick Exposure Check (QEC): The original tool, "Quick Exposure Check", developed by Li and Buckle in 1998, was employed for ergonomic risk analysis (Li and Buckle, 1998). Validity and reliability studies in Turkish were conducted by Özcan et al. (Özcan, Kesiktas, Alptekin et al., 2008). The scale consists of two sections and sixteen questions. It not only asks participants questions to identify the ergonomic risks they are exposed to but also

includes the observer's assessments. The observer's evaluation consists of a checklist that assesses the worker's back, shoulder/arm, wrist/hand, and neck postures. The section to be filled out by the worker includes questions evaluating the maximum weight lifted by hand, the average time spent performing tasks, the maximum force exerted with one hand, the required level of visual attention for the task, the use of vehicles, the use of vibrating tools, and the speed and stress factors associated with the task. By combining the responses to the relevant questions, a total HMD (Health Management Development) score is obtained, which is then used to determine the risk level. HMD scores for body regions are obtained based on the specific work being performed (Özcan, Kesiktas, Alptekin et al., 2008). Once the assessments by the worker and the observer are completed, the risk exposure value for each body region is determined by summing the intersection points of each pair of letters evaluated using the QEC score sheet. To determine the categories of action, the total percentage is calculated following the calculation of the exposure score. A specific formula is employed to derive this percentage, which corresponds to four distinct levels of action (Brown and Li,2003).

1- Acceptable
2- Investigate further
3- Investigate further and change soon
4- Investigate and change immediately

In our research, these categories were taken as a basis for comparing the risk status of participants. While the data for the section filled by the employee was collected through face-to-face interviews, the section filled by the observer was completed by the researchers through observation at the workplace.

Statistical Analysis

The data obtained from the study were analyzed using SPSS version 26.0. The independent variables were defined as age, gender, place of residence, social security status, marital status, alcohol consumption, tobacco use, type of residence, living environment, educational level, income level, and chronic illnesses. Chi-square tests (Fisher's exact test) were employed to compare categorical data. A significance level of $p < 0.05$ was accepted (Hayran, 2012).

RESULTS

A total of 97 participants were included in the study, consisting of 21 individuals from the heavy industry sector, 17 from the food sector, and 59 from the textile sector (16 females and 81 males). Among the participants, 34% were aged between 20 and 30 years, 44.3% were between 31 and 40 years, and 21.6% were between 41 and 50 years. The demographic characteristics – age, marital status, alcohol consumption, and place of residence – showed no significant differences across the three sectors ($p > 0.05$). There was a statistical difference between the groups in terms of gender, tobacco use, and educational status ($p < 0.05$). Male and primary school graduate employees were higher in the food and textile sectors. The number of employees with high school degrees was higher in the heavy metal industry. Marital status was identified as 83.5% married, 14.4% single, and 2.1% widowed. Additionally, 97.9% of the participants did not consume alcohol, while 2.1% reported alcohol consumption. Tobacco use revealed that 58.8% of the participants did not smoke, 4.1% smoked occasionally, 17.5% consumed one pack per week, and 19.6% smoked one pack daily. Regarding educational status, 3.1% were illiterate, 45.4% completed primary school, 32% completed middle school, 13.4% graduated from high school, and 6.2% held a university degree. No significant differences were found in gender, tobacco use, and educational levels among the participants ($p < 0.05$). In terms of living arrangements, 36.1% resided in flats, while 63.9% lived in standalone houses (Table 1).

Table 1. Sociodemographic data

		Sector						
		Food		Textile		Heavy Industry		
		n	%	n	%	n	%	p
Age	20-30	6	18,2%	23	69,7%	4	12,1%	0,285
	31-40	8	18,6%	26	60,5%	9	20,9%	
	41-50	3	14,3%	10	47,6%	8	38,1%	
Gender	Female	3	18,8%	13	81,3%	0	0,0%	0,012*
	Male	14	17,3%	46	56,8%	21	25,9%	
Marital Status	Married	13	16,0%	50	61,7%	18	22,2%	0,522
	Single	4	28,6%	7	50,0%	3	21,4%	

Table 1 (continue)

Alcohol Use	**No**	16	16,8%	59	62,1%	20	21,1%	0,147
	Yes	1	50,0%	0	0,0%	1	50,0%	
Tobacco Use	**Non-smoker**	10	17,5%	37	64,9%	10	17,5%	0,037*
	Occasional Smokers	2	50,0%	2	50,0%	0	0,0%	
	Weekly Smokers (1 pack per week)	0	0,0%	12	70,6%	5	29,4%	
	Daily Smokers (1 pack per day)	5	26,3%	8	42,1%	6	31,6%	
Educational Status	**Illiterate**	2	66,7%	0	0,0%	1	33,3%	0,001*
	Primary School	8	18,2%	31	70,5%	5	11,4%	
	Middle School	2	6,5%	24	77,4%	5	16,1%	
	High School	1	7,7%	4	30,8%	8	61,5%	
	University	4	66,7%	0	0,0%	2	33,3%	
Type of Residence	**Flat**	5	14,3%	19	54,3%	11	31,4%	0,218
	Standalone House	12	19,4%	40	64,5%	10	16,1%	

p: Statistical significance. "" indicates a statistical difference. (p < 0,05)*

According to QEC's action categories, 1 participant was in the first category (<40% = Acceptable), 4 in the second category (41-50% = Investigate further), 75 in the third category (51-70% = Investigate further and change soon) and 17 in the fourth category (>70% = Investigate and change immediately) (Table 2).

Table 2. Distribution of QEC action categories for all participant

Categories		n	%
1.	**<%40**	1	1.04
2.	**%41-50**	4	4.12
3.	**%51-%70**	75	77,32
4.	**>%70**	17	17,52
	Total	97	100,0

In the food sector, 52.90% of the employees were in the third action category, while 29.4% were in the fourth action category. In the heavy industry group, 81% of workers were in the third action category, while no one was in the first action category.

In the textile sector, like the heavy industry group, 83.1% of workers were in the third action category. Like in the heavy industry, none of the workers in the textile group were in the first action category. The analyses revealed no statistically significant differences between the action categories of workers in different industrial sectors (p>0.05) (Table 3).

Table 3. Relationship between QEC action categories and sector

			Quick Exposure Check Action Categories				p
			<%40	%41-%50	%51-%70	>%70	
Sector	Food	n	1	2	9	5	0,153
		%	5,9%	11,8%	52,9%	29,4%	
	Heavy Industry	n	0	1	17	3	
		%	0,0%	4,8%	81,0%	14,3%	
	Textile	n	0	1	49	9	
		%	0,0%	1,7%	83,1%	15,3%	

p: Statistical significance.

The evaluation of body regions across the participants in the three sectors yielded the following average values: hand/wrist (27.69 ± 5.0), shoulder/arm (27.63 ± 5.49), back (25.07 ± 4.82), and neck (15.05 ± 3.55) (Table 4).

Table 4. Mean Values of four body regions in the QEC for all participants

	Minimum	Maximum	Mean
Back	10	44	25,07 ± 4,82
Shoulder/Arm	10	48	27,63 ± 5,49
Hand/Wrist	10	42	27,69 ± 5,00
Neck	4	18	15,05 ± 3,55

DISCUSSION

In this study, ergonomic risk analysis was conducted among factory workers in different sectors, revealing that the ergonomic risk levels for employees in the food, textile, and heavy industry sectors were similar. Notably, only 1% of the workers were found to have ergonomically suitable working conditions, while 17% required ergonomic assessment and intervention. The development of work-related musculoskeletal disorders is attributed to various physical working conditions, such as repetitive activities, excessive physical demands, heavy lifting, vibration exposure, and frequent forward bending (Tanır, Güzel, İşsever et al., 2013; Türkkan, 2009). A study examining musculoskeletal disorders among women working in the textile sector found that wrist problems occurred in an average of 41% of cases (Comper, Macedo and Padula, 2012). Additionally, a study by Tsigonia et al. reported that among workers in the cosmetics sector, the most commonly reported musculoskeletal disorders in the past 12 months were neck, lower back, and wrist issues (Tsigonia, Tanagra, and Linos, 2009). In another study conducted by Bakırcı et al., it was observed that nearly 85% of textile workers complained of lower back pain (Bakırcı, Torun, Sülkü et al., 2007). Similarly, among workers in the heavy industry engaged in assembly and welding tasks, neck, lower back, and wrist complaints were prevalent (Yüşün, Tunalı, Çetinkaya et al., 2019). In our study, when assessing the body regions of the participants across three factories, the mean values were determined as follows: hand/wrist (27.69), shoulder/arm (27.63), waist (25.07), and neck (15.05). Although the priority of complaints varied by sector, generally, complaints related to back, neck, shoulders, arms, elbows, and wrists were significantly more common among the workers. Furthermore, despite the differences in sectors, a higher prevalence of upper extremity complaints indicates that the upper extremities are among the most affected areas in occupational health.

The identification and documentation of ergonomic risks in workplace environments, along with the evaluation of employee exposure levels, are outlined in various regulations in Türkiye (Engür, and Chaushogly, 2019). In our study, we found that only 1% of the workers examined could be deemed as having acceptable exposure levels. The ergonomic risks across the three sectors were observed to be similar, indicating that these risks do not vary significantly by sector. This underscores the necessity for a more detailed investigation of ergonomic risks in the food, textile, and heavy industries, as well as the urgent need for interventions.

Increasing social awareness regarding ergonomics can be achieved through public or worker-focused symposiums, conferences, and workshops. Furthermore, improving existing ergonomic practices within legislation and conducting regular workplace inspections can help reduce the incidence of work-related musculoskeletal disorders. These musculoskeletal issues not only diminish

the quality and productivity of production and labor processes but also contribute to increased time wastage and costs (Ertaş and Kızılaslan, 2015). In Gaziantep, an industrial city, ergonomic conditions should be specifically tailored to sectoral needs, and collaboration with physiotherapists could effectively reduce musculoskeletal disorders among workers, thereby further enhancing productivity.

Limitations of the Study

One of the main limitations of our study is that the population consisted solely of workers from Gaziantep province. Additionally, another significant limitation is the lack of separate assessment of the participating workers by gender, despite the potential for variations in work-related musculoskeletal disorders across different gender identities.

Ethical Approval

The study was approved by the SANKO University Ethics Commission (registration number 2019/03-16) and conducted in consideration of Helsinki's Declaration principles.

Authors' Contribution

The authors confirm contribution to the paper as follows: study conception and design: HİE; data collection: FA, FÇ; analysis and interpretation of results: HİE, SY, FA; draft manuscript preparation: HİE, FA; revising the manuscript critically: HİE, SY, NE. All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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