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Article

Ergonomic Evaluation of Nail Technicians with Quick Exposure Check

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Abstract: Background/Objectives: Nail technicians frequently have musculoskeletal pain, which impairs their job performance .A high-risk profession linked to back discomfort that causes morbidity is nail technician. QEC is a tool used for observing and assessing risks in a work environment. The goal of this research is to assess the ergonomic risks, pain, and their relationship with posture among manicurists. **Methods:** The 35 nail technicians filled the assessment form which consists of occupational information, pain, European Community Respiratory Health Survey, Nordic Musculoskeletal Questionnaire and QEC worker part. Physicians assessed nail technicians' workspace and QEC outcomes . **Results:** It was stated that they worked an average of 61.92±11.09 hours per week, served an average of 11±5 customers per day, and their condition lasted 53.96±36.51 months.There is a strong significant correlation between discomforts, time spent in occupation (p=0,000) and working hours. Manicure, pedicure, unwanted hair removal, correction of eyebrow were considered for ergonomic risk evaluation. Each occupation accompanied repeated bad postures. Most of them were scored in very high risk categorisation for back static positions (more than 29 point). **Conclusions:** This study may be useful for nail technicians seeking ergonomic improvements in the areas of engineering, administration, behavior, or personal.

Keywords: ergonomics; physical; health; occupational; assessment; health risk

1. Introduction

Health is defined as "not merely the absence of disease or infirmity, but a state of complete physical, mental, and social well-being." by the World Health Organization. There is a bidirectional relationship between health and work. The work environment can enhance health by enabling employees to be more productive, socially active, and economically better off. However, while performing their duties, employees encounter numerous factors in the workplace that can pose health risks. All tools, machines, chem-ical substances, heat, cold, noise, light, radiation, dust, biological agents, and ergonomic and psycho-social hazards present in the workplace environment can affect the health of employees. As a result of these hazards, occupational diseases and work-related accidents may occur [1].

Work-related musculoskeletal disorders (WMSDs) arising from work-related activ-ities are a prevalent health issue and a primary contributor to disability in developed na-tions. [2–6]. The cost to society of WMSDs is high due to lost workdays and insurance compensation payments [7]. The factors related to the workplace, such as physical work load (strain, posture, mobility, and vibration), psychosocial stress factors, and individual characteristics have been shown to have an impact on the development of work-related musculoskeletal disorders (WMSDs). [4–6,8–10].

In recent years, initiatives by the European Union and member states have led to significant interest in identifying and controlling "risk factors" associated with WMSDs and implementing ergonomic interventions in the workspace [11,12]. In our country, WMSDs are legally recognized as

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occupational diseases [13]. However, employers, em-ployees, and physicians do not sufficiently recognize them in this regard. Research on the frequency of WMSDs, risk factors, lost workdays, insurance compensations, costs, pre-vention education, and the effectiveness of ergonomic interventions is inadequate. Tools that evaluate exposure to risk variables have not been established. [3,14]. Alongside these studies, various techniques have been developed to evaluate exposure to risks and changes in exposure for WMSDs, which is a preventable condition [15–19]. Observational approaches, experimental or direct methods, self-report methods, and other psychophysiological methods are some of these techniques.

In the scientific literature, observational and survey-based methods are still used to identify ergonomic risk dimensions in many jobs and processes [20]. WMSDs are not conditions that develop suddenly; they occur due to the repetition, frequency, and con-tinuity of improper movements [21]. Among occupational diseases, musculoskeletal system disorders are the most common. WMSDs account for 50% of all occupational disease cases. In Europe, one in four workers reports back (24.7%) and muscle pain (22.8%) [22]. In our country, hairdressers, beauty salons, and nail salons are classified as hazardous work areas. They are classified within social and personal services by Occu-pational Safety and Health Administration [23] and the Turkish Vocational Qualifications Authority (TVQA) [24]. The products used in these salons often contain harmful chemi-cals. For example, nail products like polishes, strengtheners, removers, and artificial nail liquids can contain a variety of chemicals. Prolonged exposure to these chemicals, de-pending on their concentration, can cause damage to the body, resulting in allergies and respiratory disorders over time [25].

Because of their job tasks, nail technicians are a professional population at risk for musculoskeletal discomfort and ergonomic risk factors.They frequently perform repet-itive movements using their upper extremities and work for extended periods in incorrect postures.It's critical to ascertain the working environments where these repetitive postures and bodily motions occur. WMSDs include common actions like grasping, extending, gripping, straightening, reaching, and bending [26,27]. During routine daily tasks, these normal movements are safe. Their detrimental effects stem from the motions' constant repetition, rapid execution, and lack of rest periods in between them [26,28]. Among those who perform manicures and pedicures, musculoskeletal disorders, pain, or injuries are common, leading to more time off work, worse productivity and job performance, and even early retirement.

Manicurists and pedicurists are in a high-risk profession associated with musculo-skeletal pain, morbidity, and decreased productivity, and they tend to maintain poor working postures for extended periods [29–32].

To prevent and control WMSDs, it is essential to manage all identified risks, partic-ularly ergonomic risks, through workplace risk assessments. Additionally, WMSDs ed-ucation and management efforts must be implemented [13]. The aim of this study is to evaluate the ergonomic risk factors faced by individuals performing manicures and pedicures and to examine the relationships between these factors.

2. Materials and Methods

2.1. The Study Protocol

Nail salons from four rural and urban areas (Bahçelievler, Küçükçekmece, Bey-likdüzü, Esenyurt) on the European side of Istanbul participated the study. To de-termine the sample size, it was found that 29 participants were needed for the study to achieve a medium-level correlation (r=0.5) using Pearson correlation test with 80% power and a 0.05 type 1 error [33].

The data for the study were collected from 35 nail technicians working in 14 different types of salons across four districts of Istanbul, with an average age of 25.37 ± 7.19 years. All nail technicians were female. An interviewer-administered survey based on adaptations of the European Community Respiratory Health Survey [34] and the Nordic Musculoskeletal Questionnaire (NMQ) [35] was conducted with all participants.

The Nordic Musculoskeletal Questionnaire (NMQ), developed by Kuorinka in 1987 to measure musculoskeletal pains, was used [35]. It has been adapted and expanded into the Extended Version

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of the Nordic Musculoskeletal Questionnaire (NMQ-E) [36]. In the NMQ-E, monthly pain assessment questions for body parts were retained, and yearly pain assessment questions were added to capture acute and subacute symptoms. The body is divided into 9 regions: neck, shoulders, upper back, elbows, hands/wrists, lower back, hips/thighs, knees, and ankles/feet. It queries the presence of issues in these regions, the age at which the issues began, hospitalization due to the problem, medication use, sick leave from work, job changes, and disruptions in work tasks [35].

Records of the health and safety training received by employees, along with infor-mation about their occupational health and safety, were kept. Inquiries about musculo-skeletal, respiratory, and skin conditions were also made. The definition of work-related symptoms was those that became worse at work or got better on days off. Participants filled out an assessment form that included occupational information, details about pain experienced, and the "worker's assessment" section of the Quick Exposure Check (QEC). Four physical therapy and rehabilitation specialist physicians trained in QEC evaluated nail technicians and their workplaces using QEC. The QEC Scale was developed by Li and Buckle in 1998 [15] and revised by Woods, David, and Buckle in 2003 to improve its effectiveness [17].Norwegian and French translations of the scale are available and the scale has been used in several other countries including Spain, Singapore, Brazil, South Korea, South Africa, Saudi Arabia and Iran [37–40]. It was also translated into Turkish in 2008 [41]. Health and safety authorities in Canada and the UK have developed guide-lines for WMSDs risks based on this method [42]. One of the significant features of the scale, de-veloped with a participatory approach involving approximately 200 health and safety practitioners, is ensuring the participation of workers in the assessment process. This encourages a participatory approach in ergonomic interventions [15,17]. The QEC scale, which assesses the level of risk workers are exposed to and evaluates changes in exposure, helps prioritize tasks requiring ergonomic intervention and assesses the effec-tiveness of implemented ergonomic programs.

QEC, both a guide for workers and assessors. It consists of two parts: the observer's section involves assessments of movements and posture in the neck, shoulder/arm, wrist/hand, and back during work in 18 items. The worker's section includes 25 as-sessments for manually lifting the heaviest weight, duration of tasks, maximum force applied with one hand, visual attention required by the task, vehicle operation, vibration, job performance and job stress. An interaction between these assessments produces a scoring table. Ex-posure levels (Table 3) are classified as low, medium, high, and very high based on these scores [17].

The study is approved by local Clinical Research Ethics Committee of SBU Istanbul PMR Training and Research Hospital) with protocol number 2023-12. The study was conducted in accordance with the ethical standards of the committee responsible for human experimentation and the Helsinki Declaration. Informed consent was obtained from all participants. None of the authors of the article have studies involving animal experiments.

2.2. Statistical Analysis

The statistical package for social scientists (v10.0; SPSS Inc., Chicago, IL) was used for all data analyses. The Kolmogorov-Smirnov or Shapiro-Wilk tests were used to determine whether the variables had a normal distribution. For regularly distributed data, descriptive analyses displayed means and standard deviations; for nominal and ordinal variables, counts and percentages (%) were utilized. Regression analysis was used to look at dependent factors, while Spearman and Pearson correlation tests were used to assess relationships between variables. A p-value of less than 0.05 was deemed statistically sig-nificant.

3. Results

All participants were female and used their right hand. Out of 35 employees, 21 smoked cigarettes, with 7 out of these 21 having quit smoking. Demographic data are presented in Table 1.

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Table 1. Demographic data.

	Mean±SD / Rate (%)		Min-Max
Age	25.37±7.19		18-40
Gender F/M	35/0		
Job Duration	10.92±6.5		3-23
Hours worked per week	61.92±11.09		
Number of clients served per day	11±5		
Education (high school/middle school)	19/16		
Married/single	15/20		
Rate of smoking	21/35	%60	
Rate of quitting smoking among those who smoked	7/21	%30	
Rate of respiratory problems	13/35	%37	
Rate of shortness of breath when tired	12/35	%34	
Rate of eczema	5/35	%14	
Rate of eye irritation	5/35	%14	
Rate of headaches	10/35	%28	

Four participants were also owners of the workplace. The age range of nail technicians varied from 18 to 40 years, with 100% performing manicures and 97% performing pedicures. Nearly half (51%) of technicians reported applying gel nail extensions, and all technicians reported using nail hardeners and polishes. The majority (97%) indicated that decisions on which brand products to use in the salon were made by the salon owner; it was reported that the opinions of customers (3%) and staff (3%) were also taken into account occasionally. Technicians had extensive experience in manicure and pedicure services, averaging 10.92 ± 6.5 years. It was noted that one technician worked an average of 61.92 ± 11.09 hours per week and attended to an average of 11 ± 5 clients per day. All technicians stated that they had received training and certification for their profession. However, besides occasional ventilation for chemical protection, no other protection methods were mentioned. None of the manicurists and pedicurists had ventilated tables. There were 19 nail technicians (54%) working at non-ventilated tables, while 10 technicians (29%) had setups for pedicures.

According to the interviewer-administered survey based on the European Community Respiratory Health Survey adaptations, 12 individuals (34.2%) reported difficulty breathing when tired, 8 individuals (22.8%) experienced occasional nasal congestion, 5 individuals (14.2%) reported coughing, and 3 individuals (8.5%) reported wheezing, which can lead to asthma. A total of 13 individuals (37.1%) mentioned these respiratory issues. Additionally, 5 individuals (14.2%) reported skin problems such as eczema, 5 individuals (14.2%) experienced eye irritation, and 10 individuals (28.5%) had headaches. The most frequently reported issue was musculoskeletal system problems.

A Spearman correlation test revealed a correlation coefficient (r) of 0.348 with $p < 0.04$ between respiratory problems and smoking. In regression analysis, a linear assessment related to smoking showed a statistical significance with $t = 1.78$ and $p < 0.08$. There was a statistically highly significant correlation ($r = 0.858$, $p < 0.0001$) between duration of employment and respiratory problems according to Spearman's test. When duration of employment was selected as the dependent variable for respiratory distress, it was found significant in regression analysis with $t = 16.3$ and $p < 0.0001$.

The results of the NMQ [36] are presented in Table 2

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Table 2. Nordic Musculoskeletal Questionnaire.

	Neck	Shoulders	Upper back	Elbows	Wrists/hands	Lower back	Hips/ thighs	Knees	Ankles/feet
%	Did you experience any pain in the past year?								
Yes	51	26	57	17	23	31	17	11	11
No	49	74	43	83	77	69	83	89	89
	In the past year, has your work or home life been affected?								
Yes	9	6	20	6	9	23	6	3	3
No	91	94	80	94	91	77	94	97	97
	In the past year, have you visited a doctor due to pain?								
Yes	11	6	9	6	6	17	6	3	6
No	89	94	91	94	94	83	94	97	94
	In the past year, have you taken medication for pain?								
Yes	23	11	31	9	17	31	0	0	0
No	77	89	69	91	83	69	100	100	100
	Have you had any workdays lost due to pain in the past year?								
Yes	0	0	0	0	0	0	0	0	0
No	100	100	100	100	100	100	100	100	100

Neck and back pain were reported as the most common symptoms. Participants indicated that their work was particularly affected at home due to back pain according to this questionnaire. They reported minimal visits to physicians and minimal reports for these pains. Over the past year, irregular use of over-the-counter paracetamol or NSAIDs or muscle relaxants was predominantly used without prescription. Participants rated their pain intensity at 7 on a visual analog scale when experiencing pain. There was a strong positive correlation between the degree of pain and the duration of time spent in the profession ($p = 0.001$) and weekly working hours. There was a statistically highly significant correlation between the duration of time spent in the profession and neck and back pain according to Spearman's correlation test ($r = 0.828$, $p < 0.0001$).

We identified four tasks for ergonomic risk assessment using QEC: manicure, pedicure, unwanted hair removal, and eyebrow shaping. All four tasks involved poor postures and repetitive motions. QEC levels were assessed. Specifically, back static positions scored in the very high-risk category (more than 29 points), while neck and wrist/hand QEC values indicated very high risk, and shoulder/arm exposure values showed high risk (Table 3). The driving task was not included in the assessments since participants did not use vehicles at work.

Table 3. Results of evaluation of QEC scores and exposure factors.

Exposure factor	QEC score	Min	Max	Exposure level
Back (static)	30 ±5.3	14	32	Very high
Shoulder/arm	35±3.6	30	39	High
Wrist/hand	44±3.2	39	46	Very high
Neck	18±1.4	15	18	Very high

There was a statistically significant correlation between neck and back static QEC scores and weekly working hours and job experience duration according to Spearman's correlation test ($r = 0.828$, $p < 0.0001$). Additionally, there was a statistically significant correlation between reported pain in the neck and static back areas and the QEC assessments for these regions based on Pearson's correlation test ($r = 0.944$, $p < 0.0001$).

4. Discussion

The general definition of posture is the arrangement and positioning of the arms, legs, head, and trunk in relation to one another. According to this definition, work posture is the way the arms, legs, head, and torso are positioned in relation to the tasks being done and the nature of the work. [43]. Poor postures are defined as deviations of one or more body parts from a static body posture [44].

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Ramazzini's explanation of how irregular and strenuous work movements and unnatural body postures can lead to harmful consequences for workers elucidates this concept [45].

Work-related musculoskeletal disorders (WMSDs) affect muscles, nerves, tendons, cartilage, ligaments, joints, and discs. Skeletal and muscular system syndromes occur during routine body movements such as bending, straightening, gripping, twisting, reaching, and stretching. These movements are not harmful in daily life, but their repetition, forceful nature, and speed in work settings make them detrimental. WMSDs are not acute disorders but rather gradual traumas that develop over time [21].

Currently, ergonomic risk analyses are used to determine the extent of strain on employees' body parts in relation to the tasks and operations performed. In this context, nail technicians in the service sector constitute a occupational group at risk for musculoskeletal disorders due to their job-related tasks. An adapted training model based on experiential learning theory can be implemented in manual tasks to reduce musculoskeletal system and ergonomic risks, empowering employees to take preventive measures [46]. When comparing ergonomic analysis methods, different evaluation systems exist based on parameters such as cost, capacity, versatility, generality, and accuracy [47]. Nail technicians are identified by researchers as a high-risk occupational group due to their prolonged work in poor posture and hazardous environments [48,49]. In this study, respiratory, dermatological, and musculoskeletal symptoms of nail technicians were assessed, and the challenges of working in inappropriate postures were evaluated using the QEC method. Ergonomic interventions and exercise training were provided to those who agreed.

The average age of the nail technicians evaluated in this study is similar to the averages found in some other studies, and the gender distribution of the participants also shows similarities [48,50]. In Huỳnh et al.'s study, the average age of Vietnamese nail technicians was higher, and there was a 20% male population [51].

According to our survey conducted with an interviewer based on adaptations of the European Community Respiratory Health Survey, nail technicians reported complaints of respiratory issues, headaches, and dermatological symptoms. Our study did not have a control population, but similar results were found in previous survey studies that screened these systems [48,52,53]. There is also a publication in the literature that, like our study, evaluates the health status of nail technicians without a control group, conducted with 17 participants [54]. The rate of respiratory distress in studies has been found to be 44% [50] and 47% [55]. In our study, the rate of respiratory distress was found to be 37%, which is an average value compared to other studies, with some reporting higher and lower rates [51,52,56].

The most frequently reported symptoms among nail technicians were neck, back, and hand/wrist pain. It was observed that most symptoms were related to the technicians' work experience and weekly working hours. Various symptoms have been investigated in previous studies. In different countries, regional pain assessments among nail technicians over the past year have most commonly reported pain in the neck and back, with similar results to those found by many researchers [48,50,52,57].

For those performing eyebrow shaping, the upper extremity and shoulder were affected, while the most hazardous work was found to be in manicure and pedicure tasks. Our research particularly highlights the lack of appropriate workstations. The chairs lacked lumbar and back support. There are specially designed desks and chairs for nail technicians [58]. In our study, using improper working postures, prolonged periods in a fixed bad posture, contact stress, the need for excessive force, repetitive movements, frequent pinch grips, excessive wrist movements, and manual material handling were identified as potential causes of WMSDs. These findings have also been confirmed by other researchers [59].

Relatively small sample size was the limitation of this study, despite being calculated appropriately. Additionally, we did not reassess the reduction in risk following ergonomic interventions such as the exercise program and workstation changes.

5. Conclusions

In this study, risks for WMSDs were identified in every exposure area, and there were also risks for respiratory and skin conditions. It is necessary to provide education on these issues and develop prevention programs for nail technicians. Work posture plays a critical role in the development of WMSDs. Inappropriate working postures can create conditions conducive to these disorders. Maintaining a neutral position during work is crucial for both the comfort of the worker and the prevention of WMSDs. Therefore, or-ganizing the work environment according to ergonomic principles is essential for pre-venting WMSDs. Ergonomic improvements made to ensure workers' comfort and safety also positively impact worker productivity. By conducting ergonomic risk assessments, significant protection against WMSDs and injuries can be achieved, resulting in a better working environment in terms of health and safety.

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Institutional Review Board Statement: Ethiccal approval Approved by local ethics committee (Clinical Research Ethics Committee of SBU Istanbul Physical Medicine And Rehabilitation Training and Research Hospital) with protocol number 2023-12. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (instutional and national) and with the Helsinki Declaration of 1964 and its later amendments. Informed consent was obtained from all patients for being included in the study. This article does not contain any studies with animal subject performed by the any of the authors. Conflict of interest All authors declare no conflicts of interest.

Informed Consent Statement: All the study participants gave their informed consent before enrollment.

Data Availability Statement: Available upon request.

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