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Research Article

Physical and Environmental Work Exposures and Prevalence of Musculoskeletal Disorders in Beekeepers: A Descriptive Study

Arıcılarda Fiziksel ve Çevresel Çalışma Maruziyetleri ve Kas-iskelet Sistemi Rahatsızlıklarının Yaygınlığı: Tanımlayıcı Bir Çalışma

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ABSTRACT

Purpose: Beekeepers are at risk of musculoskeletal disorders while working, though research is scarce in this field. This study assessed beekeepers' physical and environmental occupational exposure and the prevalence of musculoskeletal disorders. **Material and Methods:** The study was conducted with 123 male individuals who had been actively beekeeping for a minimum of one year. Beekeepers were administered a survey that included demographic and occupational questions. Beekeepers responded to the Nordic Musculoskeletal Questionnaire and questions related to beekeeping activity from the Quick Exposure Check. **Results:** The mean age of the beekeepers was 45.4±12.3 years. The present study revealed that migratory beekeepers encountered a greater number of demanding circumstances in comparison to stationary beekeepers ($p<0.05$). Of the beekeepers, 90.2% had work-related musculoskeletal disorders in at least one body part. The lower back was in the first localization among the body parts that were most affected (81.3%) and limiting any activity (48.8%) in the last 1 year. **Discussion:** Beekeepers had a high incidence of work-related musculoskeletal disorders. Improving working circumstances, avoiding stress and environmental health hazards, boosting physical exercise, and maintaining appropriate posture may reduce work-related musculoskeletal problems.

Keywords: Beekeeping; Musculoskeletal Pain; Workload; Occupational Exposure.

ÖZ

Amaç: Arıcılar çalışırken kas-iskelet rahatsızlıkları riski altındadır, ancak bu alanda araştırma azdır. Bu çalışma, arıcıların fiziksel ve çevresel mesleki maruziyetlerini ve kas-iskelet bozukluklarının yaygınlığını değerlendirmiştir. **Gereç ve Yöntem:** Araştırma en az bir yıldır aktif olarak arıcılık yapan 123 erkek birey ile yürütülmüştür. Arıcılara demografik ve mesleki soruları içeren bir anket uygulandı. Arıcılar, Nordic Kas-iskelet Anketi'ne ve Hızlı Maruziyet Değerlendirme'den arıcılık faaliyetiyle ilgili sorulara yanıt verdiler. **Sonuçlar:** Arıcıların ortalama yaşı 45,4±12,3'tür. Bu çalışma, gezici arıcıların sabit arıcılara kıyasla daha fazla sayıda zorlu koşullarla karşılaştığını ortaya koymuştur ($p<0,05$). Arıcıların %90,2'sinin vücudunun en az bir bölgesinde işle ilgili kas-iskelet sistemi rahatsızlığı vardı. Bel bölgesi son 1 yıl içinde en çok etkilenen (%81,3) ve herhangi bir aktiviteyi sınırlayan (%48,8) vücut bölgelerinden ilk sırada gelmekteydi. **Tartışma:** Arıcılarda işle ilgili kas-iskelet sistemi bozukluklarının görülme sıklığı yüksekti. Çalışma koşullarının iyileştirilmesi, stresin ve çevresel sağlık tehlikelerinin önlenmesi, fiziksel egzersizin arttırılması ve uygun postürün sürdürülmesi işle ilgili kas-iskelet sistemi sorunlarını azaltabilir.

Anahtar Kelimeler: Arıcılık; Kas-iskelet Ağrısı; İş Yükü; Mesleki Maruziyet.

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Work-related musculoskeletal disorders (WMSDs) are one of the most serious occupational health risks in developing countries (Putz-Anderson, Bernard, Burt et al., 1997). WMSDs are the leading causes of lost workdays, increased presenteeism, and treatment expenditure, as well as occupational illnesses, in every country. They have become a crucial workplace issue, compromising occupational health, productivity, employee careers, and causing financial damage (Abdullah, Othman, Solat et al., 2022).

Ergonomics is the study of how to set up the working and living environment so that it fits the needs of people doing the work. The goal is to create a harmonious relationship between people and machines that protects the health of workers and improves production by balancing their workload and working power (Çoker and Selim, 2019). Employee health and safety issues are more prevalent in ergonomically suboptimal working conditions, as are occupational accidents and WMSDs. Repetitive and forceful motions in the workplace, poor body positioning, and ergonomic deficiencies all contribute to the development of WMSDs (Ayanoğlu, 2007; Çoker et al., 2019; Punnett, 2014). Although WMSDs are common, they are not easily detected and often overlooked because their etiology has multiple causes, the cause-effect relationship cannot be easily demonstrated, work-related effects can be overlooked, and they may occur due to non-work-related reasons (hobbies, sports activities, housework, etc.) (Punnett and Wegman, 2004; Saat, Hanawi, Farah et al., 2022). Occupational musculoskeletal disorders related to each job should be examined separately as they involve different physical, psychosocial, personal, and socio-cultural factors related to the job.

Beekeeping is an essential agricultural industry, and bee products are important food items for balanced and healthy human nutrition. Furthermore, bees play a critical role in the preservation of ecological balance and agricultural output through the pollination of plants. Beekeeping provides jobs, income, and healthy nutrition options to rural populations. With all of these advantages, beekeeping is beneficial in agricultural activities, and Turkey is the world's second largest producer of honey after China. In recent years, honey production in Turkey has been one of the country's major economic contributors (Burucu, 2022).

One key goal of beekeeping is to ensure the health of the bees, on which the beekeepers' income is based. Scientific research in this field has been solely focused on the health of hives and food safety dangers that arise in primary apicultural production, with little information available about beekeeper health issues (Maina, Rossi and Baracco, 2016). But many beekeeping activities necessitate awkward postures (e.g., distribution of the top super, which are the boxes that comprise the hive); carrying heavy loads (e.g., honeycomb transport, moving the hives), manual handling, and lifting; working with the trunk in sustained flexion (e.g., comb storage and cleaning); and repetitive manipulation of objects (Maina, Rossi and Baracco, 2016). Beekeepers may be especially at risk for WMSDs, yet many studies lack thorough exposure evaluations. For this reason, the aim of the study was to obtain information about the work-related risks and circumstances of beekeepers and to evaluate the prevalence of WMSDs.

MATERIAL AND METHODS

The population for this research consisted of individuals who are members of the Turkish Beekeepers' Central Union. There are currently 72,325 registered beekeepers. According to a study conducted on tea pickers, the prevalence of musculoskeletal disorder (MSD) in the last 12 months was 92.4% (Chakraborty, Bhattacherjee, Mukherjee et al., 2021). The sample size was calculated using the Open-Epi 3.01 program, considering this prevalence. The minimum sample size was determined to be 108 individuals with an error rate of 5% and 95% confidence interval. Individuals who are members of the Turkish Beekeepers' Central Union, between the ages of 18 and 65 years, who have been involved in beekeeping activities for at least 1 year, and who volunteered to participate in the study were included in the study. Individuals who worked in standing positions or in occupational groups related to load bearing, had any musculoskeletal disorder before entering the beekeeping sector, had joint disease, gout, diabetes, or a history of trauma in the last year were not included in the study.

The study was approved by the Ethics Committee of Ordu University for Clinical Investigations (decision number: 2023/189) and was carried out in accordance with the Helsinki Declaration for medical research involving subjects. Prior to the start of the study, all subjects provided written informed consent.

In the study, all assessments were completed using a web-based platform in the form of an online survey administered through "Google Forms". Besides the sociodemographic information of the individuals, individuals were asked questions about beekeeping activities, the Nordic Musculoskeletal Questionnaire (NMQ), and some work-related questions from the Quick Exposure Check (QEC). The NMQ questions symptoms in nine areas of the body (feet-ankles, knees, thighs-hips, wrists-hands, waist, elbows, back, shoulders, neck) in the last 12 months and seven days. Answers are given as yes or no. Additionally, participants were questioned about the occurrence of musculoskeletal disorders (MSD) that resulted in the prevention of any work during the last 12 months with respect to each specific body region. The NMQ is appropriate for use in research with large numbers of participants, and the diversity of its application indicates its utility in the workplace (Kahraman, Genç and Göz, 2016). QEC was used to ask participants questions regarding their beekeeping practices. The QEC was created to assess the level of physical risk to which people are exposed (Kesiktaş, Ozcan, Alptekin et al., 2007). The QEC is divided into two components, which are filled by the employee and the observer. Topics evaluated by employees include H: maximum weight lifted by hand during work, J: time spent doing work, K: maximum force applied by hand while doing work, L: visual attention, M: daily vehicle usage time at work, N: vibrating tool usage time, P: difficulty in carrying out the work, and Q: general job stress parameters, which were evaluated by participants in relation to beekeeping activities.

Statistical analysis

SPSS-Version 22 (Chicago IL, USA) was used for all statistical analyses. The Shapiro-Wilk test was used to validate normal distribution. Continuous data are given as mean (SD), whereas categorical data are presented as percentages and frequencies. Descriptive and work-related information about beekeepers is presented as frequency, percentage, or mean±standard deviation. Work-related differences between stationary and migratory beekeepers were determined by chi-square analysis or Fisher's exact test. The prevalence of MSD was determined for each body area. For each body area, the percentage of prevention of any activity in the last 12 months due to MSD, the presence of MSD in the previous 12 months and in the last 7 days were calculated. $p<0.05$ was considered to be statistically significant.

RESULTS

The current study included 123 male beekeepers with a mean age (SD) of 45.4 (12.3) years. Most of the beekeepers were overweight, university graduates, and had a second job. Most of them had no exercise habits or chronic diseases and thought that they had a healthy lifestyle. Table 1 shows the descriptive characteristics of beekeepers. Table 2 provides information about the beekeeping activities of the individuals. The majority of the individuals were engaged in beekeeping activity for less than 20 years and in the Black Sea region. Ambient temperature was found to be one of the most common problems related to the working environment. Job stress was the most common among factors that disturbed health. Work-related musculoskeletal problems were determined based on whether a beekeeper experienced pain, numbness, or discomfort in a body area. Of the beekeepers, 90.2% exhibited WMSD symptoms in at least one body area. Figure 1 depicts the prevalence of WMSD symptoms in various body areas and prevention of any activity in the 12 months preceding the research. During the last 12 months, lower back, upper back, knees, and neck were the most frequently impacted areas, with prevalence rates of 81.3%, 56.9%, 44.8%, and 39.8%, respectively. The elbow was the bodily component with least injury. Additionally, lower back, upper back, neck, and knees were the most frequently impacted areas during the last 7 days, with prevalence rates of 60.9%, 37.4%, 22.8%, and 20.3%, respectively. Lower back pain (48.8%) was the most frequent MSD causing limited activity, followed by upper back pain (25.2%) and neck pain (19.5%).

When the work-related conditions of stationary or migratory beekeepers were compared, migratory beekeepers remained in static position for more than 1 hour longer, lifted maximum weight with one hand, and spent more time per day on beekeeping activities than stationary beekeepers. Additionally, they had more difficulty keeping up with work, and they found the job more stressful. The maximum force level exerted by one hand during this task and the visual demand of this task were similar for both beekeeping types (Table 3).

Figure 1. The prevalence of MSD symptoms in various body locations and activity limitation during the last 12 months in beekeepers

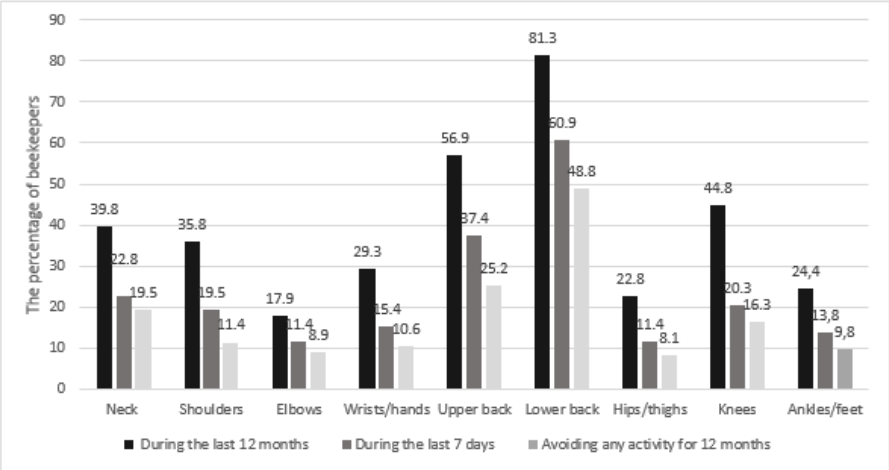

Table 1. Descriptive characteristics of beekeepers

Variables	Frequency (percent)	Mean±SD
Age (years)		45.4±12.3
<25	7 (5.7)	
26-40	34 (27.6)	
>40	82 (66.7)	
BMI (kg/m2)		27.7±4.0
Underweight	0 (0)	
Normal	33 (26.8)	
Overweight	55 (44.7)	
Obese	35 (28.5)	
Education level		
Literate	1 (0.8)	
Primary school	8 (6.5)	
Middle school	8 (6.5)	
High school	26 (21.1)	
University	63 (51.2)	
Higher education	17 (13.8)	
Exercise habit		
Yes	53 (43.1)	
No	70 (56.9)	
Seconder job		
Yes	102 (82.9)	
No	29 (23.6)	
Lifestyle		
Healthy	71 (57.7)	
Not healthy, not unhealty	46 (37.4)	
Unhealty	6 (4.9)	
Chronic disease		
Yes	33 (26.8)	
No	90 (73.2)	

BMI: Body Mass Index, SD: Standard Deviation

Table 2. Information about the beekeeping activity of the individuals

Variables	Frequency (percent)	Mean±SD
Duration of beekeeping activity (years)		16.6±12.4
<10	43 (34.9)	
11-20	42 (34.1)	
>20	38 (30.9)	
Beekeeping activity region*		
Mediterranean Region	5 (4.1)	
Eastern Anatolia Region	18 (14.6)	
Aegean Region	20 (16.3)	
Marmara Region	25 (20.3)	
Southeastern Anatolia Region	2 (1.6)	
Central Anatolia Region	24 (19.5)	
Black Sea Region	38 (30.9)	
Problems related to the working environment*		
Ambient temperature	78 (63.4)	
Lighting problem	33 (26.8)	
Noisy	18 (14.6)	
Difficult transportation conditions	4 (3.2)	
Bear attack	4 (3.2)	
Vibration	3 (2.4)	
Agricultural spraying	2 (1.6)	
Layover	2 (1.6)	
Air pollution	1 (0.8)	
Work-related factors that disturb your health *		
Occupational stress	65 (52.8)	
Working speed	64 (52.0)	
Working time	41 (33.3)	
Job control	34 (27.6)	
Break time	15 (12.2)	
Job change	4 (3.2)	

** Individuals could have multiple selections, SD: Standard Deviation*

Table 3. Work-related conditions of stationary or migratory beekeepers.

	Total Beekeepers N=123	Stationary (n=56)	Migratory (n=67)	Chi-square test or Fisher-exact test *P* value
Do you remain in the static position for more than 1 hour?				
Yes	78 (63.4)	28 (50)	50 (74.6)	0.005*
No	45 (36.6)	28 (50)	17 (25.4)	
Is the maximum weight handled manually by you in this task?				
Light (<5 g)	2 (1.6)	1 (1.8)	1 (1.5)	0.032*
Moderate (6-10 kg)	9 (7.3)	6 (10.7)	3 (4.5)	
Heavy (11-20 kg)	18 (14.6)	13 (23.2)	5 (7.5)	
Very heavy (20 kg<)	94 (76.4)	36 (64.3)	58 (86.6)	
On average, how much time do you spend per day on this task?				
<2 hours	25 (20.3)	14 (25)	11 (16.4)	0.006*
2-4 hours	37 (30.1)	23 (41.1)	14 (20.9)	
>4 hours	61 (49.6)	19 (33.9)	42 (62.7)	
When performing this task, is the maximum force level exerted by one hand?				
Low (<1 kg)	2 (1.6)	1 (1.8)	1 (1.5)	0.278
Medium (1-4 kg)	63 (51.2)	33 (58.9)	30 (44.8)	
High (>4 kg)	58 (47.2)	22 (39.3)	36 (53.7)	

Table 3 (Continue). Work-related conditions of stationary or migratory beekeepers.

Is the visual demand of this task?				
Low (almost no need to view fine details)	5 (4.1)	3 (5.5)	2 (2.9)	0.656
High (need to view some fine details)	118 (95.9)	52 (94.5)	66 (97.1)	
Do you have difficulty keeping up with this work?				
Never	9 (7.3)	7 (12.5)	2 (3)	0.002*
Sometimes	90 (73.2)	45 (80.4)	45 (67.2)	
Often	24 (19.5)	4 (7.1)	20 (29.9)	
In general, how do you find this job?				
Not at all stressful?	24 (19.5)	16 (28.6)	8 (11.9)	0.003*
Mildly stressful?	37 (30.1)	22 (39.3)	15 (22.4)	
Moderately stressful?	49 (39.8)	15 (26.8)	34 (50.7)	
Very stressful?	13 (10.6)	3 (5.4)	10 (14.9)	

**p<0.05*

DISCUSSION

The majority of the beekeeper men (90.2%) had WMSDs in at least one body area in the previous 12 months. Lower back WMSDs were the most common localization (81.3%) and caused most activity avoidance (48.8%). Ambient temperature and occupational stress were very significant work-related factors that negatively affected beekeepers. This study found that migratory beekeepers reported more challenging conditions than stationary beekeepers, including work-related posture, time, load, and stress.

In the current study, although the chronic disease frequency of most beekeepers was stated to be low and their perceived lifestyle was healthy, most of them were overweight and did not have exercise habits. Another study showing that the majority of beekeepers had risky health behaviors such as being overweight, lacking regular exercise habits, and smoking also supports our findings (Soylu, Sönmez and Silici, 2021). Additionally, beekeeping was a source of supplemental income, in line with a previous study (Soylu, Sönmez and Silici, 2021). Job stress is a mental and physical situation that impairs workers' ability, productivity, effectiveness, satisfaction, psychophysical health, and quality of work (Ezenwaji, Eseadi, Okide et al., 2019). In the study, the majority of beekeepers thought that this job was moderately stressful, and they stated that job stress was the most common factor that disturbed their health. Working speed and time were among the other important factors that disturbed health. The most common environmental factor that beekeepers were exposed to was ambient temperature.

It is common knowledge that MSD has a variety of causes and affects many people who work. Numerous studies examined the prevalence and risk factors for WMSDs in office workers, medical professionals, and industry workers (Abaraogu, Okafor, Ezeukwu et al., 2015; Anyfantis and Biska, 2018; Candan, Sahin and Akoğlu, 2019; Kocur, Wilski, Lewandowski et al., 2019). WMSDs are known to develop as a result of difficult conditions in agricultural production (Candan et al., 2019). Beekeeping is also practiced throughout a wide range of geographies, from flat plains at sea level to plateaus thousands of meters above sea level and in locations that are remote from populated areas (Soylu et al., 2021). The majority of beekeeper men had musculoskeletal complaints, according to the recent study. At the same time, migratory beekeepers have more difficult working conditions and work stress than stationary beekeepers. This result may be due to the fact that migratory beekeepers are more adversely affected by unsuitable weather, geographical features, and environmental conditions compared to stationary beekeepers. In general, migratory beekeepers who continue their activities away from their families and face many natural events experience problems with accommodation, transportation, and security (Akdemir et al., 1990). Additionally, according to the results of our study, it was found that migratory beekeepers spend longer hours per day on beekeeping activities and remained in more static positions during activity. Because of these issues, migratory beekeepers may have more trouble keeping up with beekeeping activities and may find them more stressful.

Leroux et al. (2005) found that physical and psychosocial work factors were linked to musculoskeletal pain in various body locations. Uncomfortable posture extended static work, repetitive motions, manual material handling, physical exertion, high body mass index, and job stress are all well-known risk factors for WMSDs (Candan et al., 2019; Da Costa and Vieira, 2010; Punnett et al., 2004). In our study, there were work factors such as static posture, working without a break for a long time, heavy lifting, environmental conditions, and job stress during beekeeping activities. At the same time, the fact that job stress,

working time, and speed are the most common factors that disturb the health of beekeepers supports this result in the study. The prevalence of musculoskeletal symptoms among beekeepers may be high due to these factors.

In our study, the most frequently reported discomfort was in the back, knees, and neck among beekeeper men. Our findings are consistent with other research that suggests that back pain has the highest prevalence among symptoms (Leroux et al., 2005). Work-related physical activities, including heavy lifting, were recognized as risk factors for back pain (Leroux et al., 2005). Lower extremity discomfort was linked to prolonged standing at work, repetitive tasks, and heavy lifting in epidemiological research (Anthony Ryan, 1989; Messing, Tissot and Stock, 2006). Repetitive arm movement were linked to neck pain and issues with the upper extremities (Leroux et al., 2005). Numerous beekeeping tasks require individuals to assume uncomfortable positions. Additionally, there is a need to carry heavy loads, such as honeycombs and hives, which involve manual handling and lifting. Furthermore, beekeepers often work with their trunks in a sustained flexed position, particularly during comb storage and cleaning. Lastly, repetitive movement of objects is a common aspect of beekeeping activities. Therefore, our findings are compatible with the literature.

A notable strength of this study was the comprehensive representation of beekeepers from seven geographical regions in Turkey. This is the first study comparing migratory and stationary beekeepers in terms of ergonomic conditions. This study can be a guide for beekeepers in terms of identifying possible occupational ergonomic risk factors, conditions that disturb their health, and musculoskeletal system problems, and taking the necessary precautions. However, the following limitations are relevant to the current findings. No direct causal link could be derived from the research because the study was cross-sectional. Another limitation is that the findings of this study are based on self-reported results. However, it is one of the rare studies on this subject. In future studies, the biomechanics and working environment conditions of beekeepers should be evaluated with observational and objective methods. The Nordic questionnaire, which allows for reporting of discomfort on a schematic image of the human body, was used to assess musculoskeletal complaints. While this specific questionnaire does not offer a medical or clinical diagnosis, its validity has been established, particularly in relation to musculoskeletal problems affecting the upper extremities (Descatha, Roquelaure, Chastang et al., 2007). One other limitation of this study is the major presence of participants working in secondary employment, as well as the inclusion of individuals with chronic illnesses.

Consequently, MSDs were frequently observed in male beekeepers, affecting at least one specific anatomical region of the body. Because of this, beekeepers need to be closely monitored for MSDs. Interventions aiming to decrease both physical and environmental work exposures may be beneficial in preventing musculoskeletal complaints. It is essential to ensure that beekeepers are provided with favorable working conditions, potential risks are minimized and they receive appropriate education and instructions. This study suggests that increased physical activity, posture exercises, and relaxation exercises may be prescribed to reduce MSD and manage job stress.

Ethical Approval

Ethical approval was obtained from Ordu University Clinical Research Ethics Committee (Protocol number: 2023/189).

Authors' Contribution

Study conception, design, data collection, analysis and interpretation of results, draft manuscript preparation: Ulku Kezban Sahin. All authors reviewed the results and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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