Pediatric Surgery International
https://doi.org/10.1007/s00383-021-04928-9

ORIGINAL ARTICLE

Evaluation of work-related musculoskeletal problems in pediatric surgeons

Fatih Akbiyik[1] · **Özgün Uysal**[2] · **Tüzün Firat**[2] · **Nilgün Bek**[3]

Accepted: 19 May 2021

Abstract

Purpose Pediatric surgeons are exposed to intense work-related activities, depending on their profession, including residency training. This study aims to investigate the musculoskeletal symptoms and analyze the relationship between musculoskeletal symptoms and the demographics, physical activity levels, and body mass index (BMI) of pediatric surgeons.

Methods A total of 82 pediatric surgeons (female, 20; male, 62) were included in this study. The musculoskeletal symptoms were determined using the Cornell Musculoskeletal Discomfort Questionnaire. The levels of physical activity were determined using the International Physical Activity Questionnaire.

Results The mean age of the participants was 48.97 ± 8.894 years, the mean BMI was 26.72 ± 4.12 kg/m^2, and the mean working time after acquiring their specialty was 18.65 ± 9.83 years. The average surgery counts per week were 15.22 ± 12.17. Pediatric surgeons mostly complained from lower back pain, upper back pain, neck pain, and right and left shoulder pain. Surgeons with higher BMI had higher pain scores and received more treatment sessions.

Conclusions Pediatric surgeons' complaints are related to their total numbers of surgery. Higher BMI and lower physical activity seem to be the major contributing factors for developing musculoskeletal symptoms. The study results indicated that surgeons should keep their BMI levels to the optimum and increase their physical activity levels.

Keywords Pain · Exercise · Body mass index · Pediatric surgeons · Occupational stress

Introduction

Healthcare workers are also among those at the risk of work-related musculoskeletal problems [1–4]. In particular, surgeons are exposed to intense work-related activities, depending on their profession, including residency training. Pediatric surgeons who perform long-term intensive operations for pediatric pathologies are also included in this group and are at risk of these problems. Maintaining standing for a long time is one of the important reasons why surgeons develop work-related musculoskeletal symptoms. Static back and shoulder posture and repetition of large amounts of similar movements during long-term operations may increase postural fatigue in the back and shoulders [5]. Espisito et al. reported that there is a limited working area, limited use of instruments, and poor ergonomic especially during pediatric laparoscopy; also, the frequent use of pain relievers by surgeons performing laparoscopy [6, 7]. In addition, lack of physical activity has been pointed out as another factor that creates musculoskeletal problems for surgeons [1, 2, 6]. In recent studies, the relationship between musculoskeletal system problems, sports, and physical activity has been examined, and the results showed that physically inactive people can develop musculoskeletal problems if they stay in static postures for a long time while they work [8, 9]. The results also indicated that regular and purposeful physical activity was effective in the prevention of musculoskeletal system pain and the treatment of musculoskeletal system problems [8–10]. Therefore, studies have been conducted to identify and prevent musculoskeletal problems resulting from work-related postures and positions [11]. There is a relationship between the working conditions of many healthcare professionals and musculoskeletal problems. Although some studies investigated musculoskeletal disorders in pediatric surgeons, none of these studies investigated the relationship

✉ Fatih Akbiyik
drfatihakbiyik@gmail.com

[1] Ankara City Hospital, Ankara, Turkey

[2] Hacettepe University, Ankara, Turkey

[3] Lokman Hekim University, Ankara, Turkey

Published online: 27 May 2021

between physical activity level, body mass index (BMI), and musculoskeletal disorders in pediatric surgeons [6, 7]. This preliminary study aims to identify musculoskeletal problems caused by the working conditions of surgeons, such as the number of operations per week, and their physical activity levels. We hypothesized that there was a correlation between musculoskeletal problems and the daily surgery counts of the surgeons. Our secondary hypothesis was that surgeons' physical activity levels and BMIs could affect the severity of their musculoskeletal symptoms.

Material and methods

The basic design of the present study was to evaluate the questionnaire forms given to the participants. The recruited participants were voluntary surgeons who specialized in pediatric surgery and were actively working between March 2018 and April 2019. The demographic information of the participants, such as years worked as a pediatric surgeon, daily and weekly surgery count, approximate surgery duration, treatment duration (days) received and workdays lost due to work-related musculoskeletal injuries were recorded. Informed consent was taken before the study was conducted.

The questionnaires were distributed at two separate regional meetings in which there were 94 registered participants. A total of 82 volunteers participated and only complete forms were evaluated.

Musculoskeletal problems were determined using the Cornell Musculoskeletal Discomfort Questionnaire developed by Hedge et al., which was translated and validated in Turkish in the study by Erdinc et al. [12]. This questionnaire aims to define the areas of musculoskeletal symptoms; their frequency, severity, and pain levels; and whether the problem intrudes with working ability. According to the last working week; the frequency of pain was graded using a 5-point Likert scale (1, never felt pain; 2, once or twice; 3, three or four times; 4, once every day; 5, multiple times every day). The severity of pain was graded using a 3-point Likert scale (1, mild pain; 2, moderate pain; 3, severe pain). Intrusion with working ability was graded using a 3-point Likert scale (1, never intruded; 2, a little intrusion; 3, a lot of intrusions). With this questionnaire, each body part obtains a point between 0 and 90; lower points mean lesser effect of pain, and higher points mean greater effect of pain [13, 14].

The physical activity levels of the participants were determined using the International Physical Activity Questionnaire (IPAQ) [15]. This test was translated and validated by Saglam et al. and its validity and reliability were reported as $r = 0.3$ and $r = 0.69$, respectively [13]. This questionnaire is based on physical activities lasting more than 10 min within the last 7 days, recording them as frequency, duration, and intensity and converting this information into Metabolic Equivalent of Task (MET) value. The MET value is the amount of oxygen consumed while resting in a sitting position (1 MET = 3.5 ml 02/kg/min). This questionnaire consists of four items: vigorous physical activities, moderate physical activities, walking, and sitting questions. For IPAQ, a person spends 8 MET in "vigorous physical activities," 4 MET in "moderate physical activities," and 3.3 MET in "walking". To calculate the total MET value, MET values are multiplied with minute, and frequency (day) values and final MET values are summed. Total MET values lower than 600 indicate "low physically active," MET values between 601 and 3000 indicate "moderate physically active," and MET values higher than 3000 indicate "highly physically active" [13, 15]. According to these levels of the IPAQ form, subjects were separated according to their physical activity levels and compared in terms of musculoskeletal discomfort. Additionally, participants were grouped by their BMI into two groups: 18–25 was accepted as "Normal BMI" and 25 + was accepted as "High BMI". We compared these groups for received treatment duration to analyze BMI's effect on the recovery period.

Ethical information

Ethical approval was obtained from Hacettepe University Ethical Committee (number: GO 19/901).

Statistical analysis

Statistical analysis of the data was conducted using SPSS 20.0 (IBM Statistics Coach). Descriptive information was presented as arithmetic mean (X) and standard deviation (SD). Our data were nonparametric; therefore, between-group differences were evaluated using Kruskal–Wallis and Mann–Whitney *U* tests. The correlation was evaluated using Spearman's rank correlation. $p < 0.05$ was considered as statistically significant.

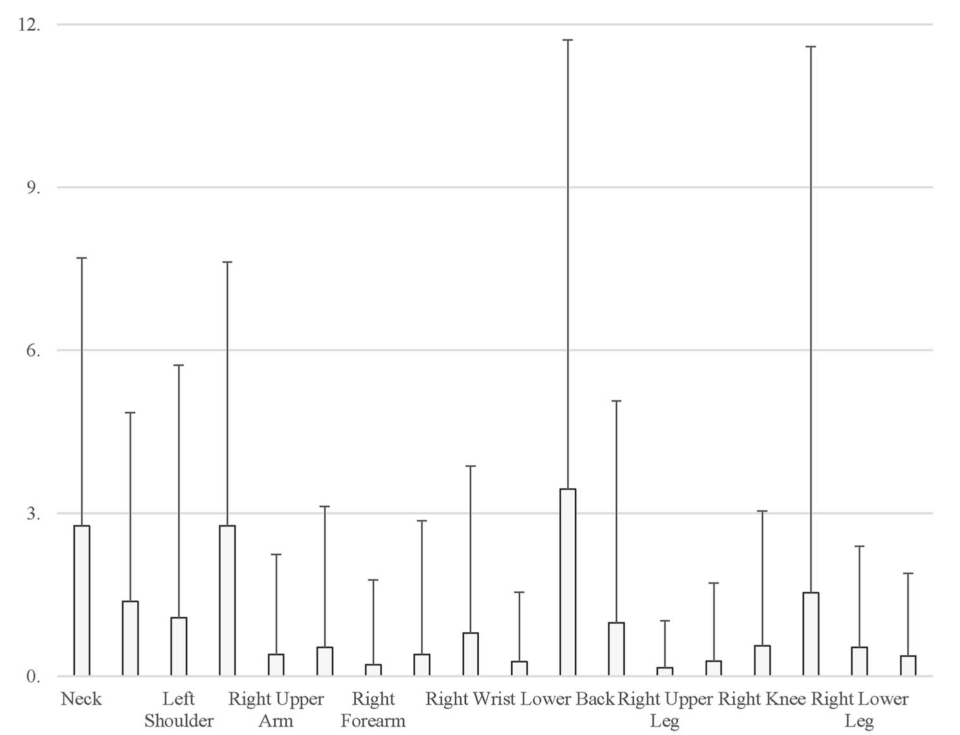
Results

The questionnaire forms of 82 pediatric surgeons (20 females, 62 males; 6 left hand dominant, 76 right hand dominant) were included in our study. The average age of the participants was 48.97 ± 8.89 years (minimum 31; maximum 75), their average BMI was 26.72 ± 4.12 kg/m^2, and the average duration of work after gaining expertise was 18.65 ± 9.83 years. The average number of operations per week was 15.22 ± 12.17 (Table 1). Considering the physical activity levels of the participants, 27 had "low", 41 had "moderate" and 14 had "high" physical activity levels. The participants' IPAQ values are presented in Table 1. The Cornell Musculoskeletal Discomfort Questionnaire results of

Table 1 Demographic information and international physical activity questionnaire (IPAQ) values of the surgeons

Demographic information Mean ± SD		International physical activity values Mean ± SD	
Height (cm)	174.14 ± 8.78	MET values	2551.29 ± 5780.56
Body mass (kg)	82.08 ± 16.87	Activity groups (Median) (*n*%)	27 low (32.9%) 41 moderate (50%) 14 high (17.1%)
BMI (kg/m^2)	26.72 ± 4.12		
Years worked as a pediatric surgeon (years)	18.65 ± 9.83	Vigorous activity duration (min/week)	82.11 ± 190.04
Average surgery count (Number/week)	15.22 ± 12.17	Moderate activity duration (min/week)	98.85 ± 162.87
Received treatment time (days)*	14 (2–10,585)	Walking duration (min/week)	424.27 ± 1584.96
Workdays lost (days)*	14 (2–140)	Sitting duration (min/week)	1166.81 ± 1167.44

Table 2 Cornell musculoskeletal discomfort questionnaire scores



The total pain score is 7.02 ± 19.28.

the participants are presented in Table 2, together with their subscales.

Spearman's correlation analysis was performed to find out if there was a relationship between BMI, pain scores, and duration of treatment. The results showed that there was a correlation between BMI and right shoulder, right thigh, and left thigh pain scores and the duration of treatment received due to work-related musculoskeletal problems ($p = 0.026$, 0.05, 0.014, and 0.006, respectively). There was a significant correlation between the weekly number of operations of participants and their low back pain scores ($p = 0.017$) (Table 3). Although the shoulder pain and upper arm pain scores were higher in surgeons with a high number of laparoscopic operations, it was not statistically significant. There was also no relationship between the gender of the participants and their musculoskeletal system problems. The workdays loss of the participants due to injury and left shoulder, left ankle, and hip pain scores were correlated ($p = 0.005$, 0.008, 0.018, respectively) (Table 3).

The conditions of the participants according to their body mass index and the duration of treatment due to work-related musculoskeletal problems were compared using Mann–Whitney *U* test; participants with a BMI over 25 were found to receive significantly more days of treatment ($Z = -2.328$, $p = 0.02$).

When the participants were compared for physical activity groups using Kruskal–Wallis test, there was a significant difference in the right shoulder pain score between the

Table 3 Correlations between scores of Cornell musculoskeletal discomfort questionnaire's sub-parameters and other parameters

		BMI	Total SURGERY COunt	Workdays lost	Met value	Met group
Shoulder pain (R)	r	−0.285	−0.190	0.163	**−0.363**	**−0.432**
	p	0.067	0.211	0.285	**0.014***	**0.002***
Shoulder pain (L)	r	−0.117	0.053	**0.417**	−0.248	−0.224
	p	0.461	0.735	**0.005***	0.109	0.140
Upper arm pain (R)	r	**−0.331**	−0.168	0.033	−0.242	−0.203
	p	**0.026***	0.255	0.822	0.101	0.157
Upper arm pain (L)	r	−0.149	0.121	0.015	0.032	0.058
	p	0.336	0.418	0.919	0.834	0.693
Wrist pain (R)	r	0.198	0.139	0.271	−0.097	−0.027
	p	0.182	0.335	0.057	0.512	0.851
Wrist pain (L)	r	0.256	0.166	**0.372**	−0.133	−0.119
	p	0.090	0.258	**0.008***	0.384	0.410
Neck pain	r	0.003	−0.067	−0.014	−0.199	**−0.264**
	p	0.981	0.620	0.917	0.142	**0.044***
Low back pain	r	0.158	**0.341**	0.028	0.132	0.050
	p	0.293	**0.017***	0.850	0.381	0.727
Hip pain	r	0.186	0.103	**0.354**	−0.029	−0.135
	p	0.244	0.510	**0.018***	0.856	0.378
Thigh pain (R)	r	**−0.301**	−0.095	0.122	−0.163	−0.228
	p	**0.05***	0.530	0.417	0.284	0.119
Thigh pain (L)	r	**−0.374**	−0.095	0.070	−0.167	−0.191
	p	**0.014***	0.530	0.644	0.274	0.194

Bold values indicate the strong relationship between two parameters

*$p <= 0.05$, Spearman correlation analyses, – no significant correlation, *R* right; *L* left

groups ($\chi^2 = 8.885$, $p = 0.012$). Comparison between groups was made using the Bonferroni correction ($p < 0.017$). The participants with low activity levels were found to have higher pain scores than those with high activity levels ($p = 0.002$).

The participants' physical activity intensity was only related to the right shoulder pain score ($p = 0.014$).

Discussion

Numerous studies have shown that there are work-related musculoskeletal complaints among healthcare professionals [4]. Because of the static posture and position, up to 66% of the musculoskeletal system problems have been reported in surgical specialties [6, 7]. In the study of Esposito et al., 43% of the participants stated that laparoscopic surgery has worse ergonomics than open surgery. Again, in the same study, 44% of surgeons used daily painkillers, and approximately 17% stated that this pain negatively affected surgical activity and social activity [7]. This study concentrated on surgeons and was the first to investigate the correlation of physical activity, BMI, and musculoskeletal disorders in pediatric surgeons. We found that the participants in this study mostly complained of low back pain, upper back pain, neck pain, and right and left shoulder pain. It was observed that as the number of operations increased, the low back pain score also increased, and surgeons with high physical activity levels had lower shoulder pain scores.

It has been determined that surgeons with higher BMI have higher pain scores. In addition, these participants had to receive more treatment sessions for their musculoskeletal symptoms. The subjects of the study had similar BMI distributions in all ages. Age had negative and weak correlations with shoulder and leg pain scores; however, with increasing age, surgeons had lower surgery counts and workload. Therefore, it is not possible to deduct an age related outcome from our study. This shows that keeping a healthy BMI is not only beneficial regarding general health but also affects work-related symptoms. Unlike other studies, no statistical difference was found in pain scoring between open and laparoscopic surgery in this study. In most of the studies, only laparoscopic surgeons were evaluated [6, 7, 14]. This study focused on surgeons who performed both open and laparoscopic surgery. Nevertheless, in accordance with the aforementioned studies, although there was no statistical difference, pain score was higher in those who performed laparoscopic surgery. Our participants were mostly male pediatric surgeons, and there was no significant difference in demographic information, except for height, weight, and BMI. In 2006, Wijnhoven stated that, regardless of the anatomical location and duration, women tend to have more musculoskeletal problems than men [16]. Coury et al. stated that work-related problems are not gender-oriented and are dependent on loading [17]. We could not find any difference in musculoskeletal problems between men and women who were similar in all respects, except height, weight, and BMI. Nilsen et al. reported that overweight and obese people have a higher risk of developing back and/or neck pain compared with normal-weight individuals [9]. Viester et al. found a relationship between BMI and lower extremity musculoskeletal problems in working people [18]. Similarly, we found a significant relationship between BMI and musculoskeletal problems in the right upper arm and right and left thigh. We assume that, during surgery, the antigravity muscles and the right arm predominantly used for surgical procedures are consistently working longer and a higher BMI means a higher workload for these muscles. As a result, increased musculoskeletal problems occur. When the participants were grouped according to their BMI, the higher BMI group received more treatments than did the normal BMI group. Consequently, it can be assumed that a higher BMI means more load on the muscles, giving higher damage to the muscles that can last longer. The significance of the relationship between the number of daily operations and low back pain scores may mean an increased number of operations and longer periods under load, and this may cause back pain in surgeons. There are similar comments regarding the increase in complaints with the increasing workload [14]. When the participants were divided into three groups as low active, moderately active, and highly active according to their activity levels, there was a significant difference between the groups in the right shoulder pain score. The comparison between groups revealed that the highly active group had lower pain scores than did the low active group. In the literature, Heneweer et al. could not find a direct link between chronic low back pain and physical activity [8]. Nilsen et al. found that physical inactivity is associated with higher musculoskeletal problems and that being active even 1 h a week can be protective [9]. Similar to the literature, the pain score was higher in the group with lower physical activity in our study. Viester et al. reported that obese people tend to be more at risk of having problems with the musculoskeletal system and recover more slowly [18]. This study shows that being highly physically active can prevent the development of musculoskeletal disorders or decrease their levels. To support the musculoskeletal system, reducing the BMI and performing programmed physical activity will help prevent both these injuries and problems. Strengthening the body, which is the most important instrument of surgeons, with sports and similar activities and learning how to ergonomically use the body are as important as surgical training. Xiao DJ et al. emphasized that similar training can be given in the simulator laboratory [19].

The present study has some limitations. This retrospective study was carried out in a single study group with a limited number of participants. To confirm the findings, prospective studies with larger sample sizes are needed.

Conclusions

It is the nature of the work to stand for a long time daily and work in a static posture with fixed head and body positions in surgical practice. These data suggest that a normal BMI and increased physical activity is associated with less musculoskeletal complaints amongst pediatric surgeons. In addition to surgical training, training in posture and ergonomics in simulation laboratories may also help make professional life healthier. A prospective study with a larger number of participants is required to determine causality versus associations found in this preliminary study.

Acknowledgements The author would like to thanks to Prof. Dr. Hakan Çavuşoğlu for his help in this research.

Author contributions Study conception and design: FA and NB. Acquisition of data: FA. Analysis and interpretation of data: FA, OU, TF, and NB. Drafting of manuscript: FA, OU, TF, and NB. Critical revision of manuscript: FA, OU, TF, and NB.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval It was obtained from Hacettepe University Ethical Committee (number: GO 19/901).

Informed consent An informed consent form was signed by participants.

References

1. Nguyen NT, Ho HS, Smith WD et al (2001) An ergonomic evaluation of surgeons' axial skeletal and upper extremity movements during laparoscopic and open surgery. Am J Surg 182(6):720–724
2. Szeto GP, Cheng SW, Poon JT et al (2012) Surgeons' static posture and movement repetitions in open and laparoscopic surgery. J Surg Res 172(1):e19–e31

3. Darragh AR, Huddleston W, King P (2009) Work-related musculoskeletal injuries and disorders among occupational and physical therapists. Am J Occup Ther 63(3):351–362
4. Çınar-Medeni Ö, Elbasan B, Duzgun I (2017) Low back pain prevalence in healthcare professionals and identification of factors affecting low back pain. J Back Musculoskelet Rehabil 30(3):451–459
5. Torp S, Riise T, Moen BE (2001) The impact of psychosocial work factors on musculoskeletal pain: a prospective study. J Occup Environ Med 43(2):120–126
6. Esposito C, Najmaldin A, Schier F et al (2014) Work-related upper limb musculoskeletal disorders in pediatric minimally invasive surgery: a multicentric survey comparing laparoscopic and sils ergonomy. Pediatr Surg Int 30(4):395–399
7. Esposito C, El Ghoneimi A, Yamataka A et al (2013) Work-related upper limb musculoskeletal disorders in paediatric laparoscopic surgery. a multicenter survey. J Pediatr Surg 48(8):1750–1756
8. Heneweer H, Vanhees L, Picavet HS (2009) Physical activity and low back pain: a U-shaped relation? Pain 143(1–2):21–25
9. Nilsen TI, Holtermann A, Mork PJ (2011) Physical exercise, body mass index, and risk of chronic pain in the low back and neck/shoulders: longitudinal data from the Nord-Trondelag Health Study. Am J Epidemiol 174(3):267–273
10. Mikkelsson LO, Nupponen H, Kaprio J et al (2006) Adolescent flexibility, endurance strength, and physical activity as predictors of adult tension neck, low back pain, and knee injury: a 25 year follow up study. Br J Sports Med 40(2):107–113
11. Murphy S, Buckle P, Stubbs D (2004) Classroom posture and self-reported back and neck pain in schoolchildren. Appl Ergon 35(2):113–120
12. Erdinc O, Hot K, Ozkaya M (2011) Turkish version of the Cornell musculoskeletal discomfort questionnaire: cross-cultural adaptation and validation. Work 39(3):251–260
13. Saglam M, Arikan H, Savci S et al (2010) International physical activity questionnaire: reliability and validity of the Turkish version. Percept Mot Skills 111(1):278–284
14. AlSabah S, Al Haddad E, Khwaja H (2019) The prevalence of musculoskeletal injuries in bariatric surgeons. Surg Endosc 33(6):1818–1827
15. Craig CL, Marshall AL, Sjöström M et al (2003) International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 35(8):1381–1395
16. Wijnhoven HA, de Vet HC, Picavet HS (2006) Prevalence of musculoskeletal disorders is systematically higher in women than in men. Clin J Pain 22(8):717–724
17. Coury HJCG, Porcatti IA, Alem ME et al (2002) Influence of gender on work-related musculoskeletal disorders in repetitive tasks. Int J Ind Ergon 29(1):33–39
18. Viester L, Verhagen EA, Oude Hengel KM et al (2013) The relation between body mass index and musculoskeletal symptoms in the working population. BMC Musculoskelet Disord 14:238
19. Xiao DJ, Jakimowicz JJ, Albayrak A et al (2012) Ergonomic factors on task performance in laparoscopic surgery training. Appl Ergon 43(3):548–553