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A study of the factors associated with musculoskeletal disorders and pain in adolescents studying in five schools in Serdivan district, Sakarya province

Sakarya ili Serdivan ilçesindeki beş okulda öğrenim gören adölesanlarda kas-iskelet sistemi rahatsızlıkları ve ağrıları ile ilişkili faktörlerin incelenmesi

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ABSTRACT

Aims: Our study has two aims. The first aim is to investigate the factors associated with musculoskeletal disorders and pain in adolescents; the second aim is to identify adolescents with pain and limitation of movement and refer them to the appropriate specialist.
Method: The total number of students in the 5 selected schools was 3589. The sample size calculated with 95% confidence was 347. Our study is cross-sectional and was conducted between September 2017 and June 2018 with a total of 525 students, using simple random sampling from 5 schools. A questionnaire form, an anthropometric measurement form and the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) for students were used as data collection tools.
Results: 51,6% of the students were female and the mean age was 14.08 years. The mean age was min: 10.0, max: 18.0 and standard deviation: 2.124. The mean pain score and pain intensity in the neck, shoulder, back, waist and wrist were found to be higher in female students ($p<0.05$). No association was found between exercise, long term use of technological devices and carrying a backpack, which are thought to be associated with pain ($p>0.05$). However, with regard to BMI, it was found that overall mean scores and mean scores for feeling pain were significantly higher in lean males than in normal/overweight or obese males ($p<0.05$).
Conclusion: It was found that girls reported more pain than boys, regular exercise, long-term use of technological devices, carrying a backpack and body mass index were not associated with pain in girls.

Keywords: Adolescent; early detection; nursing; musculoskeletal system; pain

ÖZET

Amaç: Çalışmamızda iki amacımız bulunmaktadır. Bu amaçlardan birincisi ergenlik çağındaki öğrencilerde kas-iskelet sistemi rahatsızlıkları ve ağrıları ile ilişkili faktörleri incelemek; ikincisi ise ağrı ve hareket kısıtlılığı olan ergenleri belirleyerek ilgili uzmana yönlendirmektir.
Yöntem: Seçilen 5 okuldaki toplam öğrenci sayısı 3589'dur. %95 güvenle hesaplanan örneklem büyüklüğü 347'dir. Çalışmamız kesitsel nitelikte olup, Eylül 2017-Haziran 2018 tarihleri arasında beş okuldan basit rastgele örnekleme yoluyla toplam 525 öğrenci ile yürütülmüştür. Veri toplama araçları olarak öğrenciler için hazırlanan anket formu, antropometrik ölçüm formu ve öğrenciler için Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) kullanılmıştır.
Bulgular: Öğrencilerin %51.6'sı kadın ve yaş ortalamaları 14.08'dir. Yaş ortalaması min: 10.0, maks:18.0 ve standart sapma:2.124 olarak belirlenmiştir. Boyun, omuz, sırt, bel ve el bileğinde ortalama ağrı skoru ve ağrı şiddeti kız öğrencilerde daha yüksek bulunmuştur ($p<0.05$). Ağrı ile ilişkili olduğu düşünülen egzersiz, uzun süreli teknolojik cihaz kullanımı ve sırt çantası taşıma arasında ilişki bulunamamıştır ($p>0.05$). Ancak BKİ açısından zayıf erkeklerde genel puan ortalamaları ve ağrı hissetme puan ortalamalarının normal/fazla kilolu veya obez erkeklere göre anlamlı derecede yüksek olduğu bulunmuştur ($p<0.05$).
Sonuç: Kızların erkeklere göre daha fazla ağrı bildirdiği, düzenli spor yapma, teknolojik cihazları uzun süreli kullanma, sırt çantası taşıma ve vücut kitle indeksinin kızlarda ağrı ile ilişkili olmadığı bulunmuştur.

Anahtar Kelimeler: Ergen; erken teşhis; hemşirelik; kas-iskelet sistemi; ağrı

Introduction

Musculoskeletal disorders in adolescents is a condition that includes health problems such as the presence of pain or discomfort in the musculoskeletal system, including muscles, spinal discs, tendons, bones, cartilage, ligaments and nerves, and may occur chronically or in specific situations (Martins et al., 2020; Nazari, Beigi,

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Salesi, Cousins & Mokarami, 2020). Musculoskeletal disorders are among the most common causes of disability and are also common in children and adolescents worldwide (D'Aversa, Bonetti, Gallotti & Maselli, 2021). Musculoskeletal pain is the third most common reason for visits to health care facilities in children, after headache and abdominal pain, and has a prevalence of 5-32% in children and adolescents (İlleez, 2016). When analysing the aetiology in general, it is seen that it can be genetic or acquired (Martins et al., 2020), and also other factors such as gender, family history, anthropometric measurements, spinal mobility and flexibility, poor posture, physical and sports activities, smoking, psychosocial factors, sedentary lifestyle, excessive use of computers (Özdemir, Gençbaş, Tosun, Bebiş & Sinan, 2021). School furniture that is not suitable for students' ergonomics, poor sitting posture or carrying heavy school bags (more than 10% of body weight) (Rezapur-Shahkolai et al., 2021) may be effective. Childhood and adolescence are critical periods in the development of the musculoskeletal system. As bones and muscles develop in the early stages of life, physical problems during this period may be a precursor to irreversible disorders in adulthood (Pereira, Castro, Bertoncello, Damião &Walsh, 2013). Studies also show that the prevalence of musculoskeletal pain increases from adolescence to adulthood, and those who experience pain in childhood or adolescence are more likely to experience pain in later adulthood (Prathivadi Bhayankaram, Lacey, Barnett, Jordan & Dunn, 2020).

The planning and implementation of screening programmes for musculoskeletal disorders can contribute to early diagnosis, which can detect many previously undiagnosed orthopaedic abnormalities and improve knowledge of their prevalence and patterns, as well as modify the natural course of the disease (Adegbehingbe et al., 2009). According to the results of a study conducted by Zakeri et al. in Abadan in 2016, which aimed to assess the prevalence of skeletal disorders in primary school students and was conducted on 383 students, the prevalence of musculoskeletal disorders in schoolchildren was found to be high, and therefore a preschool screening programme was recommended. In order to reduce musculoskeletal disorders in primary school students, it was found that identifying and following up students in the early stages of disorders is a necessary intervention. In addition to screening programs, it is recommended that students, families, teachers and coaches be taught corrective training to reduce the prevalence of musculoskeletal disorders (Zakeri, Baraz, Gheibizadeh, Nejad & Latifi, 2016). Considering all these reasons, it is of great importance for the protection and improvement of health to detect pain as early as possible, eliminate the cause of pain, detect the dimensions and risk factors of musculoskeletal pain at its onset, organise effective treatment and plan interventions to prevent pain (Özdemir et al., 2021; Rezapur-Shahkolai et al., 2021).

In this context, the present study on musculoskeletal disorders in adolescents has two aims. The first is to investigate the factors associated with musculoskeletal function and pain in adolescents in schools, and the second is to identify adolescents with pain and movement limitations and ensure that they are referred to the appropriate specialist.

Method

Type of Study

This is a cross-sectional adolescent screening study.

Sample and Inclusion Criteria

The universe of the study consists of adolescent students attending official secondary schools in Serdivan district, Sakarya province. In the study, 5 schools out of 17 schools in Serdivan district were selected as samples. The total number of students in the 5 selected schools is 3589. The sample size calculated with 95% confidence is 347. As the number of students whose families agreed to participate in the study and who verbally agreed to participate in the study increased, a total of 525 students from 5 schools were included in the study.

A group of adolescents between the ages of 10 and 19 who volunteered to participate in the study and whose parents signed the "parental consent form" participated in our study by sampling 525 students studying in five different public schools in Serdivan district, Sakarya province. Those who refused to participate in the study, those whose parents did not give permission, and those who had been diagnosed and treated for musculoskeletal disorders in the previous 6 months were not included in the study.

Data Collection Instruments

A questionnaire form, an anthropometric measurement form and the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) for students were used in the study.

Questionnaire Form

The questionnaire form was designed by the researcher. The questionnaire form assessed the socio-demographic characteristics of the students, musculoskeletal disorders, inactivity and obesity liability of the students (such as family diet, parental weight, child's exercise habits, backpack carrying habits, presence of previous trauma, presence of spine disease in the family, presence of known spine disease, presence of musculoskeletal discomfort and pain) (Giersbergen & Argon 2017; Demir et al., 2012).

Anthropometric Measurements Form

In the anthropometric measurements form, basic measurements such as body mass (kg), height (m) and waist circumference (cm) were recorded and body mass index (BMI) was analysed. BMI (kg/m2) is calculated by dividing body weight (kg) by height (m2) (Demir Pulat & Turgut, 2022). BMI is calculated differently in children and adolescents than in adults, depending on age and sex. In our study, we used 2008 BMI percentile values adapted to healthy Turkish children (Neyzi et al., 2008; Child and Teen BMI Categories, 2024). For the assessment, adolescents with a BMI of 5 and below were defined as underweight, those in the 5-85th percentile range as normal weight, those in the 85-95th percentile range as overweight, and those above the 95th percentile as obese (Child and Teen BMI Categories; Ece, 2021).

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) for students

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ); was developed at the Cornell University Human Factors and Ergonomics Laboratory (İde & Gündüz, 2021) by Professor Alan Hedge and colleagues (1999) (Azma, Hosseini, Safarian & Abedi, 2015). This questionnaire classifies musculoskeletal disorders in 20 different body regions under three sections: frequency, severity and disability (limitation), and participants are asked to mark the location of the pain on the body pain diagram (Alaca, Safran, Karamanlargil & Timucin, 2019).

This questionnaire, specifically adapted for students, was developed by Erdinç and Ekşioğlu in 2009. The questionnaire assesses pain in 20 different regions under 3 headings: frequency, severity and disability. This questionnaire developed by Erdinç and Ekşioğlu is a screening tool and is not intended for diagnostic purposes. There are separate versions developed for male and female students (Student Specific Cornell Musculoskeletal Discomfort Questionnaires (SS-CMDQ) Turkish, 2017). The student-specific version of the questionnaire was used in our study. The questionnaire was scored separately for the frequency, severity, and prevention of pain experienced in the past week (Erdinc, Hot & Ozkaya, 2011).For the frequency of pain, the responses were scored out of 5 points (1=never, 2=once or twice, 3=three or four times, 4=at least once a day, 5=many times a day) and each response was multiplied by 0, 1.5, 3.5, 5, and 10, respectively. For pain severity, answers were multiplied by 1, 2, 3 on a 3-point scale (1= mild, 2= moderate, 3= severe). And for the prevention of pain (limitation), the answers were multiplied by 1, 2 and 3 respectively out of 3 points (1=not at all, 2=somewhat, 3=significantly) (Student Specific Cornell Musculoskeletal Discomfort Questionnaires, 2023;

Kurt et al., 2021). Responses were scored from 0-90 for each body region and it was found that the higher the score, the more severe the musculoskeletal disorder (Kurt et al., 2021). One of the most commonly used criteria for assessing the reliability of scales is Cronbach's alpha, which is a measure of internal consistency. Calculations were made for the scale and the Cronbach's alpha value was calculated. The Cronbach's alpha values for the reliability of the CDMQ scale were found to be: frequency of feeling pain 0.816; intensity of pain 0.965; and rating of inhibition (limitation) 0.981. These values are generally higher than the acceptable value of 0.70 (Nunnally, 1978).

Data Collection Process

The researchers were directed to the appropriate classes by the administrators of the schools where the research was conducted. Students who had received permission from their families to participate in the study and who volunteered to do so answered the questions on the survey form and their anthropometric measurements were taken and recorded by the research nurse.

When measuring height, weight and waist circumference, care was taken to ensure the students' privacy. Standard scales and rulers were used to measure the height and weight of the students. As the measurements were taken in a classroom environment, all clothing was taken with the shirt, skirt or trousers of the school uniform on, and only the shoes were removed. The waist circumference was measured in cm using a tape measure. While the student was standing with her arms free at her sides, her feet touching each other and the balance on each leg equal, the tape measure was measured so that it passed at the level of the navel (Mousa, 2012, Yosmaoğlu, Baltacı & Derman, 2010).

The surveys were evaluated by the researcher, students with pain were identified and listed, and the school administration was informed to refer these students to a specialist. It was found that 102 out of 166 students evaluated at Zübeyde Hanım Middle School, 35 out of 51 students evaluated at Sakarya Anatolian High School, 42 out of 47 students evaluated at Serdivan Anatolian Imam Hatip High School, 143 out of 218 students evaluated at Serdivan Farabi Vocational and Technical Anatolian High School, and 26 out of 44 students evaluated at 15 Temmuz Şehitler Science High School had musculoskeletal pain.

Data were analysed using IBM SPSS Statistics 23.0. Frequency distributions for categorical variables and descriptive statistics for numerical variables (mean, standard deviation, minimum, maximum) were used to evaluate the study data. When examining the difference between categorical variables with two groups, the "significance test of the difference between two means" (independent t-test) was used, and when there were more than two groups, the "one-way analysis of variance" (ANOVA) was used.

Ethical Principles of Study

For the study, permission was obtained from Sakarya University Clinical Research Ethics Committee (number 71522473/050.01.04/209 dated 3/11/2017). For the collection of research data, the necessary permissions were obtained from Serdivan District Governorate, Serdivan District National Education Directorate and the schools mentioned in the study. In addition, verbal and written consent was obtained from the participating students and their families.

Results

Characteristics of the Total Population

A total of 51.6% of the students (n=525) participating in the study are female and the mean age is 14.08 years. The birth setting was hospital with a rate of 91.8% and the highest rate was vaginal birth with a rate of 55.6%. There was a relationship between the parents of 10.5% of the students.

A total of 53.5% of the adolescents exercised regularly, 64.2% spent 1-2 hours per week using a computer, 18.8% spent 3-5 hours per week and 17.0% spent more than 5 hours per week using a computer. In terms of rucksack carrying, 17.9% of students carried their rucksack on one shoulder, 81.9% carried it on both shoulders and 0.2% carried a wheelie bag.

Obesity was diagnosed in 3.1% of mothers, 3.8% of fathers, 1.1% of both mothers and fathers and 1.9% of siblings.

According to the results of the analysis, a total of 69.7% of the adolescents were of normal weight. Their BMI (Body Mass Index) distributions are shown in Table 1.

Table 1. BMI distributions of the students according to their genders

		Gender					
		Female		Male		Total	
		N	%	N	%	N	%
BMI	Thin	34	12.5	29	11.4	63	12.0
	Normal Weight	189	69.7	177	69.7	366	69.7
	Over weight/Obese	48	17.7	48	18.9	96	18.3
	Total	271	100.0	254	100.0	525	100.0

BMI: (Body Mass Index)

In our study, we used BMI percentile values adapted to healthy Turkish children, which were carried out by Neyzi and his colleagues in our country in 2008 (Neyzi et al., 2008). In their evaluation; BMI 5th percentile and below was defined as underweight, 5-85th percentile range as normal weight, 85-95th percentile range as overweight and 95th percentile and above as obese (Child and Teen BMI Categories, 2024; Saner et al., 2010).

Musculoskeletal Pain Findings

A total of 40.39% (n=212) reported pain, while 59.61% (n=313) reported no pain. When examining the pain areas of the students who reported pain, 24.1% of the students had pain in the neck and shoulder, 20.3% in the back, 14.1% in the waist-hip, 7.1% in the knee and 19.3% in the foot-ankle. The results also show that 35.6% of students consulted a doctor because of pain that occurred when they moved.

When the regions of pain were analysed according to gender, there was no statistically significant difference between the sexes in the mean scores for the upper arm, forearm, hip, thigh, knee, lower leg and foot regions ($p>0.05$). The average scores for the shoulder, back, waist and wrist were higher for girls than for boys, which was statistically significant ($p<0.05$).

As shown in Table 2, the mean pain perception was 9.32 in girls and 5.89 in boys; the mean pain intensity was 4.58 in girls and 3.13 in boys; the mean inhibition was 4.51 in girls and 3.11 in boys; and the total scale score was 18.40 in girls and 12.12 in boys. Girls had statistically significant higher mean scores than boys for pain perception, pain severity, limitation and overall (Table 2).

Table 2. Mean scores from the CMDQ scale

	Female		Male		General	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Feeling the pain	9.32	12.521	5.89	11.524	7.66	12.159
Severity of the pain	4.58	4.783	3.13	4.712	3.88	4.800
Limitation	4.51	4.666	3.11	4.640	3.83	4.701
General Score	18.40	21.138	12.12	19.712	15.36	20.681

A total of 53.5% of the participants exercised regularly, and the proportion of those who reported their exercise frequency as 1-2 hours per week was 34.3%. According to the results of the independent samples t-test; there was no statistically significant difference between the mean scores of pain perception, pain severity, limitation and overall score between girls and boys in terms of their weekly exercise performance ($p>0.05$).

Examining the findings related to the use of technological goods such as computers, tablets, etc. and their effects on pain, it was found that 64.2% of the students spent approximately 1-2 hours, 18.8% spent 3-5 hours and 17.0% spent more than 5 hours per week using computers. The results of the ANOVA test showed that there was no statistically significant difference between the level of long-term use of technological devices and the average scores of pain sensation, pain severity, limitation and general scores for boys and girls ($p>0.05$). According to the results of a study conducted by Skemiene and colleagues in Lithuania in 2012, it was found that musculoskeletal pain in adolescents aged 13-18 years was associated with computer use and duration. (Skemiene et al., 2012). An epidemiological study by Silva and colleagues found that 31.8% of adolescents who used computers had at least one musculoskeletal pain symptom (Silva et al., 2016, Scarabottolo et al., 2017). Neck and shoulder pain increased in parallel with the increase in computer use, internet use, digital games and mobile phone use. The risk of neck and shoulder pain increased when computer use was 2-3 hours or more per day, and the risk of back pain increased when computer use and digital game playing exceeded 5 hours per day (Hakala, Rimpela, Saarni & Salminen, 2006). A study conducted in Turkey in 2008 by Kuzu and colleagues found that computer and internet use caused physiological and psychological problems such as eye strain.

A study conducted in Türkiye by Kuzu and colleagues in 2008 found that computer and internet use caused physiological and psychological problems such as eye strain/red eyes, back/neck pain, headaches, joint/muscle pain, fatigue, insomnia, tension, stress, weight gain and eating problems, and that these problems increased with the duration of internet and computer use (Kuzu et al., 2008, Akbulut 2013, Arslan et al., 2014). In the studies reviewed, it was concluded that the duration and frequency of use of technological devices causes pain to individuals at different rates and in different parts of the body. It was observed that the adolescents participating in our study did not use technological devices for more than 2 hours, and the comparison was made according to this result.

When the states of carrying a backpack and feeling pain were examined, it was found that a total of 17.9% of the students carried their backpacks on one shoulder, 81.9% carried them on both shoulders and 0.2% carried wheelie bags. Independent samples t-test showed that there was no statistically significant difference between backpack carrying status and pain sensation, pain severity, limitation and general mean scores of girls and boys ($p>0.05$).

Table 3. Statistical significance of CMDQ scale and subgroup scores according to BMI status

		Female				Male			
		Mean	**S.D.**	**F**	**p**	**Mean**	**S.D.**	**F**	**p**
Feeling the pain	Thin	6.51	6.922	1.076	0.342	11.91	20.882	4.644	**0.010**
	Normal	9.53	13.369			5.00	9.343		
	Overweight / Obese	10.45	12.036			5.50	10.136		
Severity of pain	Thin	4.32	4.897	0.062	0.939	4.38	5.039	1.216	0.298
	Normal	4.63	4.960			2.91	4.228		
	Overweight / Obese	4.54	4.010			3.17	6.026		
Limitation	Thin	4.24	4.729	0.149	0.862	4.52	5.145	1.567	0.211
	Normal	4.48	4.750			2.88	4.147		
	Overweight / Obese	4.79	4.356			3.10	5.854		
General score	Thin	15.07	15.595	0.535	0.586	20.81	29.634	3.288	**0.039**
	Normal	18.65	22.429			10.79	16.855		
	Overweight / Obese	19.78	19.326			11.77	21.243		

In the analysis of BMI and pain status, it was found that there was no statistically significant difference between the BMI status of both sexes in terms of pain sensation, pain severity, limitation and general mean scores of girls and pain severity and limitation mean scores of boys ($p>0.05$), but there was a statistically significant difference between the BMI status in terms of sub-dimensions of pain sensation and general mean scores of boys ($p<0.05$). According to this finding, pain perception and general mean scores were significantly higher in thin boys than in normal or overweight/obese boys (Table 3).

Discussion

As adolescence is an important milestone in growth and development, it is also a critical period for musculoskeletal disorders (Martínez-Romero, Cejudo & Sainz de Baranda, 2022). Musculoskeletal pain is generally more common in female students than in male students, and childhood pain can persist into adulthood. For example, back and lower back pain is more common in 14-year-old girls than boys in the same population (Salim & Vishal, 2021). A study of high school students in Scotland found that girls reported significantly more headaches and shoulder and neck pain than boys after prolonged computer use (Nazari et al., 2020; Alexander and Currie, 2004). According to the results of another study by Akturk and colleagues (2019), it was found out that more than half of the students (57.3%) had musculoskeletal disorders in one or more parts of their body and the majority of these students (52.2%) consisted of girls (Aktürk, Büyükavcı & Aktürk, 2019). It has been proven in studies that musculoskeletal disorders differ significantly according to gender and in our study, the pain regions were investigated according to gender. The results showed that there was no statistically significant difference between genders in terms of mean scores in the upper arm, forearm, hip, thigh, knee, lower leg and foot regions ($p>0.05$). However, the mean pain scores in the neck, shoulder, back, waist and wrist regions were statistically significantly higher in female students than male students ($p<0.05$). In this respect, the results of the relevant literature and the results of our study are similar. It is stated that the reason for this finding is that girls are more sedentary than boys and have an underdeveloped musculoskeletal system (Zakeri et al., 2016).

Vitta et al. conducted a study in 2021 to determine the factors associated with the frequency and severity of low back pain in high school students. According to the findings, the majority of students suffering from back pain are female students and the severity of pain is reported to be higher in female students aged 14-18 years. (Vitta et al., 2021).

Malmborg et al. (2022) found that the prevalence of musculoskeletal pain and the rate of reporting pain in more than one part of the body was higher in girls than in boys during the period from 14 to 16 years of age. (Malmborg, Bremander, Bergman, Haglund & Olsson, 2022). Another study found that the severity of pain was higher in female adolescents than in males (Toghroli et al., 2021). Similarly, our study found that the mean scores for pain perception, pain severity, limitation and overall scores were statistically significantly higher in female students compared to male students ($p<0.05$).

Based on the results of a study by Cankurtaran et al. (2021), a total of 1000 healthy students were examined and a significant correlation was found between neck pain and the use of computers to play games was found to be 86.96 ± 67.30 min, for tablet it is 65.18 ± 55.99 min, for phone it is 75.88 ± 70.78min. In addition, there was a statistically significant relationship between game addiction on digital devices and pain in the wrists, back and lower back (Cankurtaran et al., 2022).

A study by Nastri et al. (2021) concluded that the use of digital media (computers, internet, electronic devices and mobile phones) was a risk factor for musculoskeletal pain in healthy and obese adolescents (Nastri et al., 2021). It is thought that the lack of a significant association with the presence of pain is due to the fact that 64.2% of the adolescents in our study did not spend more than 2 hours a day in front of a computer.

Daily computer use of 2 hours or more increases the risk of pain in most anatomical regions (Hakala et al., 2012). Bilgin and Kutsal also emphasised in their study that musculoskeletal symptoms, which can range from moderate to severe in daily life, are usually caused by sitting in front of the computer for more than 2 hours. This information supports the lack of difference in our study in terms of the relationship between the duration of technological device use and the gradual increase in time (Bilgin & Kutsal 2017).

The difference between the relevant literature and our findings is due to the fact that more than half of the adolescents participating in our study did not spend more than two hours per day using computers. In the study conducted by Khan et al., it was expressed that the threshold for neck and shoulders was more than 2-3 hours of computer use per day and for lower back pain it was more than 5 hours. This information supports the lack of significant difference in our study (Khan, Shahid, Nasir, Karamat & Abdullah, 2021).Students carry backpacks to carry their books and other educational materials. Several studies have shown that backpack carrying affects the musculoskeletal system and posture in children and adolescents. In a systematic review aimed at investigating the relationship between backpack carrying and musculoskeletal pain and posture in Iranian students, it was found that backpack carrying, duration of carrying, type of backpack and weight had a significant effect on back, wrist, shoulder, upper back and neck pain in general (Sheikhhoseini, Sayyadi & Piri, 2021). In another study by Khawar et al. (2021), it was clearly expressed that the fact that most of the students had reported musculoskeletal pain due to school bag carrying was an indicator of the effect of ergonomically incompatible school bag carrying or inappropriate use of school bags on the early development of musculoskeletal pain and disorders (Khawar et al., 2021).

Toghroli et al. (2021) pointed out the statistically significant positive correlation between backpack carrying pain and the prevalence of musculoskeletal disorders in most male and female adolescents (Toghroli et al., 2021). In our study, no significant difference was found between backpack carrying status and musculoskeletal pain ($p>0.05$).When comparing the results of the literature and our study, it was found that the majority (81.9%) of the adolescent students participating in our study carried their backpacks on both shoulders. In this regard, it has been suggested that the way students carry their backpacks is an effective factor in reducing musculoskeletal pain.Health recommendations on backpack carrying styles have been made by Nemours Kids Health and it has been emphasised that backpacks should be carried on both shoulders (Backpack Basics, 2023).

Limitations

Students were not classified according to whether or not they were preparing for university exams. Exam stress, excessive sitting, staying in the same position for a long time, and intensive question solving may cause increased pain in high school students and especially in senior students. Further studies investigating these variables should also be carried out. In addition, students' absences from school during the data collection period due to illnesses such as flu or school exams were not taken into account, and only students who attended school during the period were included in the study.

Implications for Practice

The incidence of pain problems in children and adolescents has increased over the last 20 years and is now considered an important public health problem. In this context, it is important to identify pain at an early stage and to direct treatment through screening programmes implemented by school nurses.

Conclusions

Children and adolescents most often experience recurrent or chronic pain conditions such as headache, abdominal pain or musculoskeletal pain. According to the results of our study; it was found that girls reported

more pain than boys, regular exercise, long-term use of technological devices, carrying a backpack and body mass index were not associated with pain in girls. The pain experienced affects the daily and social lives of children and adolescents. In this context;

- It is clear that there is a need for preventive programmes involving parents, school nurses and teachers.
- Students with musculoskeletal problems should be identified as early as possible through screening programmes in schools and referred to health services for appropriate treatment. In this context, it is considered appropriate to assign school nurses to schools and areas where an institutional approach to adolescent health problems can be provided.
- It is thought that it would be beneficial to conduct awareness studies among adolescents within the school health framework, as well as early diagnosis and screening programmes for adolescents who experience intense and severe pain and limited movement due to activities.
- In addition, this study did not differentiate between students according to their preparation period for central exams. In high school students, especially in the final year, exam stress, excessive sitting, staying in the same position and intensive problem solving may increase pain. Studies investigating these variables should also be carried out.

Declaration of competing interests

The author(s) declared no potential conflicts of interest with regard to the research, authorship, and/or publication of this article.

References

Adegbehingbe, O. O., Fatusi, A. O., Adegbenro, C. A., Late, A. O. O., Abass, G. O., & Akintunde, A. (2009). Musculoskeletal disorders: Epidemiology and treatment seeking behavior of secondary school students in a Nigerian community. *Indian Journal of Community Medicine, 34*(1), 52–56. https://doi.org/10.4103/0970-0218.51231

Akbulut, Y. (2013). Çocuk ve ergenlerde bilgisayar ve internet kullanımının gelişimsel sonuçları. *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 3*(2), 53–68.

Aktürk, S., Büyükavcı, R., & Aktürk, Ü. (2019). Relationship between musculoskeletal disorders and physical inactivity in adolescents. *Journal of Public Health, 27*(1), 49–56. https://doi.org/10.1007/s10389-018-0923-7

Alaca, N., Safran, E. E., Karamanlargil, A. İ., & Timucin, E. (2019). Translation and cross-cultural adaptation of the extended version of the Nordic musculoskeletal questionnaire into Turkish. *Journal of Musculoskeletal & Neuronal Interactions, 19*(4), 472.

Alexander, L. M., & Currie, C. (2004). Young people's computer use: Implications for health education. *Health Education, 104*(4), 254–261. https://doi.org/10.1108/09654280410546745

Arslan, E., Bütün, P., Doğan, M., Dağ, H., Serdarzade, C., & Arıca, V. (2014). Çocukluk çağında bilgisayar ve internet kullanımı. *İzmir Dr. Behçet Uz Çocuk Hastalıkları Dergisi, 4*(3), 195–201. https://doi.org/10.5222/buchd.2014.195

Azma, K., Hosseini, A., Safarian, M. H., & Abedi, M. (2015). Evaluation of the relationship between musculoskeletal discomforts and occupational stressors among nurses. *North American Journal of Medical Sciences, 7*(7), 322. https://doi.org/10.4103/1947-2714.161250

Backpack Basics. (n.d.). KidsHealth. https://kidshealth.org/en/teens/backpack.html (Accessed: 21.01.2023)

Bilgin, E., & Kutsal, Y. G. (2017). Bilgisayar kullanımı ile ilişkili boyun ve üst ekstremite rahatsızlıkları. *STED Dergisi, 26*(6), 251–255.

Cankurtaran, F., Menevşe, O., Namlı, A., Kızıltoprak, H. Ş., Altay, S., Duran, M., ... & Ekşi, C. (2022). The impact of digital game addiction on musculoskeletal system of secondary school children. *Nigerian Journal of Clinical Practice, 25*(2), 153. https://doi.org/10.4103/njcp.njcp_177_20

Child and Teen BMI Categories. (2024). Centers for Disease Control and Prevention. https://www.cdc.gov/bmi/child-teen-calculator/bmi-categories.html

D'Aversa, A., Bonetti, F., Gallotti, M., & Maselli, F. (2021). Is it really musculoskeletal pain? Differential diagnosis and screening for referral in paediatric musculoskeletal disorders: A scoping review protocol. *MedRxiv*. https://doi.org/10.1101/2021.11.23.21266780

Demir Pulat, H., & Turgut, S. (2022). Turkish version of the preschool children's nutrition screening tool (Nutristep®): A validity and reliability study. *European Journal of Clinical Nutrition, 76*(6), 1–7. https://doi.org/10.1038/s41430-022-01092-8

Demir, Y. P., Çırak, Y., Dalkılınç, M., Yılmaz, G., Uraş, İ., & Kömürcü, M. (2012). İlkokul çocuklarında çanta taşıma, bilgisayar kullanma alışkanlığı ve postür. *Ankara Medical Journal, 12*(4), 182–187.

Ece, C. (2021). The relations between the family nutrition and physical activity levels and prevalence of obesity of their children in Turkey. *Progress in Nutrition, 23*(1). https://doi.org/10.23751/pn.v23iS1.11611

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. https://doi.org/10.3233/WOR-2011-1173

Giersbergen, M., & Argon, G. (2017). Kas iskelet sisteminin değerlendirilmesi ve klinik karar verme. Içinde: F. Eti Aslan (Editör), *Sağlığın Değerlendirilmesi ve Klinik Karar Verme*. Akademisyen Tıp Kitabevi.

Hakala, P. T., Rimpela, A. H., Saarni, L. A., & Salminen, J. J. (2006). Frequent computer-related activities increase the risk of neck–shoulder and low back pain in adolescents. *European Journal of Public Health, 16*(5), 536–541. https://doi.org/10.1093/eurpub/ckl025

Hakala, P. T., Saarni, L. A., Punamäki, R. L., Wallenius, M. A., Nygård, C. H., & Rimpelä, A. H. (2012). Musculoskeletal symptoms and computer use among Finnish adolescents: Pain intensity and inconvenience to everyday life: A cross-sectional study. *BMC Musculoskeletal Disorders, 13*(41). https://doi.org/10.1186/1471-2474-13-41

Student Specific Cornell Musculoskeletal Discomfort Questionnaires (SS-CMDQ). (n.d.). Cornell University. https://ergo.human.cornell.edu/ahSSCMDQquest.html

İde, D., & Gündüz, T. (2021). Koronavirüs kapanma (kısıtlama) döneminde üniversite öğrencilerinin yorgunluk düzeyi ve kas-iskelet sistemi rahatsızlıkları arasındaki ilişkinin bazı değişkenler açısından incelenmesi. *Ergonomi (Online), 4*(2), 107–118. https://doi.org/10.33439/ergonomi.935728

İlleez, Ö. G. (2016). Çocuk ve adölesan yaş grubunda bel ağrılarına genel yaklaşım. *Boğaziçi Tıp Dergisi, 3*(3), 113–117.

Khan, F. M., Shahid, M. H., Nasir, M., Karamat, A., & Abdullah, C. (2021). Screen time-related musculoskeletal symptoms among adolescents: A cross-sectional survey in twin cities. *Pakistan Journal of Public Health, 11*(3), 132–135. https://doi.org/10.32413/pjph.v11i3.527

Khawar, A., Khan, A., Kanwal, A., Munir, K., Omar, J., Najam, S., Zia, S., Ali, M. U., & Khaliq, N. (2021). Musculoskeletal pains associated with schoolbag carriage in children and adolescents: A cross-sectional study in twin cities. *BMC Journal of Medical Sciences, 2*(2), 41–45. https://doi.org/10.70905/bmcj.02.02.022

Kurt, S., İbiş, S., Aktuğ, Z. B., & Aka, H. (2021). Üniversite öğrencilerinin kas iskelet sistemi rahatsızlıkları ile fiziksel aktivite düzeyi ve internet bağımlılığı arasındaki ilişkinin incelenmesi. *Uluslararası Güncel Eğitim Araştırmaları Dergisi, 7*(2), 709–721.

Kuzu, A., Odabaşı, H. F., Erişti, S. D., Kabakçı, I., Kurt, A. A., Akbulut, Y., Dursun, Ö. Ö., Kıyıcı, M., & Şendağ, S. (2008). İnternet kullanımı ve aile. T.C. Başbakanlık Aile ve Sosyal Araştırmalar Genel Müdürlüğü. https://ailetoplum.aile.gov.tr/uploads/pages/arastirmalar/internet-ve-aile.pdf

Malmborg, J. S., Bremander, A., Bergman, S., Haglund, E., & Olsson, M. C. (2022). Musculoskeletal pain and its association with health status, maturity, and sports performance in adolescent sport school students: A 2-year follow-up. *BMC Sports Science, Medicine and Rehabilitation, 14*(1), 1–11. https://doi.org/10.1186/s13102-022-00437-x

Martínez-Romero, M. T., Cejudo, A., & Sainz de Baranda, P. (2022). Prevalence and characteristics of back pain in children and adolescents from the region of Murcia (Spain): ISQUIOS programme. *International Journal of Environmental Research and Public Health, 19*(2), 946. https://doi.org/10.3390/ijerph19020946

Martins, R. L., Carvalho, N., Albuquerque, C., Andrade, A., Martins, C., Campos, S., Batista, S., & Dinis, A. I. (2020). Musculoskeletal disorders in adolescents: A study on prevalence and determining factors. *Acta Paulista de Enfermagem, 33*(1), 1–8. https://doi.org/10.37689/acta-ape/2020AO0173

Mousa, U. (2012). Ötiroid tiroid patolojilerinde metabolik parametreler ve vücut yağ dağılımı. *Başkent Üniversitesi Tıp Fakültesi İç Hastalıkları Anabilim Dalı Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı Yan Dal Uzmanlık Tezi*.

Nastri, M. M. F., Lourenço, B., Queiroz, L. B., da Silva, L. E. V., Lourenço, D. M. R., Castro, A. P. B. M., Silva, C. A., & Pastorino, A. C. (2021). Idiopathic musculoskeletal pain, musculoskeletal pain syndromes, and use of electronic devices in adolescents with asthma. *Jornal de Pediatria*. https://doi.org/10.1016/j.jped.2021.06.002

Nazari, M., Beigi, R., Salesi, M., Cousins, R., & Mokarami, H. (2020). Development and validation of the tool for the evaluation of the behavioral factors affecting the prevalence of musculoskeletal disorders in Iranian students. *BMC Pediatrics, 20*(1), 1–9. https://doi.org/10.1186/s12887-020-02452-8

Neyzi, O., Günöz, H., Furman, A., Bundak, R., Gökçay, G., Darendeliler, F., & Baş, F. (2008). Türk çocuklarında vücut ağırlığı, boy uzunluğu, baş çevresi ve vücut kitle indeksi referans değerleri. *Çocuk Sağlığı ve Hastalıkları Dergisi, 51*(1), 1–14. https://cshd.org.tr/article/view/354

Nunnally, J. C. (1978). *Psychometric Theory* (2nd ed.). New York: McGraw-Hill.

Özdemir, S., Gençbaş, D., Tosun, B., Bebiş, H., & Sinan, O. (2021). Musculoskeletal pain, related factors, and posture profiles among adolescents: A cross-sectional study from Turkey. *Pain Management Nursing, 22*(4), 522–530. https://doi.org/10.1016/j.pmn.2020.11.013

Pereira, D. S., Castro, S. S., Bertoncello, D., Damião, R., & Walsh, I. A. (2013). Relationship of musculoskeletal pain with physical and functional variables and with postural changes in school children from 6 to 12 years of age. *Brazilian Journal of Physical Therapy, 17,* 392–400. https://doi.org/10.1590/S1413-35552013005000106

Prathivadi Bhayankaram, N., Lacey, R. J., Barnett, L. A., Jordan, K. P., & Dunn, K. M. (2020). Musculoskeletal consultations from childhood to adulthood: A longitudinal study. *Journal of Public Health, 42*(4), E428–E434. https://doi.org/10.1093/pubmed/fdz141

Rezapur-Shahkolai, F., Gheysvandi, E., Karimi-Shahanjarini, A., Tapak, L., Heidarimoghadam, R., & Dianat, I. (2021). Identification of factors related to behaviors associated with musculoskeletal pain among elementary students. *BMC Musculoskeletal Disorders, 22*(1), 1–12. https://doi.org/10.1186/s12891-021-04413-3

Salim, N., & Vishal, J. (2021). Prevalence and factors associated with musculoskeletal pain among secondary school students. *International Journal of Musculoskeletal Pain Prevention, 6*(3), 519–528. https://doi.org/10.52547/ijmpp.6.3.519

Saner, G., Durmaz, Ö., & Gökçe, S. (2010). Beslenme durumunun değerlendirilmesi. In O. Neyzi & T. Ertuğrul (Eds.), *Pediatri* (4. baskı, cilt 1, pp. 233–238). İstanbul: Nobel Tıp Kitabevi.

Scarabottolo, C. C., Pinto, R. Z., Oliveira, C. B., Zanuto, E. F., Cardoso, J. R., & Christofaro, D. G. D. (2017). Back and neck pain prevalence and their association with physical inactivity domains in adolescents. *European Spine Journal, 26*(9), 2274–2280. https://doi.org/10.1007/s00586-017-5144-1

Sheikhhoseini, R., Sayyadi, P., & Piri, H. (2021). The relationship between schoolbag carriage with musculoskeletal pain and posture in Iranian students: A systematic review study. *Journal of Orthopedic and Spine Trauma, 7*(4), 123–126. https://doi.org/10.18502/jost.v7i4.8857

Silva, G. R. R., Pitangui, A. C. R., Xavier, M. K. A., Correia-Júnior, M. A. V., & Araújo, R. C. (2016). Prevalence of musculoskeletal pain in adolescents and association with computer and videogame use. *Jornal de Pediatria (Rio J), 92*(2), 188–196. https://doi.org/10.1016/j.jped.2015.06.006

Skemiene, L., Ustinaviciene, R., Luksiene, D., Radisauskas, R., & Kaliniene, G. (2012). Computer use and musculoskeletal complaints in the Lithuanian adolescent population. *Central European Journal of Medicine, 7*(2), 203–208. https://doi.org/10.2478/s11536-011-0126-x

Student Specific Cornell Musculoskeletal Discomfort Questionnaires (SS-CMDQ). https://ergo.human.cornell.edu/ahSSCMDQquest.html.

Toghroli, R., Reisy, L., Mansourian, M., Azar, F. E. F., Ziapour, A., Mehedi, N., & Nejhaddadgar, N. (2021). Backpack improper use causes musculoskeletal injuries in adolescents: A systematic review. *Journal of Education and Health Promotion, 10*(1), 237. https://doi.org/10.4103/jehp.jehp_306_20

Vitta, A., de Oliveira, P. P., Bento, T. P. F., Cornélio, G. P., Felippe, L. A., & Simeão, S. F. A. P. (2021). Factors associated with intensity and frequent low back pain in high school students. *ABCS Health Sciences, 46,* E021223. https://doi.org/10.7322/abcshs.2020043.1997

Yosmaoğlu, H. B., Baltacı, G., & Derman, O. (2010). Obez adolesanlarda vücut yağı ölçüm yöntemlerinin etkinliği. *Fizyoterapi ve Rehabilitasyon, 21*(3), 125–131.

Zakeri, Y., Baraz, S., Gheibizadeh, M., Nejad, D. B., & Latifi, S. M. (2016). Prevalence of musculoskeletal disorders in primary school students in Abadan-Iran in 2014. *International Journal of Pediatrics, 4*(1), 1215–1223. https://doi.org/10.22038/ijp.2016.6265