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ORIGINAL ARTICLE

Effects of Physical Activity Level and Sedentary Behavior on the Musculoskeletal System in Young Adults

Genç Erişkinlerde Fiziksel Aktivite Düzeyi ve Sedanter Davranişin Kas-İskelet Sistemi Üzerindeki Etkileri

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ABSTRACT

Aims: To investigate the relationship between the level of physical activity and sedentary behavior in young adults aged 18-35 and to evaluate the effects of this relationship on musculoskeletal pain, posture, muscle shortness, and trunk muscle endurance
Material and Methods: 219 students were included in this cross-sectional study. Data were obtained by using the case report form which determines the demographic characteristics and sedentary behavior of the students, The International Physical Activity Index - short form, posture analysis form, muscle shortness evaluation form, and trunk muscle endurance evaluation form.
Results: In the study, 66.2% of patients were female and 33.8% were male. The ratio of highly active individuals in males, and inactive and insufficiently active individuals in females was significantly higher (p <0.05). Musculoskeletal pain was significantly higher in inactive and insufficiently active individuals (p<0.001). A statistically significant negative correlation exists between physical activity level and pain frequency, duration, and pain scores (p<0.001). There was a statistically significant positive correlation between trunk endurance tests and both physical activity level and exercise participation. In individuals who did not exercise, there was a significant shortening of the lumbar extensor muscles and gastrosoleus and an increase in thoracic kyphosis (p<0.05). It was observed that a statistically significant positive correlation exists between daily sitting time and elbow, wrist, and knee pain, an increase in lumbar lordosis (p<0.05). In those who spent more time in front of the computer, head-neck and elbow pain, the duration of pain, and pain scores, the shortness of the teres major, latissimus dorsi, rhomboideus major, and minor muscles, thoracic kyphosis, shoulder protraction, and anterior head tilt were significantly higher (p<0.05).
Conclusion: In our study, we observed that students with low levels of physical activity and sedentary behavior experienced decreased trunk muscle endurance, posture disorders, increased pain, and heightened muscle shortness.

Keywords: Musculoskeletal disorders, Muscle shortness, Pain, Pphysical activity,Posture, Sedentary lifestyle, Trunk muscle endurance, Young adults Epicardial adipose tissue, Cardiovascular disease, monocyte-HDL ratio, Nonalcoholic fatty liver disease, Inflammation

ÖZ

Amaç: 18-35 yaş arası genç erişkinlerde fiziksel aktivite düzeyi ile sedanter davranış arasındaki ilişkiyi araştırmak ve bu ilişkinin kas-iskelet sistemi ağrısı, postür, kas kısalığı ve gövde kas dayanıklılığı üzerine etkilerini değerlendirmek.
Gereç ve Yöntemler: Bu kesitsel çalışmaya 219 öğrenci dahil edildi. Veriler, öğrencilerin demografik özelliklerini ve sedanter davranışlarını belirleyen vaka bildirim formu, Uluslararası Fiziksel Aktivite İndeksi-kısa formu, duruş analiz formu, kas kısalığı değerlendirme formu ve gövde kas dayanıklılığı değerlendirme formu kullanılarak elde edildi.
Bulgular: Araştırmada hastaların %66,2'si kadın, %33,8'i erkekti. Erkeklerde çok aktif olanların oranı, kadınlarda ise inaktif ve yetersiz aktif olanların oranı anlamlı derecede yüksekti (p<0,05). Kas-iskelet ağrısı, hareketsiz ve yeterince aktif olmayan bireylerde anlamlı olarak daha yüksekti (p<0,001). Fiziksel aktivite düzeyi ile ağrı sıklığı, süresi ve ağrı skorları arasında istatistiksel olarak anlamlı negatif korelasyon bulunmaktadır (p<0,001). Gövde dayanıklılık testleri ile hem fiziksel aktivite düzeyi hem de egzersiz katılımı arasında istatistiksel olarak anlamlı pozitif korelasyon vardı. Egzersiz yapmayan bireylerde lomber ekstansör kaslarda ve gastrosoleusta anlamlı kısalma ve torakal kifozda artış görüldü (p<0.05). Günlük oturma süresi ile dirsek, el bileği ve diz ağrısı, lomber lordoz artışı arasında istatistiksel olarak anlamlı pozitif korelasyon olduğu görüldü (p<0,05). Bilgisayar başında daha fazla vakit geçirenlerde baş-boyun ve dirsek ağrıları, ağrı süresi ve ağrı skorları, teres major, latissimus dorsi, rhomboideus major ve minör kaslarının kısalığı, torakal kifoz, omuz protraksiyonu ve anterior baş eğimi anlamlı derecede yüksekti (p<0.05).
Tartışma: Çalışmamızda fiziksel aktivite düzeyi düşük ve sedanter davranış sergileyen öğrencilerin gövde kas dayanıklılığında azalma, duruş bozuklukları, ağrı artışı ve kas kısalığında artış yaşadıklarını gözlemledik.

Anahtar Kelimeler: Epikardial yağ dokusu, Kardiyovaskuler hastalık, Monosit-HDL oranı, Nonalkolik yaplı karaciğer hastalığı, İnflamasyon

Introductıon

Physical activity is the actions that use our muscles and joints in daily life, increase our respiration and heart rate, and cause fatigue (such as walking, running, jumping, swimming, and cycling) (1). There are studies with strong evidence showing that an adequate level of physical activity improves body composition, bone health, cardiorespiratory endurance, muscle strength, and health-related blood levels in individuals of all age groups (2,3). The World Health Organization (WHO)

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recommends for a healthy lifestyle that adults aged 18 to 64 engage in at least 150 minutes of moderate or 75 minutes of vigorous physical activity (PA) per week and limit the time spent sitting (4). Studies on participation in lifelong physical activity have shown that the rate of individuals' participation in physical activity decreases especially depending on age. Especially the university period is considered as one of the most critical periods in gaining or quitting the habit of doing regular physical activity (5).

Sedentary behaviors are defined as any waking activity characterized by energy expenditure of ≤1.5 metabolic equivalents (METs) in a sitting, lying, or reclining position. These behaviors have become increasingly common in modern societies due to changes in physical, social, and economic environments (6). Young adults, in particular, spend increasingly more time studying, watching TV, or playing computer and console games, and these risky behaviors pose a threat to their future health. The increase in diseases caused by physical inactivity, poor physical condition, and a sedentary lifestyle among young people is considered one of the most significant public health problems today (7,8).

Musculoskeletal diseases are a common both an occupational and public health problem in all societies that affects up to 20% of adults worldwide and contributes substantially to increased health costs and reduced productivity (9). The etiology of these disorders includes a sedentary lifestyle characterized by poor ergonomic conditions, poor posture, low physical activity level, and lack of exercise. Musculoskeletal complaints in young individuals have been increasing in recent years and they have a negative effect on daily life activities. Also, it has become a chronic, recurrent painful problem that can lead to school absenteeism, learning disabilities, and psychological problems (4). While public health research on sedentary behavior among working-age adults has largely focused on office workers (10), university students are also a population subgroup at risk for inactivity because they spend a significant portion of their time studying or in the classroom.

When we examined the literature, it was observed that the number of current studies evaluating the effects of a sedentary lifestyle and low physical activity level on the musculoskeletal system in university students is insufficient. The data from this study may be useful in assessing the impact of a sedentary lifestyle and low physical activity levels and guiding future interventions, given the following conditions: (1) Especially in developed countries, the number of university students constitutes a significant portion of the young adult population, (2) The number of students applying to university increases every year, (3) The university period is critical for the development of future life patterns, (4) Many health-related behaviors of adults are shaped in late adolescence and early adulthood. In light of this information, this study was designed to investigate the relationship between the level of physical activity and sedentary behavior in young adults aged 18-35 and to evaluate the effects of this relationship on musculoskeletal pain, posture, muscle shortness, and trunk muscle endurance.

Materıals And Methods

In this study, we hypothesized that in young adults with low physical activity levels and/or sedentary behavior, trunk muscle endurance will decrease, imbalance and shortness in trunk and posture muscles will increase, poorer physical condition and posture will be observed, and pain secondary to these musculoskeletal disorders will occur.

Study Design

This is a descriptive and cross-sectional study conducted to assess the relationship between the level of physical activity and sedentary behavior in young adults aged 18-35 and to examine the effects of this relationship on musculoskeletal pain, posture, muscle shortness, and trunk muscle endurance.

Participants

Individuals were recruited by the same researcher from a University Faculty of Health Sciences. 219 students aged 18-35, who agreed to participate and provided written informed consent, were enrolled in the study. Students with progressive chronic musculoskeletal problems, physical disabilities, progressive neurological deficits, and uncontrolled chronic diseases were excluded from the study.

Procedure

Demographic characteristics of patients, pain-related characteristics such as duration (months), frequency, and site, and the presence of sedentary behavior were recorded on a report form. In the sedentary behavior evaluation, daily sitting time, weekly course time, weekly time spent at the computer, and exercise status and duration (in terms of days per week and hours per day) were questioned. Pain threshold measurements for all patients were assessed using the

Visual Analogue Scale (VAS). When assessing pain with VAS, a 10 cm long horizontal line with closed corners was shown (11). The scale considered 0 cm to represent no pain and 10 cm as maximum pain. The physical activity level of the individuals was determined using the International Physical Activity Questionnaire - short form (IPAQ-short form) (12). The guideline prepared by The Physical Activity Guidelines Advisory Committee, which categorizes physical activity according to Metabolic equivalents of task (MET) intensities, was updated in 2018. The intensity defined for energy expended was maintained (13). This updated guideline established four levels of physical activity and in our study, the physical activity levels of the young adults were evaluated in these four categories:

Inactive: Not doing moderate or vigorous-intensity physical activity beyond the basic movements arising from daily life activities.

Insufficiently active: Doing some moderate- or vigorous-intensity physical activity but ≤ 150 minutes of moderate-intensity physical activity or ≤ 75 minutes of vigorous-intensity physical activity a week

Active: Doing the equivalent of 150 minutes to 300 minutes of moderate-intensity physical activity a week.

Highly active: Doing the equivalent of more than 300 minutes of moderate-intensity physical activity a week.

Posture analysis, muscle shortness test, and dynamic trunk muscle endurance test were evaluated at physical examination. Muscle shortness tests were performed on lumbar extensors, hamstring, gastrocnemius-soleus, tensor fascia lata, pectoral, teres major, latissimus dorsi, rhomboideus major and minor muscles. Sits up test, modified push-ups test, lateral flexion-repeat tests were examined in the evaluation of dynamic trunk muscle endurance. In posture analysis, students were evaluated from the anterior, lateral, and posterior and deviations from the normal axis were recorded.

Sample Size

This study, it is aimed to reach the students of the Faculty of Health Sciences an University. In determining the sample size, n = t2pq / d2 power analysis formula was used (Süt, 2011). In the study, the sample size was determined as 100-384 people a confidence interval of 90%, an error rate of 0.05, and an effect size of 0.35 based on the result of power analysis, and 219 volunteers were included.

Ethical Considerations

The present study was carried out according to the Declaration of Helsinki. The research was approved by an ethics committee (Non-interventional Clinical Researches Ethics Committee of a University, decision no 13948 dated 09/10/2018). An informed consent form was obtained from all participants to take part in the research.

Statistical Analysis

Statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) for Windows 22.0 software (IBM Corp. 2013, Armonk, USA.). The study's dependent variables included physical activity level and sedentary behavior, while independent variables encompassed demographic features, musculoskeletal pain, posture, muscle shortness, and trunk muscle endurance. Demographic data, such as age, sex, exercise, smoking, and drinking, were compared across all groups. Participant characteristics were summarized using means and standard deviations for continuous numerical variables and frequencies and percentages for categorical variables. Pain intensity, posture analysis, muscle shortness test, and dynamic trunk muscle endurance were assessed between groups. For continuous numerical variables, differences were analyzed using independent sample T-tests, Mann-Whitney U tests, Kruskal-Wallis H tests, and Analysis of Variance (ANOVA) as appropriate. Categorical variables were compared using the Chi-square test. Significant factors identified in the univariate analysis were included in a multivariate binary logistic regression analysis. The confidence interval was set at 95%, and statistical significance was determined at a p-value <0.05.

Results

In this study, 145 females (66.2%) and 74 males (33.8%) who were educated at the Faculty of Health Sciences were evaluated. The ages of the 219 individuals in the study ranged between 18 and 35, the mean age is 21.44±2.58.

Within the study population, 50 individuals (22.83%) were classified as inactive, 67 (30.59%) as insufficiently active, 49 (22.37%) as active, and 53 (24.20%) as highly active. A statistically significant positive correlation was identified between exercise status and physical activity level (rho value 0.336). Post hoc analysis indicated that exercise participation was significantly higher in highly active individuals and significantly lower in inactive individuals. However, no significant relationships were observed between physical activity level and daily sitting time, weekly course time, or weekly time spent at the computer. Detailed data can be found in Table 1.

Table 1. The Relationship Between Sedentary Behavior and Exercise and Physical Activity Level

	Total (N=219)		Inactive (N=50)		Insufficiently active (N=67)		Active (N=49)		Highly Active (N=53)		p value
	N (%)	Mean±SD	N(%)	Mean±SD	N (%)	Mean±SD	N(%)	Mean±SD	N (%)	Mean±SD	
Exercise											<0.001*
No	113 (51.6%)		39 (78%)		35 (52.2%)		25 (51%)		14 (26.4%)		
Yes	106 (48.4%)		11 (22%)		32 (47.8%)		24 (49%)		39 (73.6%)		
Exercise Time (Hours)		0.84±1.14		0.38±0.85		0.72±1.01		0.71±0.84		1.55±1.43	**<0.001**¥
Exercise Duration (Days)		1.65±2.06		0.60±1.17		1.67±2.16		1.57±1.99		2.70±2.19	**<0.001**¥
Daily Sitting Time (Hours)		4.59±2.19		4.34±2.19		5.03±2.51		4.14±1.74		4.70±2.07	0.201¥
Weekly Course Time (Hours)		26.22±10.30		24.92±10.15		27.36±10.03		24.47±11.41		27.64±9.56	0.462¥
Weekly Time Spent At The Compu-ter (Hours)		3.70±7.48		5.20±11.49		2.58±4.07		3.53±5.84		3.87±7.33	0.676¥

Data presented as mean (±SD) or number (N) of patients. SD= Standard deviation. The p-value refers to the difference between the groups. p<0.05 statistically significant. *Chi-square test. ¥ Kruskal Wallis H test.

The Effects of Physical Activity Level on Musculoskeletal Pain, Posture, Muscle Shortness, and Trunk Muscle Endurance

When examining the relationship between physical activity level and gender, a statistically significant association was observed. Post hoc analyses revealed that inactive and insufficiently active individuals were significantly more prevalent in the female gender, while highly active individuals were significantly more prevalent in the male gender. Furthermore, a statistically significant positive correlation was identified between height and weight with physical activity level (rho values 0.146, 0.161, respectively).

Table 2. Relationship between Demographic Data and Physical Activity Level

	Total (N=219)		Inactive (N=50)		Insufficiently active (N=67)		Active (N=49)		Highly Active (N=53)		p value
	N (%)	Mean±SD	N (%)	Mean±SD	N (%)	Mean±SD	N (%)	Mean±SD	N (%)	Mean±SD	
Gender											<0.001*
Female	145 (66.2%)		42 (84%)		52 (77.6%)		28 (57.1%)		23 (43.4%)		
Male	74 (33.8%)		8 (16%)		15 (22.4%)		21 (42.9%)		30 (56.6%)		
Age		21.44±2.58		21.69±2.64		21.22±2.46		21.57±2.49		21.19±2.37	0.363 ¥
Height (cm)		167.83±8.21		165.64±6.81		166.03±7.09		169.05±10.12		170.49±7.84	**<0.01** ¥
Weight (kg)		62.61±11.28		60.44±12.04		60.76±10.52		65.43±11.88		64.38±10.33	0.023 ¥
BMI		22.19±3.25		21.97±3.86		22.05±3.32		22.61±2.71		22.17±3.07	0.766#
Weak	18 (8.2%)		5 (10%)		9 (13.4%)		1 (2%)		3 (5.7%)		0.134*
Normal	167 (76.3%)		35 (70%)		51 (76.1%)		38 (77.6%)		43 (81.1%)		
Fat	27 (12.3%)		8 (16%)		5 (7.5%)		10 (20.4%)		4 (7.5%)		
Over-weight	6 (2.7%)		1 (2%)		2 (3%)		0 (0%)		3 (5.7%)		
Obese	1 (0.5%)		1 (2%)		0 (0%)		0 (0%)		0 (0%)		
Place of resi-dence											0.268*
Student Dor-mitory	139 (63.5%)		34 (68%)		49 (73.1%)		28 (57.1%)		28 (52.8%)		
Apart	8 (3.7%)		2 (4%)		1 (1.5%)		3 (6.1%)		2 (3.8%)		
House	72 (32.9%)		14 (28%)		17 (25.4%)		18 (36.7%)		23 (43.4%)		

Data presented as mean (±SD) or number (N) of patients. BMI= Body Mass Index. SD= Standard deviation. The p-value refers to the difference between the groups. p<0.05 statistically significant. *Chi-square test. ¥ Kruskal Wallis H test. #Analysis of Variance (ANOVA)

This correlation was significantly higher in active and highly active individuals. It is worth noting that this trend may be attributed to the significantly greater number of highly active individuals within the male gender. No statistically significant relationships were found between physical activity level and other demographic variables. Detailed data are presented in Table 2.

When examining the relationship between musculoskeletal pain and physical activity level, it was observed that 32 (64%) of inactive individuals, all 67 (100%) of insufficiently active individuals, and 25 (47.2%) of highly active individuals reported pain complaints. In contrast, no complaints of pain were noted in the active individuals. These findings indicated a statistically significant relationship between physical activity level and musculoskeletal pain. Post hoc analyses revealed that pain complaints were significantly higher in inactive and insufficiently active individuals (p<0.001). Moreover, a statistically significant relationship and negative correlation were identified between physical activity level and pain frequency, duration, as well as pain scores assessed by the Visual Analog Scale (VAS) (p<0.001, rho values -0.334, -0.140, -0.235, respectively). The duration of pain, VAS Activity scores, and VAS Rest scores were significantly higher in insufficiently active individuals compared to other groups. Detailed data are presented in Table 3.

Table 3. The Relationship Between Musculoskeletal Pain and Physical Activity Level

	Total (N=219)		Inactive (N=50)		Insufficiently active (N=67)		Active (N=49)		Highly Active (N=53)		p value
Characteristics of Pain	N (%)	Mean±SD	N (%)	Mean±SD	N (%)	Mean±SD	N (%)	Mean±SD	N (%)	**Mean±SD**	
Musculoskeletal Pain											<0.001*
No	95 (43.4%)		18 (36%)		0 (0%)		49 (100%)		28 (52.8%)		
Yes	124 (56.6%)		32 (64%)		67 (100%)		0 (0%)		25 (47.2%)		
Frequency of Pain											<0.000*
No	96 (43.4%)		18 (36%)		0 (0%)		0 (0%)		28 (52.8%)		
Every Day	30 (14.2%)		6 (12%)		19 (28.4%)		0 (0%)		6 (11.3%)		
Once A Week	70 (32%)		19 (38%)		35 (52.2%)		0 (0%)		16 (30.2%)		
Once In A Month	23 (14.5%)		7 (14%)		13 (19.4%)		0 (0%)		3 (5.7%)		
Duration of Pain (Months)		12.57±18.76		15.14±21.03		18.94±18.71		0.08±0.57		13.62±20.98	**<0.001**¥
VAS Rest		1.28±1.76		1.25±1.84		2.24±1.66		0.10±0.73		1.18±1.82	**<0.001**¥
VAS Activity		2.59±2.71		2.69±2.52		4.52±2.06		0.12±0.84		2.35±3.84	**<0.001**¥
VAS Night		1.17±1.80		1.07±1.54		1.11±1.97		0.11±0.74		1.10±1.97	**<0.001**¥

Data presented as mean (±SD) or number (N) of patients. SD= Standard deviation. The p-value refers to the difference between the groups. p<0.05 statistically significant. *Chi-square test. ¥ Kruskal Wallis H test.

Analyzing pain localization, head and neck pain, back pain, and knee pain were significantly more prevalent in insufficiently active individuals (p values <0.001, <0.001, <0.01, respectively). Low back pain was higher in both inactive and insufficiently active individuals (p<0.001), and shoulder pain as well as ankle pain were significantly higher in insufficiently active and highly active individuals (p values <0.001, 0.022, respectively).

In the evaluation of the relationship between posture disorders and physical activity level, no statistically significant relationship was identified. However, when examining the relationship between muscle shortness and physical activity level, gastrosoleus muscle shortness was significantly higher in inactive individuals. Additionally, there was a higher shortness in the hamstring, tensor fascia lata, pectoralis major, and minor muscles in inactive individuals, although these differences did not have statistical significance. Detailed data can be found in Table 4.

It was observed that there was a statistically significant positive correlation between trunk endurance tests and physical activity level (rho values 0.322, 0.360, 0.270, 0.250, respectively). All trunk endurance tests were significantly higher in very active individuals than in inactive and insufficiently active individuals. The data are given in Table 5.

The Effects of Exercise on Musculoskeletal Pain, Posture, Muscle Shortness, and Trunk Muscle Endurance

When examining the relationship between exercise and gender, a statistically significant association was observed, with exercise participation and exercise duration being significantly higher in males (p-values <0.01, 0.047, respectively). Regarding the relationship between exercise participation and BMI, a statistically significant association was found. In individuals with a normal BMI, both the likelihood and duration of exercise were significantly higher, while in overweight individuals, the likelihood of not engaging in exercise was significantly higher (p-values 0.030, <0.001, respectively). A statistically significant positive correlation was identified between the presence of exercise participation and duration, and height (p-value= 0.018, rho-value=0.185). However, no statistically significant relationships were found between exercise status and other demographic variables (p>0.05).

Table 4. The Relationship Between Muscle Shortness Tests and Physical Activity Level

	Total (N=219)	Inactive (N=50)	Insufficiently active (N=67)	Active (N=49)	Highly Active (N=53)	p value
Muscle Shortness Tests	N (%)	N (%)	N (%)	N (%)	N (%)	
Lumbal Extensors						0.440¥
No	169 (77.2%)	38 (76%)	50 (74.6%)	42 (85.7%)	39 (73.6%)	
Yes	50 (22.8%)	12 (24%)	17 (25.4%)	7 (14.3%)	14 (26.4%)	
Hamstrings						0.536¥
No	129 (58.9%)	26 (52%)	40 (59.7%)	28 (57.1%)	35 (66%)	
Yes	90 (41.1%)	24 (48%)	27 (40.3%)	21 (42.9%)	18 (34%)	
Gastrosoleus						**<0.01**¥
No	198 (90.4%)	39 (78%)	63 (94%)	47 (95.9%)	49 (92.5%)	
Yes	21 (9.6%)	11 (22%)	4 (6%)	2 (4.1%)	4 (7.5%)	
Tensor Fascia Lata						0.923¥
No	211 (96.3%)	47 (94%)	65 (97%)	47 (96%)	52 (98.1%)	
Yes, Right	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Yes, Left	5 (2.3%)	2 (4%)	1 (1.5%)	1 (2%)	1 (1.9%)	
Yes, Bilateral	3 (1.4%)	1 (2%)	1 (1.5%)	1 (2%)	0 (0%)	
Hip Flexors						0.807¥
No	202 (92.2%)	46 (92%)	61 (91%)	44 (89.8%)	51 (96.2%)	
Yes, Right	2 (0.9%)	0 (0%)	1 (1.5%)	1 (2%)	0 (0%)	
Yes, Left	1 (0.5%)	0 (0%)	1 (1.5%)	0 (0%)	0 (0%)	
Yes, Bilateral	14 (6.4%)	4 (8%)	4 (6%)	4 (8.2%)	2 (3.8%)	
Pectoralis Major/Minor						0.458¥
No	216 (98.6%)	48 (96%)	67 (100%)	49 (100%)	52 (98.1%)	
Yes, Right	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Yes, Left	2 (0.9%)	1 (2%)	0 (0%)	0 (0%)	1 (1.9%)	
Yes, Bilateral	1 (0.5%)	1 (2%)	0 (0%)	0 (0%)	0 (0%)	
Other Muscles*						0.377¥
No	179 (81.7%)	38 (76%)	54 (80.6%)	43 (87.8%)	44 (83%)	
Yes, Right	3 (1.4%)	0 (0%)	2 (3.0%)	0 (0%)	1 (1.9%)	
Yes, Left	9 (4.1%)	5 (10%)	1 (1.5%)	1 (2%)	2 (3.8%)	
Yes, Bilateral	28 (12.8%)	7 (14%)	10 (14.9%)	5 (10.2%)	6 (11.3%)	

Data presented as number (n) of patients. The p-value refers to the difference between the groups. p<0.05 statistically significant. *Teres Majör, Latissimus Dorsi, Rhomboideus Majör / Minör. ¥ Chi-square test.

Table 5. The Relationship Between Trunk Endurance Tests and Physical Activity Level

	Total (N=219)	Inactive (N=50)	Insufficiently active (N=67)	Active (N=49)	Highly Active (N=53)	p value
Trunk Endurance Tests	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Sits Up Test	23.09±9.64	19.90±9.47	20.57±6.98	24.63±8.62	27.85±11.45	**<0.001**¥
Modified Push Up Test	32.09±13.28	26.92±11.84	28.39±10.14	34.76±11.99	39.17±15.59	**<0.001**¥
Right Lateral Flexion Test	34.41±17.11	28.58±12.46	31.43±13.71	37.94±17.96	40.42±21.28	**<0.01**¥
Left Lateral Flexion Test	34.73±17.30	28.60±13.29	32.49±14.04	38.55±18.71	39.79±20.79	**<0.01**¥

Data presented as mean (±SD) of patients. SD= Standard deviation. The p-value refers to the difference between the groups. p<0.05 statistically significant. ¥ Kruskal Wallis H test

When examining the relationship between musculoskeletal pain and exercise participation, no statistically significant relationship was found (p>0.05). However, a statistically significant relationship was observed between low back pain, hip pain, and widespread pain, and exercise duration. Exercise duration was significantly lower in those with low back pain, hip pain, and widespread pain (p-values 0.024, <0.001, 0.011, respectively).

In the analysis of the relationship between exercise participation and muscle shortness, a statistically significant relationship was found in shortness of the lumbar extensors and gastrosoleus muscles. Specifically, individuals who did not exercise had significant shortness in the lumbar extensors and gastrosoleus (p-values 0.015, 0.015, respectively). Additionally, a statistically significant negative correlation was found between gastrosoleus shortness and exercise duration (p-value <0.037, rho value= -0.156).

In the relationship between exercise participation and posture, it was revealed a statistically significant association with thoracic kyphosis. Thoracic kyphosis was significantly higher in individuals who did not exercise (p-value = 0.022). Furthermore, the analysis of the relationship between exercise duration and posture indicated a statistically significant negative correlation with the presence of a decrease in lumbar lordosis (p-value <0.01, rho value = -0.120).

Regarding trunk endurance tests, a statistically significant positive correlation was observed with exercise status (rho values 0.278, 0.299, 0.256, 0.231, respectively). All trunk endurance tests were significantly higher in individuals who exercised (p-value <0.001).

The Effects of Sedentary Behavior on Musculoskeletal Pain, Posture, Muscle Shortness, and Trunk Muscle Endurance

No statistically significant relationship was found between demographic data and daily sitting time, weekly course time, as well as weekly time spent at the computer. It was observed that a statistically significant positive correlation exists between daily sitting time and elbow, wrist, and knee pain (p-values of 0.045, 0.027, 0.015; rho values of 0.136, 0.149, 0.164, respectively). Similarly, there was a statistically significant positive correlation between daily sitting time and an increase in lumbar lordosis (p-value = 0.001; rho-value = 0.213).

No statistically significant relationship was found between weekly lesson hours and the all study data. Additionally, a statistically significant positive correlation was observed between the time spent in front of the computer and head-neck and elbow pain (p-values < 0.01, 0.012; rho-values 0.180, 0.170, respectively). Furthermore, a statistically significant positive correlation was found between the time spent in front of the computer and the duration of pain, VAS activity, and VAS rest (p-values of 0.025, 0.034, 0.030; rho-values of 0.152, 0.144, 0.146, respectively). A statistically significant positive correlation was observed between the time spent in front of the computer and the shortness of the teres major, latissimus dorsi, rhomboideus major, and minor muscles (p-value 0.020, respectively; rho-value 0.157, respectively). When examining the relationship between the time spent in front of the computer and posture, it was found that there is a statistically significant positive correlation between thoracic kyphosis, shoulder protraction, and anterior head tilt (p-values of 0.025, 0.011, 0.044; rho-values of 0.152, 0.172, 0.136, respectively).

Discussion

Physical activity level is influenced by gender, age, socio-economic status, education, environment (climate, weather, air pollution, etc.), biological and psychological factors (15). In a study evaluating the level of physical activity in young adults, it is seen that 23.3% of the participants are inactive, 48.6% are active and 28.1% are very active (16). Another study, 50% of students were classified as minimally active, and 50% as engaging in health-promoting physical activity. Additionally, this study stated that the more physically active students are, the less sitting time they spend and vigorous-intensity physical activity should be included in a health improvement plan (17). In our study population, 22.83% were classified as inactive, 30.59% as insufficiently active, 22.37% as active, and 24.20% as highly active.

Studies have reported a negative relationship between sedentary behavior and physical activity level (18,19). One study indicated that the magnitude of this relationship depends on the type of physical activity, showing a small to moderate negative correlation between sedentary behavior and moderate to intense physical activity, as well as a moderate to large negative correlation between sedentary behavior and light intensity physical activity (19). In our study, we found no significant relationship between physical activity level and daily sitting time, weekly lesson time, or weekly time spent at the computer, while there was a statistically significant positive correlation between physical activity level and exercise participation and duration. However, it was observed that daily sitting time was higher in insufficiently active individuals, and the weekly time spent at the computer was higher in inactive individuals.

The Effects of Physical Activity Level on Musculoskeletal Pain, Posture, Muscle Shortness, and Trunk Muscle Endurance

In a study evaluating the relationship between gender and physical activity level, it was observed that 31.5 % of female were inactive, 47.2 % were active, and 21.3 % were very active, while 13.5 % of male were inactive, 50 % were active, and 36.3 % were very active. In our study, inactive and insufficiently active individuals were significantly more prevalent in the female gender, while highly active individuals were significantly more prevalent in the male gender.

Studies have found a negative correlation between physical activity level and intensity and body fat percentage, and a positive correlation with muscle mass. However, no correlation was found between physical activity and BMI (17,20). In our study, consistent with the literature, no relationship was found between BMI and physical activity level, while a positive correlation was observed between height and weight and physical activity level. This correlation was significantly higher, especially in active and highly active individuals. This can be explained by the higher height and weight of male participants and the greater number of highly active individuals compared to female participants.

Several studies evaluating musculoskeletal disorders in university students reported that the prevalence rates of musculoskeletal disorders are between 32.9% and 89.3% (3,4). Stommen et al. (21) reported that the physical activity levels of young adults with chronic nonspecific musculoskeletal pain were not significantly different compared to healthy participants. However, they stated that the participation of painful individuals in sports and heavy-loaded activities was significantly lower (21). Long et al. (22) reported that there was a significant negative relationship between physical activity level and musculoskeletal pain in adolescents. In another study, in the group of patients diagnosed with spinal deformity in childhood and evaluated in adulthood, physical activity level was found to be associated with pain in both control and scoliosis patients (23). In our study, we observed a statistically significant relationship between physical activity level and musculoskeletal pain. Pain complaints were found to be significantly higher in inactive and insufficiently active individuals. Additionally, a statistically significant negative correlation was found between physical activity level and pain frequency, duration, and pain scores evaluated by VAS. Insufficiently active individuals exhibited significantly higher pain duration, VAS Activity scores, and VAS Rest scores compared to other groups.

In a study, it was found that in inactive individuals, the most common regions for musculoskeletal pain were the neck (28.0%), back (27.4%), low back (23.6%), wrists/hand (22.9%), and hip/thigh (21.0%) (3). In some conducted studies, neck and back pain are reported as the most common areas of pain in teachers, academicians, and students who have low physical activity levels due to prolonged periods of education and study (24,25) Similar to the existing literature, in our study, head and neck pain, back pain, and knee pain were significantly more prevalent in insufficiently active individuals. Low back pain was higher in both inactive and insufficiently active individuals, and shoulder pain as well as ankle pain were significantly higher in insufficiently active and highly active individuals.

As a consequence of prolonged incorrect posture, low physical activity level and a sedentary lifestyle, individuals may experience muscle pain, muscle shortening, and a decrease in the endurance of trunk muscles (26). In our study, although there was no significant relationship between physical activity level and posture disorders, a relationship was observed between muscle shortness and physical activity level, and gastrosoleus muscle shortness was found to be higher in inactive individuals. Additionally, it was observed that the shortness of the hamstring, tensor fascia lata, pectoralis major, and minor muscles was greater in inactive individuals, but these differences were not statistically significant.

A study examining trunk endurance and physical activity levels showed that as physical activity levels increased, there were also increases in core muscle endurance, and test durations were prolonged (27). In studies comparing individuals' core muscle endurance based on gender and physical activity levels, it has been shown that men generally exhibit better core muscle endurance. Additionally, as the level of physical activity increases, core muscle endurance tends to improve in both genders (28,29). In our study, similar to the literature, all trunk endurance tests were significantly higher in very active individuals compared to inactive and insufficiently active individuals. Additionally, it was observed that males had higher physical activity levels and achieved better results in all trunk muscle endurance tests.

The Effects of Exercise on Musculoskeletal Pain, Posture, Muscle Shortness, and Trunk Muscle Endurance

In our study, a statistically significant positive correlation was identified between exercise status and physical activity level. Furthermore, exercise participation was significantly higher in highly active individuals and significantly lower in inactive individuals. Additionally, it was observed that 48.4% of the study populations engaged in regular exercise, with higher rates of exercise presence and longer exercise duration noted in males.

Studies indicate that regular exercise and physical activity may have beneficial effects in preventing chronic pain. Individuals with high levels of physical activity often employ coping strategies such as trying to ignore pain and diverting attention, which can contribute to the management and prevention of chronic pain (30). In our study, no statistically significant relationship was found between musculoskeletal pain and exercise participation. However, it has been observed that there is a relationship between exercise duration and pain, and exercise duration is significantly shorter in individuals with low back pain, hip pain and widespread pain.

Studies suggest that the lack of physical activity and participation in exercise may be one of the possible causes of the development of postural deviations (31,32). One study reported a negative association between physical activity levels and exercise participation with anterior head tilt. Additionally, it has been suggested that activities focusing on strengthening the transverse abdominal muscles and other thoracic muscles without simultaneously strengthening the thoracic extensor muscles during exercise may contribute to muscle imbalance and hyperkyphosis in the thoracic spine (31). Another study demonstrated that increased physical activity and exercise can reduce the magnitude of increased angles in lumbar lordosis and thoracic kyphosis (32). In our study, it was found that individuals who did not exercise exhibited significant shortness in the lumbar extensors and gastrosoleus muscles, and a statistically significant negative correlation was observed between gastrosoleus shortness and exercise duration. Furthermore, thoracic kyphosis was significantly higher in individuals who did not exercise, and a statistically significant negative correlation was identified between exercise duration and the presence of a decrease in lumbar lordosis.

The Effects of Sedentary Behavior on Musculoskeletal Pain, Posture, Muscle Shortness, and Trunk Muscle Endurance

Contradictory results have been found in studies evaluating the relationship between sedentary behavior and gender. One study found that gender was not associated with total sitting time and screen time (combining TV, computers, and video games) (33). On the contrary, some studies evaluating sedentary behavior in university students have indicated that video game use is significantly higher among males of different ages (34), while study and mobile phone usage is significantly higher among females (35). Studies have found that sedentary behavior and sitting time are not associated with obesity, body fat, or muscle mass (17,36). In our study, no statistically significant relationship was found between demographic data and daily sitting time, weekly course time, as well as weekly time spent at the computer.

In a study evaluating sedentary behavior and musculoskeletal system complaints in university students, it was reported that musculoskeletal pain was positively associated with total sitting time, computer use, playing video games, and mobile phone use (18). Studies reported that office workers who had to work in a static posture all day experienced pain related to musculoskeletal disorders. The neck, shoulder, back, and low back areas were identified as the most affected regions in terms of both pain frequency and severity (37,38). In our study, we found that elbow, wrist, and knee pain were significantly more common in individuals who spent more time sitting daily. Moreover, head, neck, and elbow pain were significantly more prevalent in individuals who spent more time in front of the computer. Additionally, those who spent more time in front of the computer exhibited significantly higher pain duration, VAS activity, and VAS rest scores. Studies have reported that spending time in front of a computer in a static posture for a long time increases chronic neck pain, especially due to increased tension in the upper trapezius and cervical extensor muscles (39,40). Similarly, in our study, it was observed that the shortness of the teres major, latissimus dorsi, rhomboideus major, and minor muscles, thoracic kyphosis, shoulder protraction, and anterior head tilt were significantly higher in individuals who spent more time in front of the computer.

Posture and behavioral habits adopted for sitting and using the computer are identified as risk factors for posture changes. A decrease in lumbar lordosis, thoracic hyperkyphosis, and increased anterior head tilt may result from postural habits acquired over time (41). Since maintaining an upright sitting posture for a prolonged period, which requires balance and muscle strength, is challenging, the most commonly adopted sitting postures among people are a hunched posture and sitting cross-legged. Studies have documented that these sitting postures increase lumbar flexion and posterior pelvic tilt compared to sitting upright (42,43). In our study, we observed that the increase in lumbar lordosis was significantly higher in individuals with more daily sitting time. Additionally, thoracic kyphosis, shoulder protraction, and anterior head tilt were significantly higher in those who spent more time in front of the computer.

Studies have further shown that sedentary behavior is significantly associated with lower cardiopulmonary endurance, and longer screen time or increased frequency of computer use is also significantly associated with lower muscle strength and endurance, as well as reduced levels of flexibility (44,45). In our study, we observed a negative correlation between trunk endurance tests and time spent in front of the computer; however, no statistically significant relationship was found.

Strengths and Limitations of the Study

Firstly, this study is one of the rare studies to investigate the effects of physical activity levels and sedentary behavior on musculoskeletal disorders such as pain, muscle shortness, postural disorders, and reduced spine muscle endurance in young adults. In addition, the other main strengths of this study are that the results are based on a great prospective cross-sectional study, a sufficient number of patients was reached, and the patients were evaluated with physical examination and evaluation forms which allow objective evaluations by the same physician under equal conditions.

The principal limitation of this study is the self-assessment of physical activity using questionnaires rather than the objective analysis of weekly physical activity using the tri-axial accelerometer. Also, the cross-sectional constitution of the analyses limits causal conclusions concerning the association between the level of physical activity, clinical examination, and pain outcomes.

Conclusıon

In our study, we have determined that both a low level of physical activity and a sedentary lifestyle have negative effects on the musculoskeletal system in young people. Consequently, it can be asserted that problems within the musculoskeletal system arising from insufficient physical activity and a sedentary lifestyle can be mitigated through the education and guidance of individuals on the importance of physical activity and exercise. Furthermore, it is necessary and significant to acknowledge that establishing a routine of regular physical activity and exercise during young adulthood can serve as a protective measure against chronic diseases that may manifest due to a sedentary lifestyle in the later stages of life.

Author contributions

I as the corresponding author confirm that the manuscript has been read and approved by all authors and that there are no other persons who satisfied the criteria for authorship but are not listed. All authors had full access to the data, contributed to the work, and approved the final version for publication, and took responsibility for its accuracy and completeness.

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