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The relationship between intervertebral disc pathologies and the use of digital devices and lack of physical activity in adolescents

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Ethics Committee Approval
The study was approved by the Altınbaş University Clinical Research Ethics Committee (Decision No: 70212) on June 27, 2024.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Existing research on herniated discs in adolescents primarily focuses on surgical interventions and outcomes, with fewer studies investigating the effectiveness of non-surgical therapies. The correlation between obesity, facet tropism, lumbosacral transitional vertebrae, trauma, certain sports activities, and herniated discs in adolescents is well-documented. Comparable to adults, a sedentary lifestyle in adolescents potentially carries a significant risk of developing disc degeneration and herniation. Consequently, this study aims to examine the relationship between increased digital device usage, decreased physical activity, and the onset of disc pathologies in adolescents.

Methods: The study group included 94 patients aged between 10 and 16 years diagnosed with cervical (CDH), thoracic (TDH), and lumbar (LDH) disc disease. For each participant, the individual daily usage time spent on desktop computers, tablets, laptops, and mobile phones and the total time spent on all digital devices were evaluated. Their level of physical activity was also assessed using the International Physical Activity Questionnaire – Short Form (IPAQ-SF). The study eliminated causes such as listhesis, facet tropism, lumbosacral transitional vertebra, trauma, and sports injuries that could prompt the development of these spinal pathologies. Additionally, other conditions that might cause spinal pain, such as scoliosis, rheumatological diseases with spinal involvement, tumors, and myofascial pain, were also ruled out.

Results: The average age of all patients was 13.44 (2.07) years. A majority were women (n=55), comprising 58.50% of the sample. Of the patients, 60.64% had CDH, 12.77% had TDH, and 75.53% had LDH. The amount of physical activity and time spent on digital devices were similar across both genders (P=0.194 and P=0.770). A significant correlation was found between CDH and the time spent on tablets, laptops, and mobile phones (P<0.001). Again, a significant correlation was observed between LDH, usage of desktop computers, total time spent on all digital devices, and the IPAQ-SF score for low physical activity (P<0.001).

Conclusion: The prevalence and duration of digital device use among adolescents are increasing, while physical activity is decreasing. Our study indicates that this situation may be linked to the development of disc degeneration and hernias. Understanding this association can help reduce treatment and rehabilitation costs and prevent the potential loss of workability and quality of life resulting from a herniated disc. Consequently, additional comparative research on this topic is crucial.

Keywords: adolescents, disc pathologies, digital devices, physical activity

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Introduction

Neck/shoulder pain (NSP) and lower back pain (LBP) are increasingly recognized as significant issues in many countries, with social and economic ramifications for both individuals and governments. These conditions not only deteriorate the quality of life for those afflicted but also escalate the cost of treatment and rehabilitation, placing a substantial financial burden on the state. Adolescents suffering from LBP are likely to continue experiencing pain into their economically active years, thereby leading to inflated indirect costs through absenteeism, reduced productivity, early retirement, and sick leave. These indirect costs account for approximately 85% of total expenses [1,2].

LBP starts in childhood and adolescence, with prevalence rates mirroring that of adults [3,4]. Recently, there has been an uptick in studies examining the prevalence of NSP and LBP in these age brackets. These studies suggest an increased prevalence and higher lifetime prevalence rate than those observed in prior years [5-8].

Lumbar disc herniation (LDH) and cervical disc herniation (CDH) are significant contributors to lower back and neck pain, though they are less common in adolescents. Primarily, publications exist regarding the relationship between obesity, facet tropism, lumbosacral transitional vertebrae, trauma, certain sports activities, and LDH in adolescents [9-12].

Current studies predominantly utilize survey methods and disclose that the use of digital devices and insufficient physical activity are significant, rising contributors to spinal pain in adolescents [13-14]. Consequently, a sedentary lifestyle could be a factor in the development of disc herniations among adolescents, mirroring adults [15]. We posit that this correlation deserves attention, to mitigate future losses of workforce productivity, quality of life, and higher treatment and rehabilitation costs due to disc herniations.

Most studies on herniated discs in adolescents concentrate on surgical treatment methods and outcomes [16-19]. Non-surgical treatment results receive far less attention [20]. Only one study to date has highlighted a potential connection between excessive smartphone use and degeneration of the cervical spine [21].

In this study, we aimed to examine the relationship between digital device use and lack of physical activity, not only as causes of spinal pain but also as contributors to the development of intervertebral disc pathologies.

Materials and methods

Approval was granted by the clinical ethics committee of our institution: the Altınbaş University Health Sciences Scientific Research Ethics Committee. The Ethics Committee approved the study on 27 June 2024, with the protocol number 70212. The research took place between December 2021 and December 2023 at the Physical Medicine and Rehabilitation Centre and the Orthopedic Clinic of Altınbaş University Medical Park Bahçelievler Hospital. In this cross-sectional study, permission was obtained from the families of 94 patients, aged between 10 and 16 years, who had reported spinal pain and whose Magnetic Resonance Imaging (MRI) scans showed bulging, protrusion, and extrusion. As none of the parents refused, all patients were included in the study.

All surveys and inquiries were personally administered to the patients and completed by them in a separate setting from their families. Therefore, special care was taken to ensure that the participants were mentally healthy and not depressed. The Mini-Mental Test was used to gauge their mental abilities, while the Beck Depression Scale assessed their depression levels. All the patients were native Turkish speakers who could both read and write in the language. The data were recorded in the outpatient clinic files by orthopedists and physical therapy doctors. Entries of the data into Excel were made by a third person unassociated with the study.

The duration of digital device use and physical activity levels were probed during clinical examinations of patients with spine pain. Patients were asked about their daily usage time for each digital device, including tablets, laptops, desktop computers, and mobile phones. They were also asked to provide the total daily usage time for all devices, in hours.

The level of physical activity was evaluated using the International Physical Activity Questionnaire-Short Form (IPAQ-SF) [22]. The Turkish validity and reliability of this scale were analyzed by Saglam et al. [23] in 2010. The IPAQ-SF is a questionnaire featuring seven items that determine the frequency and duration of moderate to vigorous physical activity, as well as daily walking, during the past week. The final question probes the amount of time spent sitting daily. Individuals' level of physical activity is gauged based on the responses to the questionnaire, using the Metabolic Equivalent of Task (MET) method, a measure of a person's oxygen consumption in mL/kg/min. A person's overall MET value is computed by considering the duration and type of physical activity performed over the week. Participants are subsequently categorized into three groups – low, medium, or high – according to their total calculated MET values [22].

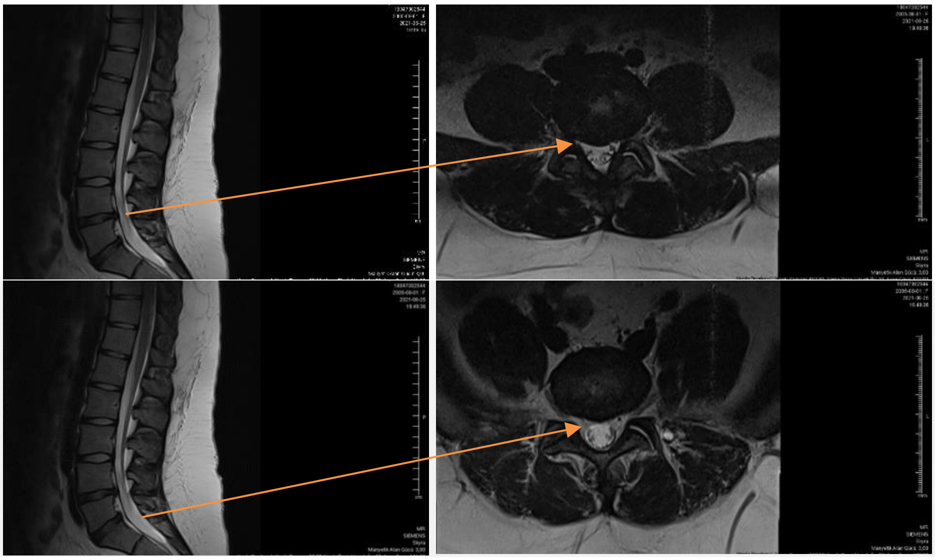
Furthermore, along with age and gender, the presence of disc pathologies in the spine was documented. A family history of disc disease was gathered from the first-degree relatives of the participants.

Exclusion criteria include causes like listhesis, facet tropism, lumbosacral transitional vertebra, trauma, and sports injury, which may lead to the development of disc pathology in the spine. Other pathologies that may cause spinal pain, such as scoliosis, rheumatological diseases resulting in spinal involvement, spinal tumors, and myofascial pain, are also considered. Additionally, a Mini-Mental score below 24 and a Beck Depression score above 7 are part of the exclusion criteria.

Statistical analysis

In conducting the statistical analysis of the study, descriptive statistics for the numerical data were provided in terms of mean and standard deviation, while categorical data were presented as numbers and percentages. The distribution of numerical data was analyzed using a skewness test and histogram graphs. Numerical data were evaluated using both the Student's t-test and the Mann-Whitney U-test for two independent groups, whereas the Chi-square test was used to analyze the categorical data. Correlations were determined using the Pearson correlation test, with a P-value accepted as <0.05.

Figure 1: Lumbar MRI L4-5 and L5-S1 central disc protrusion (arrows)



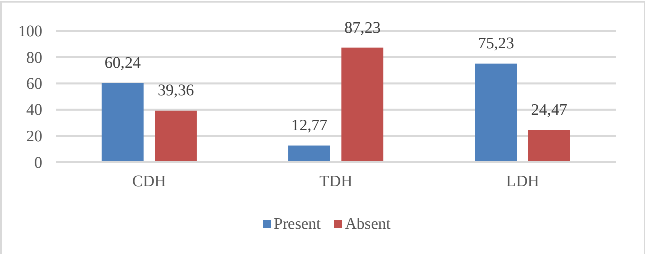
All analyses were carried out using the SPSS 23.0 software program.

Results

Out of the 116 individuals who had spinal pain, 12 were identified with scoliosis and ten with myofascial pain, and as a result, they were excluded from the research. Eventually, a total of 94 people whose MRI showed swelling, protrusion, and extrusion (sample MRI image, Figure 1) were enrolled in the study.

The average age of the patients was 13.44 (2.07) years. The study included 55 women and 39 men. Among the participants, 60.64% (n=57) had CDH, 12.77% (n=12) had thoracic disc herniation (TDH), and 75.53% (n=71) had LDH (Figure 2).

Figure 2: Distribution of disc herniation areas



None of the patients had a previous medical record of sports injuries, falls, or trauma, and no abnormalities such as listhesis, facet tropism, or lumbosacral transitional vertebrae were observed on the imaging. All participants were intellectually sound, non-depressed adolescents with Beck Depression Scores below 7, and Mini-Mental Scores above 24. There were 18 occurrences of hernias among first-degree relatives, accounting for 19% of the total.

In analyzing the number of bulging, protrusions, and extruded hernias in the cervical, thoracic, and lumbar regions, it was found that the cervical and thoracic regions had a high incidence of bulging. The number of bulging and protrusions in the lumbar region was similar, while all cases of extruded hernias were observed in the lumbar region (Figure 3). The cervical spine was most commonly affected at the C5-6 and C6-7 disc levels, the thoracic spine at the T10-T11 level, and the lumbar spine at the L4-5 and L5-S1 levels (Figure 4).

Figure 3: Regional distribution of bulging, protrusion, and extrusion

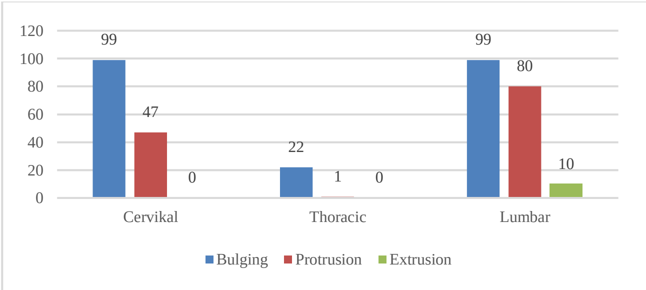
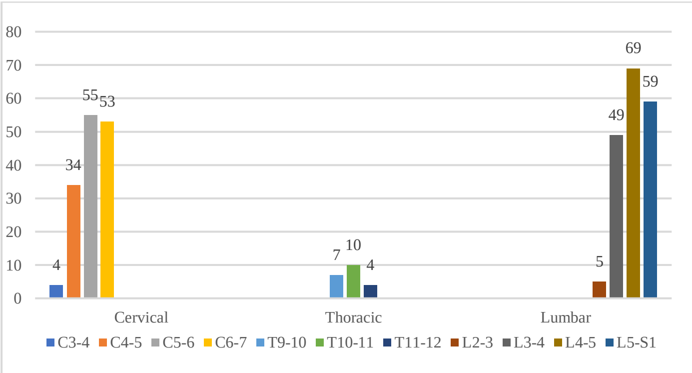


Figure 4: Regional distribution of the most frequently impacted disc levels



The distribution of disc herniations (CDH, TDH, LDH) among patients showed no significant difference by gender (*P*=0.480, *P*=0.522, *P*=0.792, [Table 1]). We found that half of the patients (50%) had a low level of physical activity, while very few (5.32%) reported a high level. The study did not reveal any statistically significant variation in physical activity level based on gender (*P*=0.194, [Table 1]).

Table 1: Evaluation of the distribution of herniated discs and physical activity by gender

		Gender						
		Male		Female		Total		
		n	%	n	%	n	%	*P*-value *
CDH	Present	22	56.41	35	63.64	57	60.64	0.480
	Absent	17	43.59	20	36.36	37	39.36	
TDH	Present	6	15.38	6	10.91	12	12.77	0.522
	Absent	33	84.62	49	89.09	82	87.23	
LDH	Present	30	76.92	41	74.55	71	75.53	0.792
	Absent	9	23.08	14	25.45	23	24.47	
IPAQ-SF	Low physical activity	19	48.72	28	50.91	47	50.00	0.194
	Moderate physical activity	16	41.03	26	47.27	42	44.68	
	High physical activity	4	10.26	1	10.82	5	5.32	

* Ci-Square Test, CDH: Cervical disc herniation, TDH: Thoracic disc herniation, LDH: Lumbar disc herniation, IPAQ-SF: International Physical Activity Questionnaire-Short Form

All 94 participants diagnosed with disc pathology had a daily routine of using desktop computers, tablets, laptops, and mobile phones. We analyzed the relationship between patients'

Table 3: Evaluation of the numerical data based on the CDH, TDH and LDH status of the patients.

	CDH			TDH			LDH		
	Present	Absent		Present	Absent		Present	Absent	
	Mean (SD)	Mean (SD)	*P*-value *	Mean (SD)	Mean (SD)	*P*-value *	Mean (SD)	Mean (SD)	*P*-value *
Age	13.46 (2.19)	13.41 (1.92)	0.814	14.00 (1.86)	13.35 (2.10)	0.288	13.63 (1.99)	12.83 (2.27)	0.116
BMI	20.90 (2.93)	21.13 (3.08)	0.464	21.68 (1.99)	20.89 (3.09)	**0.047**	20.98 (2.68)	21.01 (3.82)	0.342
Tablet	1.54 (1.56)	3.74 (1.00)	**<0.001**	0.83 (1.11)	0.38 (0.51)	0.124	0.39 (0.66)	0.61 (0.50)	**0.028**
Laptop computer	2.10 (1.15)	0.20 (0.40)	**<0.001**	1.58 (1.24)	1.32 (1.33)	0.515	0.97 (0.51)	1.00 (0.45)	**0.006**
Desktop computer	0.61 (0.70)	0.18 (0.38)	**0.009**	2.42 (2.02)	2.41 (1.71)	0.988	3.02 (1.48)	0.52 (0.95)	**<0.001**
Mobile phone	1.09 (0.55)	0.81 (0.32)	**<0.001**	0.96 (0.14)	0.98 (0.52)	0.394	1.06 (1.25)	2.24 (1.13)	**0.01**
Total duration	5.30 (1.19)	4.95 (1.25)	0.174	5.79 (1.23)	5.07 (1.20)	0.055	5.42 (1.23)	4.37 (0.81)	**<0.001**

* Student t-test, Mann-Whitney U-test, SD: Standard deviation, CDH: Cervical disc herniation, TDH: Thoracic disc herniation, LDH: Lumbar disc herniation, BMI: Body Mass Index. Usage time for each digital device in hours and total daily usage time of all devices in hours

body mass index (BMI), the duration of their device use (tablets, laptops, desktop computers, mobile phones), and their total device use in terms of gender distribution. While the BMI was found to be significantly higher in men (*P*=0.022), no significant difference was observed between the duration of digital device use (daily use for each device individually and total daily use of all devices) by gender (*P*=0.770, [Table 2]). Considering the length of usage time for both genders, the order is desktop computer, laptop, mobile phone, and tablet. The desktop computer had the most extended usage, with an average time of 2.41 h. Laptops were the second most-used device, with an average usage time of 1.35 h. Mobile phones noted an average use of 0.98 h, while tablet usage averaged 0.44 h. The cumulative duration of digital device use amounted to 5.16 h.

Table 2: Evaluation of the numerical data of the patients by gender

	Gender						
	Male		Female		Total		
	Average	SD	Average	SD	Average	SD	*P*-value
BMI	21.88	3.96	20.35	1.78	20.98	2.97	**0.022****
Tablet	0.45	0.50	0.44	0.71	0.44	0.63	0.486**
Laptop computer	1.31	1.07	1.38	1.47	1.35	1.31	0.789*
Desktop computer	2.46	1.76	2.37	1.73	2.41	1.73	0.809*
Mobile phone	0.94	0.38	1.01	0.56	0.98	0.49	0.924**
Total duration	5.12	1.32	5.19	1.16	5.16	1.22	0.770*

* Student t-test, ** Mann-Whitney U-test, SD: Standard deviation?, BMI: Body Mass Index. Usage time for each digital device in hours and total daily usage time of all devices in hours

The analysis of patients' BMI, tablet, laptop, desktop computer, and mobile phone usage time, along with their overall digital device usage time, was conducted based on their CDH, TDH, and LDH statuses (Table 3). CDH patients demonstrated significantly longer durations of tablet, laptop, and mobile phone usage, but noticeably shorter desktop computer usage durations. While the BMI of individuals diagnosed with TDH was the only one showing a significant increase (*P*=0.047), there was no meaningful difference in their overall digital device usage durations. Conversely, individuals with LDH used tablets, laptops, and mobile phones for significantly shorter durations, but exhibited notably longer durations of usage with desktop computers and overall digital device usage.

No significant relationship was observed between the patients' CDH, TDH status, and IPAQ-SF scores (*P*=0.318, *P*=0.162, [Table 4]). However, a significant rise in LDH rate was noted in patients with low physical activity levels (*P*=0.001, [Table 4]).

Table 4: Evaluation of the CDH, TDH and LDH status of the patients and IPAQ-SF

		IPAQ-SF						
		Low physical activity		Moderate physical activity		High physical activity		
		n	%	n	%	n	%	*P*-value *
CDH	present	32	68.09	22	52.38	3	60.00	0.318
	Absent	15	31.91	20	47.62	2	40.00	
TDH	present	9	19.15	3	7.14	0	0.00	0.162
	Absent	38	80.85	39	92.86	5	100.00	
LDH	present	43	91.49	26	61.90	2	40.00	**0.001**
	Absent	4	8.51	16	38.10	3	60.00	

* Ci-square test, CDH: Cervical disc herniation, TDH: Thoracic disc herniation, LDH: Lumbar disc herniation, IPAQ-SF: International Physical Activity Questionnaire-Short Form

No significant, moderate, or strong correlation was found between the duration of digital device usage by patients and their age or BMI (Table 5).

Table 5: Correlation table of age and BMI and duration of use of communication devices

	Age (r; *P*-value)	BMI (r; *P*-value)
Tablet	-0.025; 0.807	0.092; 0.380
Laptop computer	0.002; 0.982	-0.063; 0.550
Desktop computer	0.111; 0.288	0.019; 0.885
Mobile phone	0.205; 0.176	-0.006; 0.956
Total duration	**0.205; 0.047**	-0.002; 0.987

BMI: Body Mass Index, r: Pearson correlation coefficient

Discussion

Incidences of NSP and LBP in childhood and adolescence are increasing [5-8]. LDH is a significant factor in LBP and is prevalent among adults with degenerated discs but is less typically seen in children and adolescents. Publications exist that explore the correlation between herniated lumbar discs and factors such as obesity, facet tropism, lumbosacral transitional vertebrae, trauma, and certain sports activities in adolescents [9-12].

The prevalence of spinal pain among adolescents has dramatically increased due to the widespread use of technology, including mobile phones, tablets, laptops, and desktop computers. The inclusion of these devices in educational settings contributes to a sedentary lifestyle.

In the past 2 years, we have observed an uptick in the number of adolescent patients visiting physiotherapy and orthopedic outpatient clinics due to spinal pain. Interestingly, a significant number of these patients (94 out of 102) were diagnosed with intervertebral bulging, protrusions, and extrusions – conditions that are typically rare within this age group. Most studies regarding herniated discs in adolescents are focused on surgical methods of treatment and their outcomes [16-19]. To a lesser extent, the outcomes of non-surgical treatments are discussed [20]. Only one study links the degeneration of the cervical spine discs, as shown by MRI scans, to excessive mobile phone use [21]. Consequently, our study aims to delve into the relationship between the use of digital devices, insufficient physical activity, and the onset of intervertebral disc disease.

Intervertebral discs (IVD) are anatomical structures that fill the gap between the vertebrae, contributing to their flexibility and functioning as shock absorbers [24]. Three structures comprise the IVD: the central nucleus pulposus encased between two cartilage endplates at the top and bottom, all surrounded by the annulus fibrosis (AF) ring [25,26]. A herniated disc is a medical condition whereby the annulus fibrosus, the disc's outer layer, ruptures and allows the inner part, the nucleus pulposus, to protrude. This causes the intervertebral disc to exert pressure within the spinal canal on adjacent nerves, leading to pain.

Nourishment for the intervertebral discs arrives via diffusion from the endplate, a process aided by the pumping action that occurs during movement [27,28]. If a static posture is maintained for an extended period, this impedes the pumping motion, resulting in deterioration in the nourishment of the intervertebral disc and subsequent degeneration. The potential reason for disc herniation occurring at younger ages in recent years could be youthful inactivity, which can provoke early degeneration of vertebral discs [15].

All individuals in our study exhibited disc degeneration. There was no record of any patients experiencing a sports injury, fall, or trauma that might have resulted in a hernia. Moreover, the imaging did not indicate any presence of listhesis, facet tropism, or lumbosacral transitional vertebra. Since the turn of the millennium, studies have started to underline that disc degeneration can also occur in adolescents, just as in adults. A histological study found that 11 out of 15 adolescents (73%) showed degenerative changes in the intervertebral discs similar to those seen in adults [29]. While previous studies highlighted the significance of trauma and history of congenital anomaly as factors in the pathogenesis of intervertebral disc prolapse among young patients, this research indicates that pre-existing disc degeneration should be considered in isolated traumatic disc herniations, similar to adults [29]. The study examined intervertebral disc degeneration (IVDD), changes in endplates, and paraspinal muscles in the lumbar spine of 214 children and adolescents who underwent MRI for LBP. In this study, severe IVDD was identified at all levels of the lumbar spine except L2-L3 [30].

Existing studies, primarily in the form of surveys, suggest that the use of digital devices and a lack of physical activity are significant and increasing factors in spinal pain among adolescents [13-14]. However, aside from one study that emphasizes the link between cervical disc degeneration and mobile phone use in teenagers, no research has yet observed the relationship between disc herniations, digital device use, and a lack of physical activity. In the study examining the connection between cervical disc degeneration and mobile phone use, the degree of cervical disc degeneration was evaluated in 2438 patients using the Cervical Disc Degeneration Scale (CDDS), which was developed based on the Pfirrmann classification. The CDDS scores of patients who excessively used smartphones were discovered to be higher than those of patients who did not use their smartphones excessively [21].

Evidence suggests that hereditary variants significantly contribute to the incidence of disk degeneration and herniations. The reported prevalence of family history ranges from 13% to 57% [31-34]. In our study, we found that 18 out of 94 patients had a first-degree relative with a hernia, a rate comparable with those reported in the literature. While some publications explore the correlation between pediatric disk herniations and the apophyseal ring fracture, we did not observe an apophyseal ring fracture in any of our study’s cases [35-37].

Although women are more frequently represented in studies on pain complaints, we found no statistically significant difference between genders in the incidence of intervertebral disc disease in our research. We also discovered that physical activity levels and digital device use were similar for both genders [9,14,38,39].

According to our study, desktop computers were the most-used device, with an average usage time of 2.41 h. Laptops were the second most commonly used device, with an average usage time of 1.35 h. Mobile phones were used for an average of 0.98 h, while tablets were used for roughly 0.44 h. The combined usage duration of all digital devices amounted to approximately 5.16 h. A literature review reveals that adolescents with back pain issues may spend almost 3 h a day using their electronic devices [1,6,38-40]. As there is no current study examining the relationship between disc herniation and duration of digital device use, a comparison cannot be drawn. However, our study suggests the total duration of digital device use is longer than that reported in studies about chronic back pain.

Our study indicated that 60.44% of patients had CDH, 12.77% had TDH, and 75.23% had LDH. Low physical activity prevalence was 50%, while moderate physical activity prevalence was 44.68%. Similar to NSP and LBP study findings in adolescents, the prevalence of high physical activity in our study was exceptionally low (5.32%). There was also a significant association between low physical activity and the presence of LDH [38-40]. This finding implies that, beyond causing spinal pain, low physical activity might be a crucial factor contributing to LDH development.

In our examination of the most frequently impacted disc levels, we observed pathology in the C5-6 and C6-7 levels of the cervical spine, the T10-T11 levels of the thoracic spine, and the L4-5 and L5-S1 levels of the lumbar spine. In a study involving 70 patients with adolescent LDHs (ages ranging from 9 to 19 years), it was found that the L4-5 level was most frequently affected, followed by the L5-S1 disc [15]. Bulging discs were discovered in 42 cases, with extruded hernias in six cases, and protrusions in 22 cases. As with our study, extrusion occurred at the lowest rate, and the most common level of involvement in the lumbar region was similar.

In our study, we found a significant relationship between CDH and the usage time of tablets, laptops, and mobile phones. The correlation between tablet use and NSP is similar to that between improper reading posture and NSP [41,42]. Stationary computers offer benefits due to their adaptability to ergonomic features, such as adjustment of screen, keyboard, table, and chair settings. However, laptops and tablets, which can be used anywhere, often fail to comply with ergonomic conditions, thereby causing spinal pain [40]. Our study indicates that similar to NSP, CDH is also caused by improper posture.

In our study, we found a significant association between LDH and the duration of desktop computer use, as well as the total time spent using digital devices. We concluded that static immobility and the total duration of inactivity during the day, compounded by a lack of physical activity, are more significant factors for LDH than poor posture. Another study that investigated the usage of digital devices concerning spinal pain found a significantly lower prevalence of LBP among mobile phone users [40]. This was attributed to the possibility of using mobile phones while standing and moving, which is consistent with our observations.

In our study involving 94 patients (10–16 years old), we found a significant relationship between CDH and the duration of tablet, laptop, and mobile phone usage. We also observed a significant association between LDH and the length of desktop computer usage. A connection was additionally detected between the total usage time of all digital devices, reduced physical activity (as measured by the IPAQ-SF score), and LDH.

Limitations

A control group could not be established, as only 22 out of 116 patients who visited our clinic with spine pain complaints lacked disc pathology. This highlights the need for future comparative studies on this subject.

Conclusion

The prevalence and duration of digital device use among adolescents is increasing, while physical activity decreases. Our study is pioneering in evaluating the relationship between the duration of digital device use, lack of physical activity, and disc pathologies in adolescents. The findings from our study group suggest that prolonged use of digital devices and a lack of physical activity appear to be significant factors contributing to intervertebral disc degeneration and hernia formation. Understanding this relationship is crucial for preventing future workforce loss, and diminished quality of life, as well as treatment and rehabilitation costs due to disc herniations.

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