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THE EFFECT OF DIGITAL GAME ADDICTION ON AGGRESSION IN SCHOOLAGE CHILDREN

OKUL ÇAĞI ÇOCUKLARDA DİJİTAL OYUN BAĞIMLILIĞININ SALDIRGANLIK ÜZERİNE ETKİSİ

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ABSTRACT

Objective: This study was conducted to determine the impact of digital game addiction on aggression in school-age children.

Method: This descriptive and cross-sectional study was conducted in January-June 2023 with children aged 10-11 years studying in secondary schools in Batman. The study was completed with 300 children who met the research criteria. Data were collected by distributing the questionnaire form, Digital Game Addiction Scale for Children and Aggression Scale to the children whose parental consent was obtained in a time period that would not disrupt the class hours. In the evaluation of the data; percentages, averages, t test, Anova, Bonferonni, Pearson Correlation analyzes were used.

Results: It was determined that 52% of the students participating in the study were male and 57.3% were 11 years old. The digital game addictions and aggression of male students, those whose mothers and fathers are civil servants, those who have a tablet/computer/phone, those who play games for 4 hours or more a day with a tablet/computer/phone, and those who mostly prefer computers to play games are statistically significant. There was a significant positive correlation between children's digital game addiction and aggression ($p<0.05$).

Conclusion: It was determined that as students' digital game addiction levels increased, their aggression levels increased. In addition, as the daily playing time of the students increased, their digital game addiction and aggression levels also increased.

Key Words: Addiction, Child, Digital game, Aggression

ÖZ

Amaç: Bu araştırma okul çağı çocuklarda dijital oyun bağımlılığının saldırganlık üzerine etkisini belirlemek amacıyla yapıldı.

Yöntem: Tanımlayıcı ve kesitsel yapılan bu araştırma, Ocak-Haziran 2023 tarihinde Batman'da bulunan ortaokullarda eğitim gören 10-11 yaş grubu çocuklarla yapıldı. Araştırma kriterine uyan 300 çocuk ile araştırma tamamlandı. Ebeveyn onamları alınan çocuklara ders saatini aksatmayacak bir zaman diliminde anket formu, Çocuklar için Dijital Oyun Bağımlılık Ölçeği ve Saldırganlık Ölçeği dağıtılarak veriler toplandı. Verilerin değerlendirilmesinde; yüzdelik, ortalamalar, t testi, Anova, Bonferonni, Pearson Korelasyon analizlerinden yararlanıldı.

Bulgular: Araştırmaya katılan öğrencilerin %52'sinin cinsiyetinin erkek ve %57.3'ünün 11 yaşında olduğu belirlendi. Erkek öğrencilerin annesi ve babası memur olanların, tableti/bilgisayarı/telefonu olanların, tablet/bilgisayar/telefon ile günlük 4 saat ve üstü oyun oynayanların ve oyun oynamak için en çok bilgisayarı tercih edenlerin dijital oyun bağımlılıkları ve saldırganlıkları istatistiksel olarak anlamlıydı. Çocukların dijital oyun bağımlılıkları ile saldırganlıkları arasında pozitif yönde anlamlı bir ilişki olduğu bulundu ($p<0.05$).

Sonuç: Öğrencilerin dijital oyun bağımlılık düzeyleri arttıkça saldırganlık düzeylerinin arttığı belirlendi. Ayrıca öğrencilerin günlük oynadığı oyun süresi arttıkça dijital oyun bağımlılıkları ve saldırganlık düzeyleri de artmaktadır.

Anahtar Kelimeler: Bağımlılık, Çocuk, Dijital oyun, Saldırganlık

INTRODUCTION

With the developing technology, it is an indispensable part of human life and brings many new practices [1]. According to TUIK 2021 data, internet usage for children in the 6-15 age group was 50.8% in 2013 and 82.7% in 2021. When internet usage is analyzed by gender, it is seen that the internet usage rate of boys, which was 53.7% in 2013, increased to 83.9% in 2021, while the internet usage rate of girls, which was 47.8% in 2013, increased to 81.5% in 2021 [2]. Internet use shapes many basic areas of life, from education to health, transportation, communication and entertainment [3].

At one step of this shaping; game behavior, which started with imitating some natural events, has gained a different dimension with imaginary games (digital games) played with special computer software and game tools. It is a known fact that this developing technology, along with the practices it has brought to human life, has also led to some negative consequences. One of the most important of these problems is technology addiction. Although technology addiction is a subject that is evaluated in a wide range, one of the most prominent topics is computer addiction and "digital game addiction", which is evaluated under this title [3].

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Again, according to TUIK 2021 data; 36.0% of children play digital games, while this rate is 32.7% among children in the 6-10 age group and 39.4% among children in the 11-15 age group. When the rate of playing digital games is analyzed by gender and age group; while the rate of playing digital games of boys in the 6-15 age group is 46.1%, the rate of playing digital games of girls is 25.4% [2].

These games, which are programmed with various software and use various technologies, are also classified as digital console games, computer games and online games according to the technology used [4]. When the effects of digital games on children's developmental areas are evaluated in general; especially in terms of contribution to cognitive development, they have positive contributions such as strategic thinking, fast and accurate decision making, problem solving, and learning the use of technology [5-10]. One of the most important criticisms of digital games is that they cause addiction and negatively affect children mentally, physically, socially and morally [11]. It is known that violent games that are not played in a controlled manner threaten mental health. Biologically, these resulting effects cause disorders such as regression in developmental stages, eye diseases, weight loss or excessive weight gain, and impairment in the appearance of hands, shoulders, spine and psychomotor skills due to constant sitting [12,13]. In particular, violent games cause children to internalize the feeling of violence and aggression and normalize this feeling over time, leading to the upbringing of individuals prone to violence and aggression [6,11,14-16]. In the literature, it is emphasized that the most important negative effects of digital games are violence, aggression and addiction [13,17-19].

Aggression is, in general, behaviors carried out by a person or a group with the aim of harming another person [18]. A large number of games that digitize and reconstruct the children's world, while fulfilling useful functions as a means of leisure time evaluation, to relieve fatigue and stress, can also make aggression a normal behavior by containing elements of violence [17]. Especially in violent games based on winning/losing, children are often defeated, and the more they are defeated, the more ambitious they become, and this can lead to more anger and aggressive behavior [20]. In the literature, Kars (2010) concluded in a study that anti-social aggression increases as the time spent playing computer games increases [21]. Koçak and Köse (2014) stated in their study that computer games negatively affect the family, school and friendship relations of adolescents and thus the socialization process of adolescents [22]. According to Torun, Akçay, and Çolaklar (2015), the types of games played or the child's level of addiction to games may cause the child to exhibit negative attitudes towards himself and his environment [11]. Therefore, this research was conducted to determine the impact of digital game addiction on aggression in school-age children as a situation assessment and addresses the gap to determine the link between digital game playing and aggression in the transitions from middle childhood to early adolescence and from early adolescence to adolescence.

METHOD

Study Design

This research was conducted in a descriptive and cross-sectional manner over a period of time, through a section taken from the research population, to detect and describe the situation at the time of the research [23].

Participants

The population of the study consisted of 10-11 year old children studying in secondary schools in Batman in January-June 2023. The sample of the study was selected through random sampling. It was calculated using the standard deviation value (SD=16.72) of the digital game addiction scale found in the study conducted by Bircan and Öner in 2022 [24] and the formula $n=(zxSD/d)^2$ [25] in cases where the study population is unknown. In the formula, 95% confidence level and deviation d=2 were accepted and $n=(1.96x16.72/2)^2=265.69=267$. The study was completed with 300 students who volunteered to participate in the study on the specified dates.

Inclusion Criteria:

- Studying in secondary schools in the 10-11 age group,
- Volunteering to participate in the research,

Exclusion Criteria:

- Being a diagnosed mainstreaming student.

Outcome Measures

Questionnaire Form: This form, prepared by the researcher, includes questions about children's socio-demographic characteristics such as age, class, mother and father occupation, family income status, and digital game playing characteristics [3,26,27].

Digital Game Addiction Scale for Children (CDGAS): The scale was developed by Hazar et al. (2017) [3]. It consists of 24 items and 4 sub-dimensions. These sub-factors are named as "excessive focus and conflict towards playing digital games", "development of tolerance during game time and the value attributed to the game", "postponement of individual and social tasks/assignments", "psychological-physiological reflection of deprivation and immersion in the game". It includes statements such as "Playing digital games relaxes me when I am unhappy" and "I do not realize that I am hungry while playing digital games." A 5-point Likert-type scale was used to evaluate the statements in the scale (1=Strongly Disagree, 2=Disagree, 3=Disagree, 4=Agree, 5=Strongly Agree). The lowest score that can be obtained from the scale is "24" and the highest score is "120". In the scoring of the scale; "1-24: Normal group, 25-48: Low risk group, 49-72 Risky group, 73-96 Dependent group, 97-120 Highly dependent group". The Cronbach Alpha value for the total scale was 0.90, 0.78 for the first sub-factor, 0.81 for the second sub-factor, 0.76 for the third sub-factor and .67 for the fourth sub-factor [3]. In this study, it was found to be 0.95.

Aggression Scale (SA): This scale was prepared by Şahin in 2004 after a validity and reliability study. It was aimed to develop an "Aggression Scale" based on Social Learning and Cognitive Theory in order to determine the aggression levels of 10-11 year old children at the first level of primary education. The Cronbach's alpha coefficient of the scale was found to be 0.77. The correlation coefficient of the scale was calculated as 0.71 ($p<.01$). The calculated validity and reliability scores show that the scale can be used to determine the aggression levels of children aged 10-11 years. In the scale consisting of eighteen items, behaviors related to aggression were given and they were asked to answer as "I always do it", "I do it sometimes", "I never do it". 5,7,10,15,17 on the scale. The items were written as neutral items and were not included in the scoring. Accordingly, a minimum of 13 and a maximum of 39 points can be obtained from the scale. The cut-off point of the scale is one standard deviation above the mean of the group, and those who score above this value are defined as aggressive. Those who score one standard deviation above this mean, 23 or more, are defined as aggressive. "Sometimes I hurt my friends on purpose." and "When the things I want are not done, I will hit and break anything I can get my hands on." [26]. In this study, Cronbach's alpha coefficient was 0.80.

Data Collection

After ethics committee permission and school permission were obtained, the study was conducted between January and March 2023 with children in the age group of 10-11 years studying in secondary schools in the provinces and districts. Before starting to collect the research data, the children were met in line with the inclusion criteria, informed about the research topic, and a consent form was sent to the families for their written consent. Then, the forms were distributed to the consenting students in a time period determined by the classroom teachers, and they were asked to fill out the questionnaire forms by explaining all the parts they did not understand. The questionnaires

were collected by face-to-face interview technique. It took approximately 15-20 minutes to complete the questionnaires.

Ethical Approval

In order to conduct the study, ethics committee permission (12/06-30.12.2022) was obtained from the Human Research Health and Sports Sciences Ethics Committee of Erzincan Binali Yıldırım University and institutional permission was obtained from the Provincial Directorate of National Education in 2023. Written informed consent was obtained from the children and their parents, and the children and their parents were assured that their personal information would not be disclosed to others, would not be used anywhere else, and that they had the right to leave the study at any time.

Statistical Analysis

SPSS 19.0 package program was used for statistical analysis of the data. Percentages, averages, t test, Anova, Bonferonni, Pearson Correlation analysis were used in the evaluation of the data. Statistical significance level was taken as 0.05 in all tests.

RESULTS

In the study, 57.3% of the students were 11 years old, 52% were female, 50% were in the fourth grade, 59.3% had a medium income, 82% of the students' mothers were housewives, 57.7% of the students' fathers were self-employed, 72.3% did not own a tablet/computer, 87.7% did not have a phone, 57.7% played with tablet/computer/phone for 0-1 hour per day, 61.3% preferred the phone as the most preferred tool for playing games, and 40% played puzzle brain teasers as the most preferred game type. The mean scores of CDGAS and SA were compared based on the descriptive characteristics of the participating students. Among the descriptive characteristics, it was found that the students whose gender was male, who perceived their income status as good, whose parents were civil servants, who had a tablet/computer/phone, who played games with tablet/computer/phone for 4 hours or more daily, and who preferred the computer the most for playing games had an effect on the mean score of the CDGAS. It was found that male gender, poorly perceived income status, having a civil servant mother and father, having a tablet/computer/telephone, playing games with tablet/computer/telephone for 4 hours or more daily, and preferring computer the most for playing games were effective variables on the mean score of SA ($p<0.05$) (Table 1).

Table 1. Distribution of students' descriptive characteristics according to CDGAS and SA (n=300)

Characteristics		n	%	CDGAS		SA	
				X±SD	Test/p	X±SD	Test/p
Age (Year)	10 years old	128	42.7	59.39±23.50	t: 1.262	5.12±0.45	t: -1.499
(10.57±0.49)	11 years old	172	57.3	56.00±22.56	p:0.208	5.52±0.42	p:0.135
Gender	Female	156	52	47.78±17.28	**t:-8.309**	18.85±5.23	**t:-2.672**
	Male	144	48	67.91±23.85	**p:0.000**	20.40±5.41	**p:0.008**
Clasroom	Grade 4	150	50	59.54±23.35	t:1.584	5.12±0.41	t:-1.835
	Grade 5	150	50	55.35±22.50	p:0.114	5.56±0.45	p:0.067
Income status	Good [a]	103	34.3	61.82±24.13	**F:6.454**	19.87±5.15	**F:6.642**
	Middle [b]	178	59.3	53.76±21.11	**p:0.002**	19.01±5.20	**p:0.002**
	Bad [c]	19	6.3	68.21±27.01	**Bonferroni**	23.57±6.42	**Bonferroni**
					a>b, c>b		**c>a, c>b**
Mother's profession	Housewife [a]	246	82.0	54.30±19.56	**F:35.646**	19.09±5.13	**F:12.893**
	Officer [b]	34	11.3	85.41±30.47	**p:0.000**	23.82±5.54	**p:0.000**
	Self employment[c]	20	6.7	48.55±12.55	**Bonferroni**	18.60±4.92	**Bonferroni**
					a<b, c<b		**b>a, b>c**
Father's profession	Unemployment[a]	34	11.3	51.73±15.01	**F:20.818**	18.08±5.51	**F:5.033**
	Officer [b]	71	23.7	74.52±29.22	**p:0.000**	21.61±5.44	**p:0.002**
	Retired [c]	22	7.3	56.36±17.76	**Bonferroni**	19.68±4.75	**Bonferroni**
	Self employment[d]	173	57.7	51.70±18.15	**b>a, b>c, b>d**	19.05±5.19	**b>a, b>d**
Ownership of tablet/computer	Yes	82	27.3	69.69±30.33	**t:4.742**	6.08±0.67	**t:3.897**
	No	217	72.3	52.84±17.51	**p:0.000**	4.85±0.32	**p:0.000**
Ownership of telephone	Yes	36	12.0	77.25±31.50	**t:4.170**	22.88±6.18	**t:4.016**
	No	263	87.7	54.75±20.19	**p:0.000**	19.15±5.09	**p:0.000**

Duration of daily play with tablet/computer /telephone (Hours) (1.82±1.59)	0-1 hour[a]	173	57.7	49.72±15.71	**F:39.368 p:0.000 Bonferroni c>b>a**	18.35±4.64	**F:17.838 p:0.000 Bonferroni c>b>a**
	1-3 hour[b]	92	30.7	62.84±25.04		20.36±5.28	
	4 Hour and over[c]	35	11.7	81.42±27.30		23.74±6.51	
Most preferred vehicle for playing games	Computer[a]	25	8.3	81.76±31.12	**F:13.254 p:0.000 Bonferroni a>b, a>c, a>d**	24.44±6.89	**F:10.614 p:0.000 Bonferroni a>c, a>d**
	Game console[b]	18	6.0	56.77±16.85		20.83±4.94	
	Telephone[c]	184	61.3	53.14±18.77		18.57±4.70	
	Tablet[d]	73	24.3	60.13±25.47		20.23±5.50	
The type of game you play the most	Adventure games	53	17.7	56.11±20.16	F:2.608 p:0.052	19.09±5.25	F:1.872 p:0.134
	War games	62	20.7	63.82±26.09		20.70±5.82	
	Sports games	65	21.7	58.67±23.82		20.15±4.83	
	Puzzle and brain games	120	40.0	54.08±21.48		18.95±5.39	
Evaluating Friend Relationships (0-10 points) (X±SD)							8.12±1.96

SA:Aggression Scale, CDGAS:Digital Game Addiction Scale for Children

The mean scores obtained by students from CDGAS and SA are provided in Table 2.

Table 2. The mean scores obtained by students from CDGAS and SA (n=300)

Scale	Min-Max	X±SD
Total score of the CDGAS	24-120	57.45±22.99
Total score of the AS	13-39	19.60±5.36

SA:Aggression Scale, CDGAS:Digital Game Addiction Scale for Children

The groups in which the students' total scores on the CDGAS were graded are given in Table 3.

Table 3. The rating of total CDGAS score (n=300)

CDGAS	N	%
Normal group (1-24 points)	5	1.7
Low-risk group (25-48)	128	42.7
Risk group (49-72)	107	35.7
Dependent group (73-96))	29	9.7
Highly dependent group (97-120)	31	10.3

The results of the Pearson Correlation analysis for the relationship between the mean scores of the students on the CDGAS, the SA, the evaluation of their friendships, and the duration of the games played daily with the tablet/computer/phone are given in Table 4. A weak positive correlation ($0.26 \leq r \leq 0.49$) was found between CDGAS and SA ($r=0.363$; $p<0.05$). There was also a weak positive correlation ($0.26 \leq r \leq 0.49$) between CDGAS and the daily time spent playing games on tablet/computer/phone ($r=0.418$; $p<0.05$). Additionally, a very weak negative correlation ($0.20<r$) was observed between CDGAS and the evaluation of peer relationships ($r=-0.149$; $p<0.05$). It was determined that there is a weak positive correlation ($0.26 \leq r \leq 0.49$) between SA and the daily time spent playing games on tablet/computer/phone ($r=0.344$; $p<0.05$), and a very weak negative correlation ($0.20<r$) between SA and the evaluation of peer relationships ($r=-0.144$; $p<0.05$).

Table 4. Correlation evaluation of the correlation between students' CDGAS, SA, assessment of friend relationships and duration of daily play with tablet/computer/telephone (n=300)

Pearson Correlation		Duration of Daily Play with Tablet/Computer/ Telephone	Assessment of Friend Relationships	CDGAS	SA
Duration of Daily Play with Tablet/Computer/Telephone	r	**1**			
	p				
Assessment of Friend Relationships	r	**-0.126***	**1**		
	p	**0.030**			
CDGAS	r	**0.418****	**-0.149****	**1**	
	p	**0.000**	**0.010**		
SA	r	**0.344****	**-0.174****	**0.363****	**1**
	p	**0.000**	**0.003**	**0.000**	

According to the regression analysis results in Table 5, when the significance level corresponding to the F value is analyzed, it is seen that the model is statistically significant ($F=22.832$; $p<0.05$). When the beta coefficient value, t value and significance level of the independent variable were examined; it was determined that the duration of the games played with the tablet/computer/phone per day, the evaluation of friendship relationships and the total score of the SA of the CDGAS had a statistically significant effect ($t=3.889$, $p<0.05$; $t=-2.031$, $p<0.05$; $t=4.362$, $p<0.05$). The duration of daily play with tablet/computer/phone explains 18% of the variation on the assessment of peer relationships and the total score of the SA of the CDGAS (Adjusted $R2=0.180$). A one-unit increase in the variable of daily playing time with Tablet/Computer/Telephone causes a 0.225 increase ($\beta=0.225$) on the total score of SD, a one-unit increase in the variable of evaluating peer relationships causes a 0.108 decrease ($\beta=-0.108$), and a one-unit increase in the variable of ESOC causes a 0.253 increase ($\beta=0.253$). There is no autocorrelation problem in the model. Durbin Watson value is between 1.5 and 2.5 ($DW=1.846$).

DISCUSSION

In today's world, all technological tools have the task of educating, informing and entertaining people. Each individual is affected and exposed to these tools in different ways and at different rates. Undoubtedly, the role of these tools is very important for children to form a healthy personality and worldview [28]. Improper use of digital

games can lead to negative consequences, especially for children, families and the whole society [17]. One of these negative consequences is addiction and it is shown that playing digital games increases addiction and aggressive behavior [28]. In the light of this information, the study was conducted to determine the effect of digital game addiction on aggression in school-age children and discussed in line with the literature.

According to the descriptive characteristics of the students; it was found that the gender of male students was effective in the average digital game addiction. According to TUIK 2021 data, it was determined that the rate of boys playing digital games is higher than the rate of girls playing digital games [2]. In a study conducted by Küçük and Çakır (2020), it was determined that boys had higher digital game addiction than girls [1]. Likewise, this finding is compatible with the literature in other studies [3,27,29,30]. This result may be due to the fact that boys are more interested in games, the internet, and visit game halls or cafes more. In the study, it was found that students whose parents were civil servants and who perceived their income status as good had a high level of digital game addiction. There are different results with this finding in the literature [1,30]. In a study conducted by Küçük and Çakır (2020), it was found that the average of digital game addiction of students whose mothers did not work was high, but this difference was not significant, and the working status of the fathers was found that the average of the group whose father was a tradesman was higher than the other groups (non-working, worker, civil servant), but this ifference was not significant [1]. The reason for the different findings with the literature may be that civil servant families spend more time outside the house and children spend more free time at home, and those with better income can access technological opportunities and tools more easily.

Table 5. Multiple regression results on the effect of students' CDGAS, SA, assessment of friend relationships and duration of daily play with tablet/computer/telephone on SA (n=300)

Analysis	Unstandardized Coefficients		Standardized Coefficients	t	P	Collinearity Statistics		95% Confidence Interval	
	B	Standard Error	Beta			Tolerance	VIF	Lower	Upper
Fixed	17.225	1.494	-	11.528	0.000	-	-	14.284	20.166
Duration of daily play with tablet/computer/telephone	0.756	0.195	0.225	3.889	0.000	0.821	1.218	0.374	1.139
Assessment of friend relationships	-0.295	0.145	-0.108	-2.031	0.043	0.973	1.028	-0.581	-0.009
CDGAS	0.059	0.014	0.253	4.362	0.000	0.816	1.226	0.032	0.086

*SA Aggression Scale, CDGAS: Digital Game Addiction Scale for Children, DW: 1.846, R2:0.188, Adjusted R2:0.180, F:22.832, *p:0.000*

In the study, digital game addiction was found to be higher in children who play games with tablet/computer/phone for 4 hours or more daily. According to TUİK 2021 data, boys who stated that they regularly play digital games played digital games for an average of 3 hours and 2 minutes and girls played digital games for 2 hours and 18 minutes on weekdays, while boys played digital games for 2 hours and 59 minutes and girls played digital games for 2 hours and 11 minutes on weekends [2]. Hasting et al. (2009) reported that children play video/computer games for an average of 3.4 hours a day [31], and Aydoğdu-Karaarslan (2015) reported that 88% of children spend 2-5 hours of their free time on the computer and internet every day [16]. In Güvendi, Demir, and Keskin's (2019) study, it was found that students with a game playing time of 120 minutes or more also had a high level of digital game addiction [27]. There are many studies in the literature that are compatible with this finding [22,30,32]. This result may be due to the fact that children who play games for a long time are left alone and have no other activities to do, and the level of addiction increases by directing the rest of their time to the game more.

In the study, it was found that children who had a tablet/computer/phone had a high level of digital game addiction. In the literature, no study was found to determine the addiction levels according to the status of having a technological device. This finding may be due to the fact that parents are civil servants, their income status is high and children have technological tools more easily compared to other years and can be considered as an important finding for the literature. In the study, it was found that the students who mostly preferred the computer to play games were effective in the average of digital game addiction. There are also studies in the literature containing similar findings [29]. In the literature, Güvendi, Demir, and Keskin (2019) reported that the digital game addiction of students who go to internet cafes to play digital games is higher than those who play on the phone [27]. Considering that they play computer games in internet cafes, it is seen that there are similar results. In addition, in Küçükali's (2015) study, which was conducted in different age ranges, it was stated that 97.7% of children in the 6-10 age group preferred computers for games and that this group also had high digital game addiction [32].

According to the descriptive characteristics of the students, it was found that male students had an effect on the mean level of aggression. In the literature, it is seen that there is a difference in studies looking at aggression levels according to gender. In the study of Küçük and Çakır (2020), it was concluded that the mean aggression scores of girls were higher, but this difference was not significant in the sub-dimensions of the aggression scale (physical aggression, verbal aggression, hostility, indirect aggression) [1]. In the studies conducted by Kongur (2015) [33] and Hazar et al. (2017) [3] on secondary school students, no differences were found according to gender. However, in the research conducted by Hazar and Ekici (2021) [29], Arslan et al. (2014) [15], Özgür, Yörükoğlu and Arabacı (2011) [34], Ustabaş (2011) [35] to examine aggression with various variables, it was concluded that the average aggression of males was higher. These differences in aggression rates according to gender in the literatüre may be due to the cultural differences in which students live and grow up, cognitive, affective and psychomotor differences due to the developmental period, the value given to gender in the place where they live, or the opportunities they have to play games. In the study, it was determined that students whose parents were civil servants and whose income status was perceived as poor had higher levels of aggression. In a study conducted by Küçük and Çakır (2020) [1], the aggression averages of students whose mothers worked were found to be high. Şahin and Owen (2009) argued that the relationship between family income level and aggression is significant and that the feeling of deprivation that increases with the inability to meet the needs brings aggression behavior [36]. In the study, it was found that children who played with tablet/computer/phone for 4 hours or more daily had a significant effect on aggression behavior. In Güvendi, Demir, and Keskin's (2019) study, it was observed that the mean aggression scores of students who played games for 120 minutes or more were significantly higher [27]. It may be due to the fact that children who play digital games for a long time exhibit aggressive and impatient behaviors due to decreased communication with the environment. In the study, it was found that the aggression scores of children who had a tablet/computer/phone were high. There is no study in the literature that determines the level of aggression according to the status of having a technological tool. Therefore, this finding can be considered as an

important finding for the literature. In the study, it was found that students who preferred computers had an effect on the mean aggression level. Again, in Güvendi, Demir, and Keskin's (2019) study, it was observed that the aggression scores of students who went to internet cafes to play digital games were significantly higher compared to their phones [27]. Considering the fact that they play with computers in internet cafes, it is a finding compatible with the literature.

According to the digital game addiction scores of the students; 1.7% were found to be in the normal group, 42.7% in the low-risk group, 35.7% in the risky group, 9.7% in the addicted group and 10.3% in the highly addicted group. In Demir's study conducted in 2024, it was concluded that children's digital game addiction is at a low level [30]. In the study conducted by Güvendi, Demir, and Keskin (2019) for secondary school students, it was concluded that students were in the risky group in digital game addiction and were inclined to exhibit aggressive behaviors [27].

In the study, a positive and weak relationship was found between digital game addiction and aggression. Violence and aggression are common in digital games. 89% of games played by children are designed to cause injury or death to another person. There is consistent evidence of a relationship between exposure to violent digital games and aggression [37,38]. Küçük and Çakır (2020) found a positive and weak correlation between digital gaming and aggression [1]. Güvendi, Demir, and Keskin (2019) also found a significant positive correlation between aggression and digital game addiction [27]. Studies in the literature also show that playing digital games increases addiction and aggressive behavior [28,39]. In the study, a positive and weak relationship was found between digital game addiction and daily playing time with tablet/computer/phone, and a positive and weak relationship was found between aggression and daily playing time with tablet/computer/phone. This finding obtained from the research is also consistent with the regression analysis. Güvendi, Demir, and Keskin (2019) found a positive relationship between playing time and digital addiction [27]. In the study, a negative and very weak relationship was found between digital game addiction and friend relationship evaluation, and a negative and very weak relationship was found between aggression and friend relationship evaluation. This finding is also consistent with the regression analysis. In the literature, it has been reported that violent digital games are associated with mental and psychosocial problems such as loneliness, depression and anxiety, aggression, tendency to violence, and distraction [40]. This situation may also be reflected in friendship relationships.

Limitations

The study has four limitations. The first one is that the study was conducted in a province in eastern Turkey and with students between the ages of 10 and 11. Considering the living conditions and sociocultural structure of the region and the age group in which the measurement tools were used, the results of the study cannot be generalized to all students. Secondly, the scales used to collect the study data are based on self-assessment. Therefore, it should be taken into consideration that students may have concealed their true feelings. Third, the results obtained from the analyses are based on cross-sectional data; longitudinal studies should be conducted to obtain stronger results.

Strengths of the Study

The strengths of this study are that it has findings that support the studies in the literature and there are very few studies in the literature that examine the effect of digital game addiction on aggression in school-age children.

CONCLUSION

In the study, it was determined that as students' digital game addiction levels increased, their aggression levels increased. At the same time, it was determined that as the daily playing time of the students increased, their digital game addiction and aggressive levels increased. In line with these results; individual problem detection and solution can be made in children. Parents and teachers have a role to play in the formation of conscious internet and digital game use behaviors with both time and content control. In order to prevent digital game addiction, it can be suggested that children should use digital environments more instructively and be directed to sports and physical activity.

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TELEREHABILITATION FOR ADOLESCENTS WITH IDIOPATHIC SCOLIOSIS: PAIN, QUALITY OF LIFE, AND DISABILITY DURING COVID-19

İDİYOPATİK SKOLYOZLU ERGENLER İÇİN TELEREHABİLİTASYON: COVID-19 SIRASINDA AĞRI, YAŞAM KALİTESİ VE ENGELLİLİK

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ABSTRACT

Objective: To evaluate the effectiveness of 3D scoliosis exercise training delivered via telerehabilitation on pain, function, and disability in adolescents with idiopathic scoliosis during the COVID-19 lockdown.

Method: This study was conducted between April 2020 and October 2020 during the pandemic period. The effects of face-to-face exercises before the pandemic and continued exercises via telerehabilitation during the pandemic on overall health, mental well-being, pain, and physical condition were evaluated. Forty-four participants with scoliosis (27 females, 17 males) participated in a 12-week 3D scoliosis exercise program led by an experienced physiotherapist. Assessments were conducted online using SRS-22, SF-36, and ODI scales before and after social isolation.

Results: The mean age of the sample was determined to be 14.77±2.38 years. The mean SRS-22 Pain scores before and after the lockdown were 22.11±2.45 and 22.18±2.54, respectively. However, no significant differences were found between the two assessments in terms of SRS-22, SF-36, and ODI scores.

Conclusion: Telerehabilitation-based 3D scoliosis exercises may help maintain pain, function, and disability levels in adolescents with scoliosis during lockdowns. Regular home exercise programs are recommended when face-to-face therapy is unavailable. Future research should explore simulation-based training to enhance effectiveness.

Key Words: COVID-19, 3-Dimensional scoliosis exercises, Disability, Scoliosis, Spine

ÖZ

Amaç: COVID-19 kısıtlamaları sırasında idiyopatik skolyozu olan ergenlerde telerehabilitasyon yoluyla verilen 3D skolyoz egzersiz eğitiminin ağrı, fonksiyon ve engellilik üzerindeki etkinliğini değerlendirmekti.

Yöntem: Bu çalışma, Nisan 2020 ile Ekim 2020 tarihleri arasında pandemi döneminde gerçekleştirildi. Çalışmada, pandemi öncesinde yüz yüze yapılan ve pandemi sırasında telerehabilitasyon ile devam eden egzersizlerin genel sağlık, zihinsel sağlık, ağrı ve fiziksel duruma etkileri değerlendirildi. Skolyozlu 44 katılımcı (27 kadın, 17 erkek), deneyimli bir fizyoterapist tarafından yönetilen 12 haftalık 3D skolyoz egzersiz programına katıldı. Değerlendirmeler, sosyal izolasyon öncesi ve sonrası SRS-22, SF-36 ve ODI ölçekleri kullanılarak çevrimiçi yapıldı.

Bulgular: Örneklemdeki ortalama yaş 14.77±2.38 yıl olarak belirlendi. Kapanma öncesi ve sonrası ortalama SRS-22 Ağrı skorları sırasıyla 22.11±2.45 ve 22.18±2.54'tü. Ancak, iki değerlendirme arasında SRS-22, SF-36 ve ODI skorlarında anlamlı bir fark bulunmadı.

Sonuç: Telerehabilitasyon temelli 3D skolyoz egzersizleri, skolyozlu ergenlerde kapanma sırasında ağrı, işlev ve engellilik düzeylerinin korunmasına yardımcı olabilir. Yüz yüze terapinin mümkün olmadığı durumlarda düzenli ev egzersiz programları önerilmektedir. Gelecekteki araştırmalar, etkinliği artırmak için simülasyon tabanlı eğitimi keşfetmelidir.

Anahtar Kelimeler: COVID-19, 3-Boyutlu skolyoz egzersizleri, Engellilik, Skolyoz, Omurga

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INTRODUCTION

Adolescent idiopathic scoliosis (AIS), characterized by lateral deviation, axial rotation, and abnormal sagittal curvature of the spine, is the most common (70-80%) spinal deformity with an unknown cause [1]. Except for advanced cases, individuals with AIS usually do not experience any health problems during growth. However, emerging deformities often lead to decreased quality of life and psychological disorders in adolescents [2]. The main treatment options for preventing scoliosis progression include scoliosis-specific exercises, other physiotherapy applications, bracing, and surgical techniques [3]. Scoliosis-specific exercises consist of a series of specific movements aimed at stabilizing the spine, together with the three-dimensional correction of the spine, pelvis, and thoracic cage, tailored individually and applied for therapeutic purposes in reducing spinal deformity [4]. Various studies have found that scoliosis-specific exercises reduce the Cobb angle and trunk rotation angle in patients with AIS, and that these exercises are superior to traditional physiotherapy treatments in improving deformities [5-7]. In short, scoliosis-specific exercises can control the curve optimally for a prolonged period, prevent its progression, improve quality of life, and reduce the need for braces.

The COVID-19 infection has posed a serious threat to the health-related wellbeing of millions of people. The impact of this pandemic is far-reaching and includes significant psychological distress to populations worldwide [8,9]. Clearly, the psychological impact of COVID-19 has affected both infected and uninfected individuals, including those with AIS. The psychological stress caused by COVID-19 on these patients may exacerbate their symptoms [10]. The psychological strain induced by COVID-19 may further exacerbate the symptoms experienced by these patients, particularly amid decreases in physical activity and increases in sedentary behaviors during their respective lockdowns, compounded by a general reduction in health services utilization [11,12]. Additionally, billions of people were quarantined in their homes to prevent the spread of COVID-19. Physical inactivity due to social isolation could lead to musculoskeletal problems and higher levels of pain severity due to muscle weakness [13]. This situation has further decreased the physical activity levels of patients with AIS and disrupted their former face-to-face exercise treatments. The transition from face-to-face exercise sessions to home programs through telerehabilitation has gained more importance in reducing the negative effects of COVID-19. Early COVID-19 publications on scoliosis focused on the symptoms, psychological status, quality of life, and prognosis of the disease in patients with scoliosis during the pandemic [13-17]. However, no study has compared the pre- and post-lockdown levels of pain, quality of life, and functionality of patients with AIS who were followed up with a home program during the social isolation period.

The aim of our study was to determine the effects of telerehabilitation-based 3D scoliosis exercise training on pain, functionality, and disability during the COVID-19 lockdown period in individuals with AIS.

METHOD

Study Design and Participants

The current inquiry was undertaken from April 2020 to October 2020, a period notably situated amidst the pandemic outbreak. The temporal alignment of this study within the pandemic milieu affords a direct examination of the repercussions stemming from lockdown measures and the broader pandemic context. The initial assessment was designed to evaluate the effects of face-to-face exercise sessions conducted before the pandemic on overall health, mental well-being, pain, and physical condition. The second assessment aimed to determine the same effects while maintaining the continuity of exercises during the pandemic period. The sample size for this investigation was calculated using a power analysis. Based on the results of a pilot study involving 5 subjects, a sample size of 40 subjects was required to provide an effect size of 0.40, an alpha level of 0.05, and a power of 0.80. The study included 44 individuals (27 females and 17 males) with AIS who were diagnosed in the Orthopedics and Traumatology Clinic, followed up with the diagnosis of AIS for at least one year, and were treated conservatively. All participants met the following inclusion criteria: (1) 7-18 years of age, (2) Risser stage 0-3, (3) Cobb angle between 10º-30º, (4) Lenke type 1 curvature, (5) Absence of pulmonary or thoracic diseases such as rib fracture, atelectasis, asthma, (6) Absence of any neurological or psychiatric disease and no chronic disease requiring drug use, (7) Parents allowing the child to participate in the study, and (8) Involved in face-to-face 3D scoliosis exercise program before social isolation for three months. Individuals who had non-idiopathic scoliosis, those who had undergone spine surgery in the last year, who used corsets, who remained in social isolation for less than three months, who discontinued their exercise program, and those infected with COVID-19 during the study period were excluded.

All participants were informed about the content, purpose, and effects of the study.

Outcome Measures

Pain and Scoliosis-Related Quality of Life: The Scoliosis Research Society-22 questionnaire (SRS-22) was used to assess health-related quality of life. This scoliosis-specific quality of life scale, developed by the Scoliosis Research Society, has been validated and proven reliable in multiple languages [18,19]. The Turkish version's validity and reliability were established by Alanay et al. In 2005 [20]. The SRS-22 is a 5-point Likert-type scale consisting of 22 questions, divided into five subgroups: pain, general appearance/image, spine function, mental health, and satisfaction with treatment. Each question offers responses ranging from negative to positive, with scores ranging from 1 to 5. Subgroup scores are derived by summing scores and dividing by the number of questions answered. Thus, both subgroup and total scores range from 1 (lowest) to 5 (highest), with higher scores indicating better quality of life [18-20]. The SRS-22 questionnaire was administered to participants online before and after social isolation via Google Forms.

General Quality of Life: The Short Form-36 (SF-36) was utilized to evaluate the general quality of life of the participants [21]. The Turkish validity and reliability of the SF-36 were established by Koçyiğit et al. [22]. The questionnaire comprises 36 items measuring eight dimensions: physical function, social function, role limitations due to physical problems, role limitations due to emotional problems, mental health, energy/vitality, general pain perception, and overall health. Subscales assess health on a scale of 0-100 points, where 0 indicates poor health and 100 indicates good health.

Disability Status: The Oswestry Disability Index (ODI) was employed to assess the disability levels of the participants. The ODI measures an individual's performance in activities necessary for daily life and evaluates what the patient can and cannot do [23]. The Turkish validity and reliability of the ODI were confirmed by Yakut et al. [24]. It consists of 10 items that evaluate pain severity, self-management, weightlifting, walking, sitting, standing, sleeping, sexual life, social life, and travel. Each item is scored on a range of 0 to 5. The patient's disability status is determined by converting the total score, which ranges from 0 to 50, into a percentage. Higher scores indicate higher levels of disability. The ODI serves as a reliable predictor of pain during isokinetic performance, isometric endurance, sitting, standing, and return to work [25]. The index is a valid questionnaire for assessing health-related quality of life and disability levels in individuals with scoliosis [25,26]. Online application of SRS-22 and ODI to patients with AIS has been reported to be a convenient and reliable way to minimize the loss of follow-up data [27].

Exercise Program

A twelve-week 3D scoliosis exercise program (3 times per week, 60 minutes per session) was administered via telerehabilitation. This

telehealth approach involved individual video conference sessions facilitated by an experienced physiotherapist with a minimum of three years of specialized expertise in scoliosis management. Furthermore, all requisite equipment for home exercises was procured online by the respective families under the guidance of the physiotherapist.

The face-to-face scoliosis-specific exercise programme, which was included in the pre-closure inclusion criteria, was also applied as scoliosis-specific exercises in similar parallelism with a physiotherapist for 60 minutes 3 days a week.

In the 3D scoliosis exercise method, exercises are specifically planned and applied to the structure of the curvature and the individual. The treatment program commenced with defining the primary curvatures, any postural deviations caused by secondary curvatures, and the breathing zones, followed by teaching 3-dimensional corrective breathing exercises.

Auxiliary materials such as a wall bar, mirror, exercise mat, 3 rice bags, sponge pillows, chairs, and two long sticks were utilized during the exercises. Simple supine and side-lying positions were initially selected for the sessions, progressing to positions with increasing difficulty (sitting position, standing, walking).

The exercises were gradually progressed from 1 to 3 sets and from 7-10 to 10-15 repetitions. The 3D scoliosis exercise program applied for 12 weeks is outlined in Table 1. Additionally, Table 2 presents descriptors of Cobb angles for scoliosis and ATR characteristics of all participants. All consents and assessments throughout the study were exclusively obtained from participants and their family.

Table 1. 3D Scoliosis Exercises applied in the study

Beginner	Intermediate	Advanced
3D corrective breathing exercises	3D corrective breathing exercises	3D corrective breathing exercises
Shoulder countertraction in supine	Shoulder countertraction in sitting position	Shoulder countertraction in sitting position
Shoulder countertraction in prone position	Chest twister	Chest twister
Shoulder countertraction in side-lying	Muscle cylinder in kneeling position	Muscle cylinder in kneeling position
Muscle cylinder in supine position	Big bow	Big bow
Muscle cylinder in side-lying position	Shoulder countertraction between two poles	Shoulder countertraction between two poles
Muscle cylinder in sitting position	Schroth gait	Schroth gait
Chest twister	Removing the stool	Removing the stool

Table 2. Descriptors of Cobb angle for scoliosis and ATR characteristics

Characteristics		X±SD	Min	Max
Cobb Angle	Thoracic (°)	19.045±5.332	0	30
	Lumbal (°)	10.980±7.712	0	20
Angle of the trunk rotation		8.490 ± 3.227	3	17

Min:Minimum, Max:Maximum, X:Average, SD:Standard deviation

Ethical Approval

All participants agreed to take part in the study and signed written informed consent. The study was approved by the Ethical Committee of Ankara Yıldırım Beyazıt University (2022/03-10.03.2022) and was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

The distributions of age and the score differences between pre- and post-lockdown assessments for SRS-22, SF-36 and ODI were examined by Shapiro-Wilk's test, normality plots, and skewness/kurtosis statistics. All quantitative variables were reported as mean ± standard deviation (SD), and median (interquartile range, IQR: 1st-3rd quartile). Gender was summarized in frequency (%).

Considering the distribution of the differences in the scores, the paired samples t-test was used to compare SRS-22 pain score, SF-36 vitality score, and SF-36 general mental health score between two periods, and the Wilcoxon signed-rank test was performed for other scores.

All other statistical analyses were performed via IBM SPSS Statistics 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). A p-value≤0.05 was considered as statistically significant [28].

RESULTS

The mean age of the sample was 14.77±2.38 years, with a median age of 15 (IQR: 13-17, range: 7-18). The sample consisted of 61.4% (n=27) females. The mean SRS-22 Pain score was 22.11±2.45 and 22.18±2.54 before and after the lockdown, respectively. The median SRS-22 total score was 89.5 (IQR: 84.0-97.8) before the lockdown and 91.5 (IQR: 82.3-96.0) after the lockdown. However, there were no significant differences in the SRS-22, SF-36, and ODI scores between the two assessments (p>0.05, see Table 3). Table 3 shows the SRS-22, SF-36, and ODI scores before and after the lockdown.

Table 3. Pre- and post-lockdown scores of SRS-22, SF-36, and ODI

Variables	Pre-lockdown (Mean±SD)	Post-lockdown (Mean±SD)	p
SRS-22			
Pain*	22.11±2.45	22.18±2.54	0.856
Self-image/ appearance	17.52±3.06	17.32±3.41	0.962
Function/activity	22.66±2.50	22.80±2.78	0.459
Mental health	18.43±4.26	18.41±3.74	0.870
Satisfaction with management	8.59±1.34	8.41±1.72	0.484
Total	89.32±9.39	89.11±10.24	0.645
SF-36			
Physical functioning	90.00±12.71	87.95±15.53	0.195
Physical role limitation	76.14±34.08	82.39±28.82	0.179
Emotional role limitation	67.42±40.98	68.94±38.98	0.702
Vitality/Fatigue*	59.77±19.76	59.55±19.70	0.916
General mental health*	65.09±21.88	67.73±21.28	0.207
Social functioning	80.40±25.49	85.80±16.08	0.252
Bodily pain	82.84±20.06	87.39±16.00	0.214
General health perceptions	65.00±16.91	66.14±16.67	0.371
ODI	4.84±5.63	3.98±5.43	0.200

*SRS-22:Scoliosis Research Society-22 Questionnaire, SF-36:Short Form-36 Questionnaire, ODI:Oswestry Disability Index, IQR:1st quartile – 3rd quartile, CI:Confidence Interval, *Compared by paired t-test and Cohen's d was provided, while Wilcoxon signed-rank test was performed and rank biserial correlation was calculated for the others.*

DISCUSSION

In our study, whose aim was to determine the effects of telerehabilitation-based scoliosis-specific exercise training on pain, functionality, and disability in individuals with AIS during the COVID-19 quarantine period, we observed preserved pain, disability, functionality, and quality of life outcomes in AIS patients who underwent scoliosis-specific exercise training through telerehabilitation during the lockdown period.

Telehealth services and telerehabilitation, which have become more popular with the COVID-19 epidemic, should play a significant role in the rehabilitation of adolescent and juvenile scoliosis due to the requirement for regular follow-up and personalized exercise programs over long periods. The data from this study confirm that positive results can be achieved via telerehabilitation and remote follow-ups. The absence of significant differences between pre- and post-lockdown SRS-22, SF-36, and ODI scores indicates that the negative effects of the COVID-19 lockdown period can be mitigated in individuals with scoliosis through remote follow-ups and regular home exercise programs when face-to-face treatment is not feasible.

Furthermore, the higher pre-lockdown scores suggest that face-to-face rehabilitation sessions, even if intermittent, should be considered in the exercise treatment of AIS. This is because corrections requiring tactile and/or vibration stimuli, as well as corrections required to perform exercises symmetrically and correctly, may not be achievable through telerehabilitation alone.

The COVID-19 pandemic prompted a rapid expansion of telemedicine across medicine. Telemedicine allows for social distancing while also having the potential to save expenses and improve access to care [29]. Consistent with this trend, our results demonstrated similar outcomes in both periods of face-to-face rehabilitation (i.e., pre-pandemic) and telerehabilitation (i.e., post-lockdown) in measurements affecting the quality of life and disability levels in AIS.

This study represents the first attempt in the literature to evaluate the effect of 3D scoliosis exercises administered via telerehabilitation on the quality of life and disability levels in adolescent and juvenile idiopathic scoliosis patients during the COVID-19 lockdown period. With the COVID-19 pandemic, efforts to limit the spread of viral infections necessitated the interruption of non-emergency health services. Although these restrictions made standard face-to-face rehabilitation less accessible, telehealth services today can serve as an effective alternative, supporting exercise tracking in individuals with scoliosis. According to Dermott et al. [14], there has been a significant decrease in hospital admissions due to scoliosis after the COVID-19 period. Concerns about the risk of disease transmission may have made treatments more difficult, leading to longer diagnosis times. This underscores the importance of ensuring that treatment remains comprehensive and that individuals continue their exercises at home to reduce the progression of scoliosis.

A study by Marin et al. [29] in 2021, which compared the effectiveness of telemedicine services in individuals with AIS, found that remote exercises were perceived positively by all subjects. The utilization of telerehabilitation as a means of therapeutic exercise delivery is crucial in these patients, as supported by our research.

While the outcomes of our study did not show improvement, they remained stable. However, there were some concerning findings regarding certain subdomains of the SRS-22 questionnaire. Personal image, mental health, satisfaction with treatment, and general scores were lower after the pandemic, possibly due to the psychosocial impact of the pandemic and social isolation. Conversely, pain and function subscales were higher after the pandemic compared to before, indicating the positive effect of continuous follow-up of home exercise programs on pain and functional loss caused by deformity in individuals with adolescent and juvenile idiopathic scoliosis. Although these results were not statistically significant, they suggest that 3D exercises are perceived as effective from the patient's perspective.

Obtaining similar results in both pre- and post-lockdown periods in certain sub-scales of SF-36, such as limitations in physical role, limitations in emotional role, general mental health, social function, body pain, and general health perception, suggests that the negative physical, emotional, and social effects of the lockdown on individuals in this age group can be mitigated with home exercise and telerehabilitation programs. The similarity of the ODI total scores during and after the restrictions indicates that the limitations of movement and the period of staying at home are not directly related to the pain caused by scoliosis and the level of disability in daily life activities such as sleeping, standing, sitting, social life, sexual life, and traveling. A study by Kieser et al. [10] on adults who underwent surgical treatment for spinal deformities included similar test parameters. Despite the negative effects of the pandemic on the participants, the authors found no difference in SRS-22 and SF-36 test parameters. Although similar results were observed in our study regarding these parameters, it is likely that the lack of difference in these parameters might be attributed to individuals adapting to continue their exercises with the help of telerehabilitation while staying at home [12].

Contrary to our study, the same study reported an increase during the pandemic in ODI pain and movement restriction scores, but no difference in daily life activity and sociality [12]. This is likely a result of inactivity due to home confinement, as their sample consisted of adults with spinal surgery. However, our participants were individuals with juvenile or adolescent scoliosis with no history of surgical treatment. The absence of any difference in pre- and post-lockdown ODI scores can also stem from the fact that our sample continued their exercise treatment program via telerehabilitation during home confinement.

Limitations

This study has some limitations that need to be addressed. The absence of an investigation into radiological parameters, including Cobb angles, gibbosity values, and posture evaluations, precludes an understanding of the impact of the COVID-19 period on these metrics. Restricted access to fresh X-rays during the pandemic and lockdown necessitated the formulation of the exercise plan for telerehabilitation based on existing radiographs. Consequently, the direct effects of the pandemic on these radiological parameters remain undetermined. Additionally, the long-term effects of COVID-19 on patients with AIS could not be evaluated. Therefore, further studies including long-term follow-ups are warranted to address these limitations.

CONCLUSION

Pain, disability, functionality, and quality of life outcomes in AIS patients who underwent scoliosis specific exercise training through telerehabilitation during the lockdown period were preserved post-lockdown period. As a conclusion, for the patients with AIS, regular follow-up of exercises could be highly recommended as a home program in cases where face-to-face rehabilitation is not possible. Also, although the results of the study showed that pain, functionality, and quality of life scores were preserved in individuals with AIS during the pandemic period, simulation-like trainings are needed.

Ethical Approval: *2022/03 Health Sciences Ethics Committee of Ankara Yıldırım Beyazıt University*

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DOES EXERCISE HABIT AFFECT CENTRAL SENSITIZATION AND PREMENSTRUAL SYMPTOMS IN ADULT WOMEN? NON-EXERCISING VERSUS (IR)REGULAR-EXERCISING

EGZERSİZ ALIŞKANLIĞI YETİŞKİN KADINLARDA SANTRAL SENSİTİZASYON VE PREMENSTRÜEL SEMPTOMLARI ETKİLER Mİ? EGZERSİZ YAPMAYANLAR İLE DÜZENLİ/DÜZENSİZ EGZERSİZ YAPANLARIN KARŞILAŞTIRILMASI

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ABSTRACT

Objective: The aim of this study was to investigate central sensitization (CS) and premenstrual symptoms in adult women based on exercise habits.

Method: A hundred- two adult women (mean age of 25.9 (8) years) were included in the study. The participants were divided into three groups based on exercise habits: the non-exercising group (NG), the irregular-exercising group (IG), and the regular-exercising group (RG). The CS-related and CS positivity was assessed using the Central Sensitization Inventory (CSI-A and CSI-B). Premenstrual symptom severity was determined with the Premenstrual Syndrome Scale (PSS).

Results: Sociodemographic and menstrual cycle characteristics were comparable among the groups ($p>0.05$). There was a significant difference in the CSI-A ($p<0.001$), the CSI-B ($p=0.023$) and CS positivity ($p<0.001$) among the groups. The CSI-A was higher in the NG compared to the RG ($p<0.001$) and IG ($p=0.001$). The CSI-B was higher in NG compared to the RG ($P=0.002$). CS positivity was common in NG (67.6%) compared to IG (23.7%) and RG (26.7%). The median PSS total score was lowest in RG (120.5) while no significant differences were found in PSS total score ($p=0.375$) or PMS positivity ($p=0.624$) among the three groups. PSS total score correlated to CSI-A ($p=0.001$, $r=0.334$) and menstrual pain severity ($p=0.002$, $r=0.310$). The CSI-A and PSS scores are similar in terms of the phase of the menstrual cycle, and use of the medication for menstrual pain ($p>0.05$).

Conclusion: Premenstrual symptom severity is associated with CS symptoms and menstrual pain in adult women. Adopting an exercise habit may be a protective approach that reduces symptoms associated with CS and improves premenstrual symptoms.

Key Words: Exercise, Pain, Central sensitization, Premenstrual symptom

ÖZ

Amaç: Çalışmanın amacı yetişkin kadınlarda egzersiz alışkanlığının santral sensitizasyon ve premenstrüel semptomlar üzerine etkisinin araştırılmasıdır.

Yöntem: Yüz iki yetişkin kadın (ortalama yaş 25.9 (8) yıl) çalışmaya dahil edildi. Katılımcılar egzersiz alışkanlıklarına göre üç gruba ayrıldı: egzersiz yapmayan grup (NG), düzensiz egzersiz yapan grup (IG) ve düzenli egzersiz yapan grup (RG). Santral sensitizasyon ve santral sensitizasyon pozitifliği, Santral Sensitizasyon Ölçeği (SSÖ-A ve SSÖ-B) kullanılarak değerlendirildi. Premenstrüel semptom şiddeti Premenstrüel Sendrom Ölçeği (PSÖ) ile belirlendi.

Bulgular: Gruplar sosyodemografik ve menstrüel siklus özellikleri bakımından benzerdi ($p>0.05$). Gruplar arasında SSÖ-A ($p<0.001$), SSÖ-B ($p=0.023$) ve santral sensitizasyon pozitifliği ($p<0.001$) açısından anlamlı fark bulundu. SSÖ-A skoru NG'de RG ($p<0.001$) ve IG'ye ($p=0.001$) göre daha yüksekti. SSÖ-B skoru NG'de RG'ye göre daha yüksek bulundu ($p=0.002$). Santral sensitizasyon pozitifliği NG'de (%67,6) IG (%23,7) ve RG'ye (%26,7) göre daha yaygındı. Medyan PSÖ toplam skoru RG'de en düşük iken (120,5), üç grup arasında PSÖ toplam skoru ($p=0,375$) veya premenstrüel sendrom pozitifliği ($p=0,624$) bakımından anlamlı bir fark bulunmadı. PSÖ toplam puanı, SSÖ-A ($p=0.001$, $r=0.334$) ve menstrüel ağrı şiddeti ($p=0.002$, $r=0.310$) ile anlamlı korelasyon gösterdi. SSÖ-A ve PSÖ skorları menstrüel döngünün fazı ve menstrüel ağrıda ilaç kullanımı bakımından benzer bulundu ($p>0.05$).

Sonuç: Premenstrüel semptom şiddeti, yetişkin kadınlarda santral sensitizasyon semptomları ve menstrüel ağrı ile ilişkilidir. Egzersiz alışkanlığı edinmek, santral sensitizasyon ile ilişkili semptomları azaltan ve adet öncesi semptomları iyileştiren koruyucu bir yaklaşım olabilir.

Anahtar Kelimeler: Egzersiz, Ağrı, Santral sensitizasyonu, Premenstrüel semptom

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INTRODUCTION

Central sensitization (CS) is defined as an increased response in the central nervous system to stimuli that are not normally perceived as painful or irritating [1]. This phenomenon, seen in various chronic pain disorders, leads to sensory abnormalities and suggests the presence of certain signs and symptoms [2]. These signs and symptoms include various complaint such as broad pain, fatigue, sleep disorders, headache, cognitive difficulties, and other symptoms [2,3]. Furthermore, few studies have indicated that pain stimuli during the menstrual cycle may lead to CS [3,4].

Occurring during the luteal phase of the menstrual cycle, premenstrual syndrome (PMS) affects many women of reproductive age and is characterized by physiological and psychological symptoms. The syndrome typically begins approximately 7–14 days before the onset of menstruation and usually resolves spontaneously with the onset of menstruation. Symptoms of PMS include irritability, fatigue, headache, breast tenderness, depressive mood, and intense anxiety, among various physiological and psychological symptoms [5].

There are various potential causes for PMS, including estrogen and progesterone imbalances, hyperprolactinemia, prostaglandin deficiency, psychosomatic issues, and serotonin deficiency [5,6]. The condition may be related to the interaction of smoking, alcohol consumption, physical activity level, age, length of menstrual flow, dysmenorrhea, employment status, living area, and marital status. PMS may manifest with severe symptoms that can affect women's daily lives and have a negative impact on work, family, and social relationships [6-8]. Due to the unclear pathophysiology of PMS, there is currently no precise treatment available, and management typically focuses on alleviating individual symptoms. Treatment modalities can generally be categorized into pharmacological treatments (including analgesics, hormonal therapies, or antidepressants), and non-pharmacological therapies (lifestyle modifications, exercise, etc.) [6].

Exercise increases endorphin levels, regulates progesterone and estrogen, and stimulates the production of anti-inflammatory substances. Moreover, exercise offers supplementary advantages such as enhanced overall fitness, social interaction opportunities, and mitigation of depressive symptoms, all of which may contribute to mitigating the problems associated with PMS [9,10]. A study investigated the impact of aerobic exercise of varying intensity levels (low, moderate, and high) on women diagnosed with PMS over a 6-week period. Their findings revealed a significant reduction in PMS symptoms among participants engaging in moderate-intensity aerobic exercise [11]. Also, available evidences suggest that physical activity may improve pain and pain perception [12]. Participants who engaged in physical activity, such as walking for more than one hour per day, showed reduced levels of CS [13]. Besides, a systematic review indicated that aerobic exercise reduces pain sensitization in participants with musculoskeletal pain [14]. However, limited knowledge is available on the effect of exercise habits on CS and premenstrual symptoms in adult women. Furthermore, little is known about the relationship between CS and premenstrual symptoms in adult women.

METHOD

Study Design

The comparative cross-sectional study.

Participants

One hundred-two women (34 non-exercising, 38 irregular-exercising, and 30 regular-exercising) were included in the present study. The inclusion criteria were women aged between 18 and 40 who agreed to participate in the study. Women who were utilizing medication such as hormonal drugs and antidepressants, had irregular menstrual cycle (defined as lasting less than 21 days or more than 35 days and/or missing three or more cycles in a row and/or a gap of more than 4 days between cycles) [15] had alcohol dependence or chronic disease such as fibromyalgia syndrome, thyroid dysfunction, diabetes mellitus, and psychiatric disorders, had any rheumatological disease, were pregnant, or were taking oral contraceptives were excluded from the present study.

Exercise habits were considered to be more than 30 minutes at least 2 days a week for at least 3 months [16,17]. Exercise regularity was asked as two options: regular exercise or irregular exercise. Regular exercise habit is considered as a percentage of total number of exercise session (high attendance is defined as >75%) available over the 12-week period [18]. Participants were considered non-exercise if they were except for these conditions. All women were divided into three groups: Non-exercising group (NG), regular exercising group (RG) and irregular exercising group (IG).

Outcome Measures

Sociodemographic Characteristics: Age (year), height (cm), weight (kg), body mass index (BMI; kg/m^2), education level, smoking (none, active-smoker, ex-smoker) were recorded. The phase of the menstrual cycle was obtained as follows: The premenstrual period was considered as the 7- 14 days before the first day of menstruation; menstrual period was considered as the first to last day of menstruation; and postmenstrual period was considered as the day after the end of menstruation to the day before the premenstrual period [19]. The frequency of menstrual cycle (days), duration of menstrual flow (days), perceived menstrual pain on the first day of menstruation, and use of medication for menstrual pain, were recorded. Due to the study design, the CS, premenstrual symptoms, and menstrual pain were assessed in all participants, regardless of the day of the menstrual cycle. All assessments lasted approximately 4 to 7 minutes.

Central Sensitization and Positivity: The Central Sensitization Inventory (CSI) consists of a two-part questionnaire designed to assess symptoms associated with central sensitivity syndromes. The CSI aims to quantify the severity and frequency of symptoms related to CS, which include conditions such as fibromyalgia, irritable bowel syndrome, chronic fatigue syndrome, and migraine. The inventory comprises two parts: Part A comprises a 25-item scale examining the frequency of various health-related symptoms experienced by the individual, while Part B inquires about specific diagnosed disorders. Each item in Part A is scored from 0 (never) to 4 (always). Total points on the CSI vary between 0 and 100, with higher points demonstrating a greater severity of symptoms associated with CS. The cut-off point of the CSI is 40 points and ≥ 40 is defined as CS positivity [20,21].

Premenstrual Symptoms: The Premenstrual Syndrome Scale (PSS) is a widely used instrument to evaluate the severity of premenstrual symptoms experienced by women. The scale, which consists of 44 items with nine sub-domains (depressive mood, anxiety, fatigue, nervousness, depressive thoughts, pain, changes in appetite, changes in sleep pattern, and bloating), is of the 5-point Likert type. Total score ranges from 44 to 220 points. Scoring 110 points or more signifies the presence of PMS [22].

Menstrual Pain Severity: Menstrual pain was assessed using the Visual Analogue Scale (VAS). VAS typically consists of a 10-cm horizontal line. In pain severity assessment, 0 represents "no pain severity," while 10 indicates "worst pain severity imaginable." Participants were asked to indicate the point corresponding to their perceived menstrual pain on the first day of menstruation over the past three months. The higher scores show greater intensity or severity of pain [23].

Ethical Approval

The study received ethical approval from the Bingöl University Ethics Committee (date: 26/09/2023, no. 23/19) in line with the principles outlined in the Helsinki Declaration. The study was conducted from October, 2023 to January, 2024. All participants completed an informed consent form through an online form.

Statistical Analysis

A priori sample size analysis was performed with G Power software (Version 3.1.9.2, Franz Faul, University of Kiel, Kiel, Germany). Premenstrual symptom score was determined as the primary outcome measure in agreement with the study by Mizuta et al. [16] [exercise group: mean (standard deviation) =54.1 (19.1); non-exercise group: mean (standard deviation) = 60.2 (23.3)]. The total sample size of at least 102 individuals was found to have a power of 0.80, an effect size of 0.50 (medium), and an alpha value of 0.05 (one-tailed).

The statistical analyses were performed utilizing IBM SPSS Statistics 22 (IBM Corp., Armonk, NY, USA). The normality of the distribution of the data was assessed with visual and analytical methods. Sociodemographic and menstrual cycle characteristics were represented as the mean (standard deviation) or median (interquartile range). A one-way ANOVA test was used for the comparison of the CSI-A scores among groups. The Levene test was used to assess the homogeneity of the variances. Paired post hoc tests were performed using the Tamhane test as the variances were not homogeneous.

A Kruskal-Wallis test was used for PSS scores, and the Mann-Whitney U test was used to compare the differences between the groups. A p-value<0.016 was considered significant for the pairwise comparison. A Pearson's chi-square test was used for categorical data. Spearman correlation test was performed for the relationship between PSS, CSI-A, and menstrual pain. The Spearman correlation test was interpreted as follows: indicating negligible correlation for values between 0 and 0.29, poor correlation for values between 0.30 and 0.49, moderate correlation for values between 0.50 and 0.69, good correlation for values between 0.70 and 0.89, and excellent correlation for values between 0.90 and 1.00 [24]. Also, the A one-way ANOVA test or Kruskal-Wallis test was used for comparison of the CSI-A and PSS scores regarding menstrual period. A significance level was set at $p<0.05$ to indicate statistical significance.

RESULTS

A hundred-two adult women [mean age of 25.9 (8) years, mean BMI of 22.1 (3.9) kg/m^2] were included in the study. The groups according to exercise habit were similar in terms of age (p=0.163), BMI (p=0.928), education level (p=0.346), smoking (p=0.123), menstrual pain (p=0.454), cycle (p=0.962), and duration (p=0.073). The sociodemographic and menstrual cycle characteristics of groups are shown in Table 1.

The CSI-A, CSI-B, CS positivity, PSS, and PMS positivity results indicated a significant difference in CSI-A (p<0.001), CSI-B (p=0.023) and CS positivity (p<0.001) among the groups. The post hoc analysis showed that CSI-A was higher in the NG group compared to the RG (p<0.001) and IG groups (p=0.001). Also, the CSI-B was higher in NG compared to the RG (p=0.002). CS positivity was common in NG (67.6%) compared to IG (23.7%) and RG (26.7%). The median PSS total score was lowest in RG (120.5) compared to NG (126) and IG (136.5). No significant differences were found in PSS total score (p=0.375) or PMS positivity (p=0.624) among the three groups (Table 2).

PSS total score significantly correlated to CSI-A (p=0.001, r=0.334) and menstrual pain severity (p=0.002, r=0.310). The correlation analysis among PSS, CSI-A, and menstrual pain severity is indicated in Table 3. The CSI-A and PSS scores are similar based on the phase of the menstrual cycle (p=0.237 of CSI-A, p=0.374 of PSS) and use of medication for menstrual pain (p=0.873 of CSI-A, p=0.240 of PSS) (Figure 1).

Table 1. Sociodemographic and menstrual cycle characteristics of groups

Characteristics	All participants n=102	Non-exercising group (NG) n=34	Irregular-exercising group (IG) n=38	Regular-exercising group (RG) n=30	p value
Age (year), mean (SD)	25.9 (8)	27.1 (8.7)	24 (6.6)	27.1 (8.5)	0.163*
BMI (kg/m^2), mean (SD)	22.1 (3.9)	22 (4)	22 (3.9)	22.3 (3.8)	0.928*
Education level, n (%)					
Primary School	2 (2)	1 (2.9)	0 (0)	1 (3.3)	
Middle School	1 (1)	0 (0)	0 (0)	1 (3.3)	
High School	9 (8.8)	6 (17.6)	1 (2.6)	2 (6.7)	0.346[a]
University	72 (70.6)	22 (64.7)	31 (81.6)	19 (63.3)	
Master's degree	8 (7.8)	2 (5.9)	2 (5.3)	4 (13.3)	
Doctorate	10 (9.8)	3 (8.8)	4 (10.5)	3 (10)	
Smoking, n (%)					
None	78 (76.5)	26 (76.5)	32 (84.2)	20 (66.7)	0.123[a]
Active-smoker	17 (16.7)	7 (20.6)	2 (5.3)	8 (26.7)	
Ex-smoker	7 (6.9)	1 (2.9)	4 (10.5)	2 (6.7)	
Premenstrual period, n (%)	33 (32.4)	11 (32.4)	14 (36.8)	8 (26.7)	0.673[a]
Menstrual period, n (%)	19 (18.6)	8 (23.5)	5 (13.2)	6 (20)	0.515[a]
Postmenstrual period, n (%)	50 (49)	15 (44.1)	19 (50)	16 (53.3)	0.754[a]
Use of medication for menstrual pain, n (%)	56 (54.9)	18 (52.9)	23 (60.5)	15 (50)	0.661[a]
Frequency of menstrual cycle (days), median (IQR)	28 (26-30)	28 (26-30)	28 (25-30)	28 (26-30)	0.962[b]
Duration of menstrual flow (days), median (IQR)	6 (5-7)	7 (6-7)	6 (5-7)	6 (5-7)	0.073[b]
Menstrual pain (cm), median (IQR)	6 (5-8)	6 (5-7)	7 (5-8)	6 (3-8)	0.454[b]

*SD:Standard Deviation, IQR:Interquartile range, *One-way ANOVA test, a:Pearson chi-square test, b:Kruskal-Wallis test*

Table 2. Comparison of CSI and PSS scores based on exercise habits

Variables	Non-exercising group (NG) n=34	Irregular-exercising group (IG) n=38	Regular-exercising group (RG) n=30	p value
CSI-A (point), mean (SD)	48.6 (18.1)	33.3 (13.4)	32.5 (12.2)	**<0.001***
CSI-B (point), median (IQR)	0 (0-2)	0 (0-1)	0 (0-1)	**0.023[b]**
CS positivity, n (%)	23 (67.6)	9 (23.7)	8 (26.7)	**<0.001[a]**
PSS Total (point), median (IQR)	126 (104-151)	136.5 (100-160)	120.5 (91-148)	0.375[b]
Depressive mod	24 (16-28)	27.5 (20-32)	26 (18-31)	0.278[b]
Anxiety	23.5 (17-29)	24.5 (15-28)	19 (13-28)	0.334[b]
Fatigue	19 (15-22)	22.5 (16-27)	18 (13-24)	0.118[b]
Nervousness	14 (10-20)	15 (11-20)	13.5 (10-19)	0.726[b]
Depressive thoughts	20.5 (12-22)	20.5 (13-25)	14.5 (10-23)	0.386[b]
Pain	9 (8-12)	9 (7-12)	9 (6-12)	0.838[b]
Appetite changes	7.5 (6-14)	11 (9-13)	7 (6-12)	0.210[b]
Sleep changes	6 (3-9)	8 (6-11)	7 (6-11)	0.156[b]
Bloating	7 (3-11)	8 (6-12)	10 (7-12)	0.074[b]
PMS positivity, n (%)	23 (67.6)	27 (71.1)	18 (60)	0.624[a]

*PSS:Premenstrual Syndrome Scale, PMS:Premenstrual Syndrome, CSI-A:Central Sensitization Inventory Part A, CSI-B:Central Sensitization Inventory Part B, CS:Central Sensitization, SD:Standard Deviation, IQR Interquartile range, *One-way ANOVA test, a:Pearson chi-square test, b:Kruskal-Wallis test, p<0.05 is defined as significant.*

Table 3. Correlation among PSS, CSI-A and menstrual pain severity

Correlation	CSI-A		Menstrual pain severity	
	r	p	r	p
PSS total score	0.334	**0.001**	0.310	**0.002**

*PSS:Premenstrual Syndrome Scale, CSI-A:Central Sensitization Inventory part A, *Spearman's correlation test.*

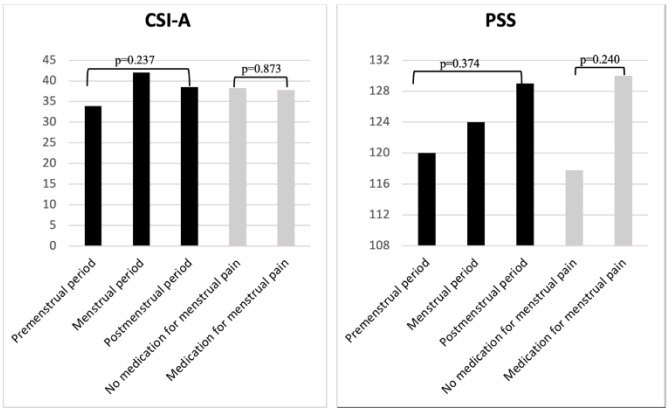

Figure 1. Comparison of the CSI-A and PSS scores based on the phase of the menstrual cycle and use of medication for the menstrual pain

DISCUSSION

The present study showed that CS was more common in non-exercising than in regular or irregular exercising and that premenstrual symptom severity was not affected by exercise habit in adult women, although PSS scores were lower in regular exercising than non-exercising and irregular exercising. Also, premenstrual symptom severity was associated with CS and menstrual pain severity, while the phase of the menstrual cycle and the use of medication for menstrual pain did not affect CS and PMS symptoms.

A review highlighted that exercise potentially modulates pain perception through activation of various endogenous systems [25]. Participants with an exercise habit exhibited elevated levels of daily well-being [26]. Current evidence indicates that physical activity and exercise may improve pain and function in daily activities [12]. A study indicated that participants who engaged in physical activity, such as walking for more than one hour per day, demonstrated lower levels of CS [13]. In the present study, CS and CS-related diseases were more common in adult women who were non-exercising than those who were regular- or irregular-exercising, consistent with the results of Haruyama et al. [13]. However, available evidence is limited regarding exercise habits and central sensitization in healthy adult women.

The present study has provided a valuable insight into the adoption of exercise habits as a protective approach to CS, thereby addressing a gap in the current literature.

A study showed that premenstrual symptoms were similar in regular exercisers and those who did not exercise regularly in women with dysmenorrhea [27]. Hwang et al. showed that there was an inverse relationship between the symptoms of PMS and exercise frequency for women in their 30s and 40s [28]. Besides, previous studies indicated that physical activity levels were similar in participants with and without PMS in Turkish women [29,30] and that there was no relationship between physical activity levels and the presence of PMS [31]. Also, a study showed that physical activity level was similar based on menstrual pain intensity in Turkish women with primary dysmenorrhea [32]. Another study determined that increased physical activity level was associated with less severe pain in Turkish women [33]. The present study was consistent with the previous studies. Although the PSS scores of regular exercisers were lower than those of non-exercisers and irregular- exercisers, there was no difference in PSS scores depending on exercise habit. These results may be related to the type of exercise performed by the participants. In future studies, the effect of different exercise types on PMS symptoms may be evaluated. As the scores of the regular exercise group were low, it is important for the participants to adopt regular exercise habits to reduce PMS symptoms.

A study found that participants with PMS exhibited a higher tendency for somatization compared to those without PMS [34]. Another study revealed that the severity of menstrual pain, sleep disturbances, and eating attitude problems influenced PMS [27]. A study suggested that there was a relationship between PMS and the risk of depression in university students [35]. Furthermore, a study showed that students with PMS experienced more menstrual pain than those without PMS and that menstrual pain was approximately 4.7 times a risk factor for PMS [36]. Consistent with previous studies, the present study found that PMS symptom severity was associated with CS and menstrual pain severity. The presence of CS in individuals with PMS should be monitored carefully.

A comprehensive cross-sectional study found that central sensitivity symptoms are prevalent in about half of the women and are linked with menstrual characteristics including dysmenorrhea-related pain severity, cycle regularity, and the presence of dysmenorrhea, along with gynecological diseases in Brazilian women [4]. Consistent with the previous study [4], the phase of the menstrual cycle and use of medication for menstrual pain did not affect CS scores in the present

study. A study in the Turkish population indicated that menstrual pain and use of analgesics for menstrual pain were not different in women with PMS and without PMS [7]. In the present study, PMS total scores were similar for being in the menstrual or premenstrual period or the use of medication for menstrual pain, in agreement with the previous study's results [7].

Limitations

The study has some limitations. Firstly, the type of exercise in regular- and irregular-exercising groups were not evaluated in detail. The type of exercise may alter not only PMS symptoms but also CS-related symptoms. Further studies should be evaluated to determine the effect of different exercise types on PMS symptoms and CS. Secondly, PMS is influenced by various factors such as diet, sleep quality, use of alcohol, and anemia. In the present study, these factors were not determined; therefore, future studies should take into consideration these factors. Thirdly, the international physical activity questionnaire or activity hours were not used when grouping participants according to their exercise habits. Lastly, the present study cannot definitively establish whether exercise habits can effectively treat symptoms of PMS due to study design. Besides, we are unable to determine whether women with symptoms may exercise more to manage their PMS symptoms, as exercise is recommended by the American College of Obstetricians and Gynecologists [37].

CONCLUSION

The regular exercise habits may be protective in reducing CS and CS-related symptoms and improving the severity of PMS symptoms. The results of this study may encourage regular exercise, a non-pharmacological approach, to improve health, reduce central sensitization and deal with premenstrual symptoms in adult women.

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EXERCISE CAPACITY, MUSCLE FUNCTION, FUNCTIONAL BALANCE, AND COGNITIVE STATUS IN PATIENTS WITH POST COVID-19 SYNDROME COMPARED TO HEALTHY CONTROLS

POST COVID-19 SENDROMU OLAN HASTALARIN SAĞLIKLI KONTROLLERE GÖRE EGZERSİZ KAPASİTESİ, KAS FONKSİYONU, FONKSİYONEL DENGE VE BİLİŞSEL DURUMU

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ABSTRACT

Objective: There is limited data on the effect of post-COVID-19 syndrome on functional outcomes compared with healthy uninfected individuals. This study aimed to compare the muscle function, exercise capacity, and quality of life of patients with post-COVID-19 syndrome with that of healthy controls.

Method: Twenty patients with post-COVID-19 syndrome and twenty healthy controls participated in the study. The Incremental Shuttle Walk Test (ISWT) was used to measure exercise capacity, and the Timed Up and Go Test (TUG) was used to assess functional balance. Quadriceps muscle strength (QMS) and handgrip strength (HGS) were measured. Assessment tools included the McGill Pain Questionnaire (SF-MPQ) for pain, the Tampa Scale for Kinesiophobia (TSK) for movement fear, the Modified Medical Research Council Dyspnea Scale (mMRC) for dyspnea, the Fatigue Severity Scale (FSS) for fatigue perception, and the Cognitive Failures Questionnaire (CFQ) for cognitive status.

Results: The mMRC dyspnea, TSK, FSS, SF-MPQ total scores, and pain severity of patients with post-COVID-19 syndrome were higher than those of healthy controls ($p<.05$). Compared to the healthy group, the ISWT and %ISWT distances were significantly lower in the post-COVID-19 group ($p<.05$).

Conclusion: Exercise capacity is negatively affected; anxiety, pain, fatigue severity, dyspnea, and kinesiophobia levels are increased in patients with post-COVID-19 syndrome compared with healthy groups. However, muscle strength, balance, and cognitive function are preserved in individuals with mild-to-moderate COVID-19 infection. Pulmonary rehabilitation programs should be designed on the basis of these multiple influences with a multidisciplinary approach in the long-term rehabilitation of individuals with COVID-19 infection.

Key Words: COVID-19, Functional status, Pandemics, Exercise test, Post-COVID-19

ÖZ

Amaç: Sağlıklı, enfekte olmamış bireylerle karşılaştırıldığında, COVID-19 sonrası sendromun fonksiyonel sonuçlar üzerindeki etkisine ilişkin sınırlı veri bulunmaktadır. Bu çalışma, post COVID-19 sendromu olan hastaların kas fonksiyonunu, egzersiz kapasitesini ve yaşam kalitesini sağlıklı kontrollerle karşılaştırmayı amaçladı.

Yöntem: Çalışmaya post COVID-19 sendromu olan 20 hasta ve 20 sağlıklı kontrol katıldı. Egzersiz kapasitesini ölçmek için Artan Hızda Mekik Yürüme Testi (ISWT), fonksiyonel dengeyi değerlendirmek için Zamanlı Kalk ve Yürü Testi (TUG) kullanıldı. Quadriseps kas kuvveti (QMS) ve el kavrama kuvveti (HGS) ölçüldü. Değerlendirme araçları arasında; ağrı için McGill Ağrı Anketi (SF-MPQ), hareket korkusu için Tampa Kinezyofobi Ölçeği (TSK), nefes darlığı için Modifiye Medical Research Council dispne skalası (mMRC), yorgunluk algısı için Yorgunluk Şiddet Ölçeği (FSS) ve bilişsel durum için Bilişsel Durum Ölçeği (CFQ) yer aldı.

Bulgular: Post-COVID-19 sendromlu hastaların mMRC nefes darlığı, TSK, FSS, SF-MPQ toplam skorları ve ağrı şiddeti sağlıklı kontrollere göre daha yüksekti ($p<.05$). Sağlıklı grupla karşılaştırıldığında ISWT ve %ISWT mesafeleri, post COVID-19 grubunda anlamlı derecede düşüktü ($p<.05$).

Sonuç: Sağlıklı gruplarla karşılaştırıldığında, post COVID-19 sendromlu hastalarda egzersiz kapasitesi olumsuz etkilenmekte; anksiyete, ağrı, yorgunluk şiddeti, nefes darlığı ve kinezyofobi düzeyleri artmaktadır. Ancak hafif-orta şiddette COVID-19 enfeksiyonu olan bireylerde kas gücü, denge ve bilişsel işlevler korunmaktadır. COVID-19 enfeksiyonu olan bireylerin uzun süreli rehabilitasyonunda pulmoner rehabilitasyon programları bu çoklu etkiler dikkate alınarak multidisipliner bir yaklaşımla tasarlanmalıdır.

Anahtar Kelimeler: COVID-19, Fonksiyonel statü, Pandemi, Egzersiz testi, Post-COVID-19

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INTRODUCTION

The multisystemic condition known as "long COVID or post-COVID-19 syndrome" is characterized by severe symptoms that last longer than three months after the first symptom onset [1]. Most cases occur in nonhospitalized individuals with mild acute illness. Common symptoms include dyspnea, chronic smell and taste problems, fatigue, pain, and neuropsychological symptoms like headache, memory loss, poor thinking, anxiety, and depression [1,2]. In a study of 1,077 hospitalized COVID-19 survivors, five months after discharge, 48% reported ongoing fatigue, 41% experienced dyspnea, and 21-28% sustained palpitations and chest pain [3].

Three months after discharge, COVID-19 survivors' exercise capacity remained unaffected by disease severity, despite preserved ventilatory efficiency. Exercise capacity is mildly reduced across severity groups [4]. A study in patients with severe COVID-19 six months after ICU discharge revealed significantly lower respiratory function, exercise capacity, and quality of life than healthy controls. These patients also experienced higher fatigue levels, and their balance and mobility were negatively impacted [5]. For up to two years following infection, physical function and activity may worsen in patients withpost-COVID-19 syndrome, as well as lower fitness levels [2]. Instead of vertigo, balance problems associated to dizziness affect about 20% of patients with post-COVID-19 syndrome. Even though their somatosensory and vestibular scores are comparable to those of controls, patients with long-COVID had poorer overall visual scores [6].

Current data show that even in mild/moderate COVID-19 cases and young survivors, muscle function, physical activity, physical performance, exercise capacity, balance, sleep quality, and psychosocial status are adversely affected [4,5,7]. Evidence on long-term functional consequences remains limited. While some studies have compared survivors' extrapulmonary functions based on severity [7] and healthy controls [5], more research is required to completely comprehend the long-term impacts of COVID-19. Thus, this study aimed to compare exercise capacity, muscle function, balance, pain, kinesiophobia levels, quality of life, and cognitive status of long-term COVID-19 survivors with those of healthy controls who had never been infected. The strength of this study was that extrapulmonary effects of patients with post-COVID-19 syndrome were compared to healthy controls who had never-infected with COVID-19 infection at the beginning of pandemic period.

METHOD

Study Design and Participants

Between February 2021 and February 2022, this study was conducted in collaboration with the Hacettepe University Faculty of Physical Therapy and Rehabilitation, Department of Cardiorespiratory Physiotherapy and Rehabilitation, and the Hacettepe University Faculty of Medicine, Department of Internal Medicine, Division of General Internal Medicine. Twenty cooperative patients between the ages of 18 and 65 years who had been diagnosed with COVID-19 infection at least 12 weeks earlier, showed persistent symptoms, were in clinical stability, and had well-managed concurrent conditions were recruited. These were non-ICU hospitalized COVID-19 patients. Exclusions comprised those with recent positive COVID-19 Polymerase chain reaction (PCR) tests, myocardial infarction, pulmonary embolism in the last 30 days, orthopedic/neurological disorders hindering walking, or neurological/psychiatric disorders impacting cooperation. The healthy group comprised 20 volunteers matched in age and gender, free from chronic diseases, orthopedic, or other walking impairments, and without COVID-19 infection at the study time and before the study.

Firstly, the participants' age, gender, body weight, height, body mass index (BMI), comorbid diseases, smoking exposure, medical history, family history, occupation, accompanying illnesses, and working status were recorded. Secondly, clinical tests and questionnaires were administered to participants.

The sample size of our study was determined with the G*Power analysis system (G*Power Software version 3.1.9.3, Heinriche Heine University, Düsseldorf Germany) based on findings of physical functions assessed by 1-minute sit-to-stand test in COVID-19 survivors by Belli et al [8]. Accordingly, it was determined that the sample size of our study should have been at least 12 participants for each group in order to reach 90% power at the medium effect level (d=0.50).

Outcome Measures

Body Composition: Body composition was evaluated using an OMRON BF-511 Body Composition Monitor (Omron Corporation, Japan). Body weight and visceral fat level (VFL), fat-free mass (FFM), and body fat (FM) were recorded [9].

Comorbidity and Dyspnea Level: The Modified Charlson Comorbidity Index (CCI) score was calculated and recorded [10]. The modified Medical Research Council (mMRC) scale score was recorded [11].

Exercise Capacity: The incremental shuttle walk test (ISWT) was used to evaluate exercise capacity. The distance was expressed in meters and as a percentage of the expected distances, and the number of shuttles was noted [12].

Muscle Strength: For peripheral muscle function, the hand grip strength (HGS) and quadriceps muscle strength (QMS) were tested. HGS was performed using a Jamar hand dynamometer (Jamar®, California, USA), and the result was expressed in kgF. The QMS was measured and recorded in kilos using the Lafayette Manual Muscle Test System (Model-01165, Lafayette Instrument Company, USA). The dominant side underwent three sets of measurements, with the best results for peripheral muscle strength being noted [13,14].

Functional Status: The Turkish valid and reliable version of the Post-COVID-19 Functional Status Scale (PCFS) was used to evaluate the functional status and activity limitations of COVID-19 survivors [15].

Balance: The timed-up and go test (TUG) evaluated functional mobility and balance. Using a stopwatch, the total TUG time was measured in seconds. On the same day, the TUG test was administered twice, with the best test duration being recorded as the final score [16].

Pain: Participants' pain characteristics and severity were evaluated using the Short Form of the McGill Pain Questionnaire (SF-MPQ), translated into Turkish. The sum of the sensory, emotional, and overall pain descriptors yielded the final score. The overall SF-MPQ score ranges from 0 to 45 and higher scores denote worse pain. Lastly, the Visual Analog Scale (VAS) was used to assess the patient's pain threshold [17].

Fatigue Perception and Fear of Movement: The Turkish version of the Fatigue Severity Scale (FSS) assessed participants' fatigue levels. A total FSS score≥4 indicates severe fatigue [18]. The subjects' fear of movement was measured using the Turkish translation of the Tampa Scale for Kinesiophobia (TSK). Overall, the TSK score on the rating system ranges from 17 to 68. A TSK score of less than 37 indicates kinesiophobia [19].

Cognitive Function: The 25 items of the Cognitive Failures Questionnaire (CFQ) are used to self-report perception, memory, and motor function problems in order to assess cognitive state. Scores vary from 0 to 100, with higher numbers denoting more cognitive dysfunction [20].

Psychosocial Status: Using the Turkish translation of the Hospital Anxiety and Depression Scale (HADS), the participants' anxiety and depressive symptoms were evaluated. Between 0 and 7, the HADS score is considered normal; 8–10 is borderline; and ≥11 indicates significant anxiety or depression [21].

Quality of Life: Quality of life was assessed among participants using the Short Form-36 (SF-36) questionnaire. Higher ratings indicate a higher quality of life; values range from 0 to 100 [22].

Work Productivity: According to VAS, based on pre-pandemic and post-pandemic periods, the work productivity of COVID-19 survivors and healthy individuals was evaluated with the following questions: (i)"I can easily focus on my tasks at work," (ii)"I feel productive at work," and (iii)"I can quickly adjust to changes in the work I do."

Ethical Approval

The Hacettepe University Non-Interventional Clinical Research Ethics Committee approved the study on 02.02.2021, with the decision number 2021/03-03. All participants were informed about the study protocol and signed the informed consent. The authors declare that the procedures were followed according to the regulations established by the Ethics Committee and to the Helsinki Declaration of the World Medical Association. This study was registered in ClinicalTrials.gov: NCT04836767.

Statistical Analysis

The statistical analyses were performed using the Windows-based statistical package program Statistical Package for the Social Sciences (SPSS) 23.0 (IBM, Ver.23.0, Newyork, USA). When comparing quantitative data between groups, regularly distributed data was compared using the Student's t-test; non-normally distributed data was compared using the Mann-Whitney U test. The chi-square test was utilized to analyze qualitative data. A $p<0.05$ criterion for significance was set. A post hoc power analysis was performed using the ISWT distance data from the COVID-19 and healthy groups. The power [1-β] of the study was 99%.

RESULTS

A flowchart of the study is presented in Figure 1.

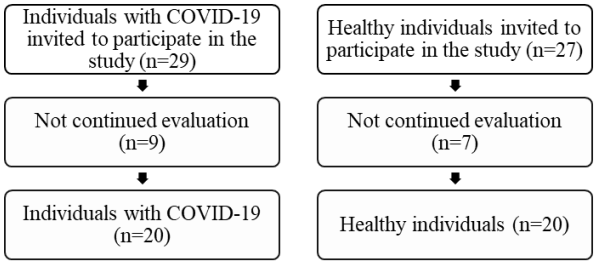

Figure 1. Flow chart of the study

Twenty COVID-19 survivors and 20 healthy, never-infected controls were included in the study. The severity of COVID-19 infection was mild/moderate in all survivors. The groups' mean age, height, body weight, BMI, smoking exposure, FFM, and FM values and modified CCI scores were similar ($p>.05$, Table 1).

Twenty percent of patients with post-COVID-19 syndrome had chronic rhinosinusitis, 5% had visual and hearing problems, 5% had gastrointestinal disorders, and 5% had DM. In both groups, 85% of the participants were females and 15% were males. The VFL of the healthy group was significantly lower than that of the COVID-19 group ($p<.05$, Table 1).

According to the PCFS score, 65% of patients with post-COVID-19 syndrome had negligible, 10% had mild, 10% had moderate, and 5% had severe functional limitations (Table 1).

There was no significant difference in QMS and HGS between groups ($p>.05$, Table 2). The TUG time was similar between groups ($p>.05$, Table 2). The ISWT distance and %ISWT distance were significantly lower in the COVID-19 group than in the healthy group ($p<.05$, Table 2). Although the changes in dyspnea, leg fatigue, and general fatigue perceptions were similar between groups ($p>.05$, Table 2), the increase in HR was lower, and the decrease in oxygen saturation (SpO_2) levels was greater in COVID-19 survivors ($p<.05$, Table 2).

Table 1. Physical characteristics, comorbidity and functional status in patients with post COVID-19 syndrome and healthy controls

Parameters	**Post COVID-19 Syndrome (n=20)**	**Healthy (n=20)**	**t/z**	**p**
	Mean±SD	**Mean±SD**		
Age (years)	28.80±8.26	26.90±4.10	-.920[&]	.363
Height (cm)	165.53±8.35	166.50±7.29	.391[&]	.698
Body weight (kg)	68.45±10.52	64.55±10.52	1.188[&]	.242
BMI (kg/m^2)	24.91±3.28	23.20±2.79	1.828[&]	.076
FM (%)	28.10±6.41	25.42±6.63	-1.296[&]	.203
FFM (%)	29.94±5.37	30.83±1.18	-.636[a]	.525
VFL	5.45±2.01	4.05±1.46	-2.513[&]	**.016***
Smoking history (Packs-year)	0.50±2.23	0.50±2.23	.000[a]	1.000
Parameters	**Median (Min-Max)**	**Median (Min-Max)**	**t/z**	**p**
Modified CCI score	0 (0-3)	0 (0-0)	-1.777[a]	.076
PCFS score	**n (%)**			
0	2 (10)			
1	13 (65)			
2	2 (10)			
3	2 (10)			
4	1 (5)			

**p<0.05, [&]t: Student-t test, [a]z:Mann-Whitney U test, BMI:Body Mass Index, CCI:Charlson Comorbidity Index, FM:Fat mass, FFM:Fat-free mass, VF:Visceral fat level, PCFS:Post-COVID-19 Functional Status (PCFS) Scale*

The mMRC, TSK, FSS, SF-MPQ, total scores, and VAS pain severity scores were significantly higher in the post-COVID-19 syndrome group than in the healthy group ($p<.05$, Table 3). The distribution of pain is presented in Figure 2. Although kinesiophobia was observed in 60% of the patients with post-COVID-19 syndrome, 75% of them had severe fatigue. Patients with post-COVID-19 syndrome had significantly lower SF-36 total and subdimension scores than healthy controls ($p<.05$, Table 3). Otherwise, the HADS anxiety and depression scores and CFQ scores were comparable between groups ($p>.05$, Table 3). According to the HADS anxiety cut-off scores, 50% of patients with post-COVID-19 syndrome had abnormal anxiety levels, whereas 10% of healthy controls had abnormal anxiety levels ($p<.05$, Table 3), there was not any significant difference based on the HADS depression cut-off scores ($p>.05$, Table 3). According to the statistical analysis of work productivity, the decrease in work productivity in patients with post-COVID-19 syndrome was significantly greater than that in healthy controls after the pandemic ($p<.05$, Table 3).

DISCUSSION

Our study highlights increased dyspnea, fear of movement, fatigue, anxiety, and pain perception in post-COVID-19 patients with mild/moderate symptoms compared with healthy controls. Despite preserved cognitive function, balance, and mobility, patients experienced reduced exercise capacity, psychosocial well-being, quality of life, and work productivity. This study examined long-term extrapulmonary effects in post-COVID-19 patients compared with never-infected healthy individuals.

Table 2. Exercise capacity, peripheral muscle function and functional balance and mobility in patients with post COVID-19 syndrome and healthy controls

Parameters	Post COVID-19 Syndrome (n=20) X̄±SS	Healthy (n=20) X̄±SS	t/z	p
Muscle function				
QMS (kg)	25.42±6.47	23.82±4.45	-1.853[a]	.064
%QMS	52.60±12.11	49.79±7.60	-.865[&]	.393
HGS (kgF)	29.30±5.81	32.80±6.65	-1.771[&]	.085
%HGS	89.07±14.52	81.88±19.73	1.312[&]	.197
Functional balance and mobility				
TUG (sec)	7.11±0.82	6.72±0.87	1.459[&]	.267
Exercise capacity				
%ISWT distance	56.80±8.30	73.32±10.23	-5.608[&]	**<.001***
ISWT distance (m)	571.00±114.74	765.95±131.07	-5.005[&]	**<.001***
ΔHR (beats/min)	68.20±27.17	84.35±20.77	-2.111	**.041***
ΔSpO_2 (%)	-2.15±1.72	0.05±1.63	-4.136	**<.001***
ΔDyspnea	3.87±1.02	4.42±1.85	-1.159[a]	.256
ΔGeneral fatigue	3.10±1.34	3.12±1.67	-.052[a]	.959
ΔLeg fatigue	3.37±1.58	2.55±1.73	1.570[a]	.125

**p<0.05, [&]t: Student-t test, [a]z:Mann-Whitney U test, ISWT:Incremental Shuttle Walk Test, HR:Heart Rate, SpO2:Oxygen Saturation, QMS:Quadriceps Muscle Strength, HGS:Hand Grip Strength, TUG:Time up and Go Test*

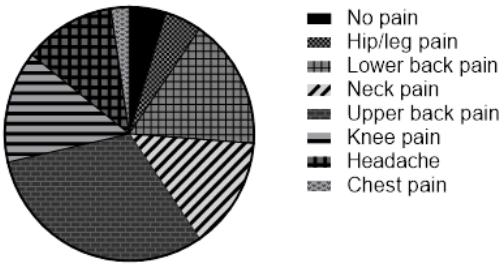

Figure 2. Distribution of pain in patients with post-COVID-19 syndrome

Watanabe et al. found that visceral fat could indicate poorer clinical outcomes in patients with COVID-19 [23]. A higher visceral fat ratio in the post-COVID-19 syndrome group confirms these findings. All participants had similar height, body weight, BMI, fat, and muscle ratio.

Anaya et al. reported that >20% of patients with post-COVID-19 syndrome experience shortness of breath [24]. Similarly, Pavli et al. determined a dyspnea incidence ranging from 10% to 40% among patients with post-COVID-19 syndrome [25].

Table 3. Dyspnea, fatigue severity, pain, kinesiophobia, quality of life, cognitive status, psychosocial status and work productivity in patients with post COVID-19 syndrome and healthy controls

Parameters	Post COVID-19 Syndrome (n=20)	Healthy (n=20)	t/z/χ^2	p
Dyspnea- Median (Min-Max)				
mMRC score (0-4)	1 (0-3)	0 (0-1)	-5.466	**<.001***
Fatigue (X̄±SS)				
FSS score (0-7)	4.78±1.63	2.61±1.33	4.608[&]	**<.001***
Pain (X̄±SS)				
SF-MPQ total score (0-45)	26.25±14.96	15.85±12.54	-2.033[a]	**.042***
VAS score (0-10)	5.30±2.49	3.00±2.15	-2.943[a]	**.003***
Kinesiophobia (X̄±SS)				
TSK (17-68)	38.05±7.61	32.25±6.80	2.539[&]	**.015***
Quality of life (SF-36) (0-100) (X̄±SS)				
Physical functioning	72.50±19.76	98.25±3.35	-4.884[a]	**<.001***
Physical role functioning	33.00±36.68	97.50±7.69	-4.850[a]	**<.001***
Bodily pain	49.75±29.17	85.75±14.57	-3.721[a]	**<.001***
General health	49.75±20.09	79.50±12.65	-5.602[&]	**<.001***
Vitality	35.50±24.16	65.50±18.41	-3.553[a]	**<.001***
Social functioning	51.87±25.41	82.50±17.86	-3.579[a]	**<.001***
Emotional role functioning	36.64±35.69	78.32±36.32	-3.230[a]	**.001***
Mental health	52.20±25.11	72.40±14.03	-3.140[&]	**.004***
Psychosocial status (X̄±SS)				
HADS-anxiety (0-21)	8.80±5.54	5.85±3.29	-1.725[a]	.084
HADS-depression (0-21)	7.70±5.10	5.25±3.9	-1.506[a]	.132
Cognitive status (X̄±SS)				
CFQ (0-100)	42.35±19.49	30.90±15.87	-1.841[a]	.066
Work productivity (X̄±SS)				
I can easily focus on my tasks at work	-3.74±2.19	-1.22±1.50	-3.478[a]	**<.001***
I feel productive at work	-4.36±2.19	-1.07±1.31	-4.368[a]	**<.001***
I can quickly adjust to changes in the work I do	-3.90±2.05	-1.06±1.35	-4.002[a]	**<.001***
Anxiety status according to HADS (X̄±SS)				
Normal	9 (%45)	14 (%70)		
Borderline	1 (%5)	4 (%20)	8.220[ɣ]	**.016***
Abnormal	10 (%50)	2 (%10)		
Depression status according to HADS (X̄±SS)				
Normal	11 (%55)	15 (%75)		
Borderline	3 (%15)	2 (%10)	1.815[ɣ]	.403
Abnormal	6 (%30)	3 (%15)		

**p<0.05, [&]t:Student-t test, [a]z:Mann-Whitney U test, [ɣ]:Chi-square test, mMRC:Modified Medical Research Council dyspnea scale, TSK:Tampa Scale for Kinesiophobia, FSS:Fatigue Severity Scale, SF-MPQ:Short Form of the McGill Pain Questionnaire, VAS:Visual Analog Scale, SF-36:Short Form-36, HADS:Hospital Anxiety and Depression Scale, CFQ:Cognitive Failures Questionnaire*

In a study evaluating patients with and without the need for ICU in the post-acute period of COVID-19, dyspnea (42%) and fatigue (55%) were the most frequently reported symptoms in a cohort of 120 patients [26]. Whereas the rate of dyspnea gradually decreases within 6 months, fatigue and neurological and mental symptoms persist for a longer period of time [27]. The dyspnea and fatigue scores, as shown by the mMRC and FSS scores, were meaningfully increased in patients with post-COVID-19 syndrome, and 75% of our patients without ICU stay had severe fatigue, as previously reported [5]. The mean-modified CCI score was 0.7±0.9 in 48 mild/moderate post-COVID-19 patients with 39.2±7.9 years [7]. The minimum and maximum modified CCI scores in the post-COVID-19 group were 0-3, respectively. Comorbid conditions, such as DM or hypertension, increase the risk of a more severe course and progression of COVID-19 disease [28]. Our participants' comparable and low comorbidity severity could be due to their relatively younger age and mild/moderate COVID-19 disease severity. Therefore, our results are consistent with findings from existing studies [7,27,28].

Sirayder et al. showed that nearly 81% of COVID-19 survivors' 6MWT distance was lower than that of controls with similar physical activity levels. The patient group had lower SpO2 values and higher dyspnea, general fatigue, and leg fatigue scores after 6MWT. Balance and functional mobility determined by TUG were also adversely affected in the COVID-19 group [5]. Raman et al. reported that a significant portion of COVID-19 patients had limited exercise capacity in their study [29]. The TUG and dual task-TUG performance were shown to be poorer in the severe and critical COVID group than in patients with chronic lung disease [30]. Beyer et al. showed that patients with post-COVID-19 syndrome and severe fatigue walked significantly lower distance in 6MWT and oxygen consumption values of patients were also lower according to reference values [31]. ISWT and %ISWT distances declined in post-COVID-19 patients with mild/moderate symptoms and severe fatigue in our study, confirming existing data on exercise capacity impairment and deconditioning [5,29,31].

39.6% of the subjects had handgrip weakness, and 35.4% had quadriceps muscle weakness in the study by Tanriverdi et al. with 48 patients after mild/moderate COVID-19 infection [7]. The patients with moderate-severity disease had significantly higher muscle weakness than the mild group 12 weeks after infection [7]. Sirayder et al. showed that 57.6% of COVID-19 survivors with ICU stay had QMS levels lower than the 95% confidence interval of the controls and handgrip weakness [5]. Blokland et al. reported that peripheral muscle strength decreased in 70% of patients in the post-COVID-19 period who were connected to mechanical ventilation [32]. Because the patients with post-COVID-19 syndrome in our study had mild-to-moderate disease severity and no history of a severe illness requiring ICU care, their peripheral muscle strength was equivalent across the two groups. Otherwise, 52.60±12.11 and 49.79±7.60 percent of predicted QMS in post-COVID-19 and healthy groups could have been related to decreased physical activity levels during the pandemic. We also explain that maintaining peripheral muscular strength, any need for ICU admission, and related immobilization processes account for the comparable functional mobility and balance of the post-COVID-19 and healthy groups.

In a systematic review, the most frequently reported symptoms were fatigue and weakness, followed by shortness of breath, disruption of normal activity, loss of taste and/or smell, depression, muscle and/or joint pain, sleep disturbance, anxiety, cough, and headache [33]. Thirty-two percent of COVID-19 patients still experienced fatigue, and 22% had cognitive impairment 12 weeks after the infection, as reported in another report [27,34]. In addition, 40% of the patients with long COVID had poor concentration, 31% had poor memory, 25% had poor attention, and 6% had confusion 24 weeks after acute infection. After 24 weeks, 67% of the patients still performed below their pre-COVID functional levels; whereas 44.9% of the patients were ambulatory, able to take care of all personal needs, but unable to perform any job-related tasks, and 38% of them were only able to perform minimal self-care, spending over 50% of their awake hours in bed or a chair [35]. In our study, any significant difference in cognitive level between the groups could be related to our patient group's relatively younger age and mild/moderate disease severity. In a study about occupation status of 214 patients with post-COVID-19 syndrome, 18% of patients were working, 40% of them were working with diffuculty and 35% had stopped working due to symptoms [36]. Despite limited evidence regarding the effect of long COVID on work productivity, there was a substantial decrease in concentration, adaptation to changes, and productivity in our patients. Increased dyspnea and fatigue perceptions, minimal cognitive impairment, decreased exercise capacity, and deconditioning could have decreased work productivity in line with findings of Green et al [36].

The most reported pain in the post-COVID-19 period was back pain, followed by neck pain, backache, knee pain, and headaches. Musculoskeletal symptoms such as headache, myalgia, and arthralgia are also common in the post-COVID-19 period [1,27]. Pain may persist for weeks or months in patients who recover from COVID-19 [27]. We also confirmed previous findings that the most reported pain regions were the upper back, lower back, and neck, respectively [1]. Higher pain intensity scores in post-COVID-19 syndrome patients could have been a result of a higher proportion of females [85%] and increased anxiety levels. There are limited data on kinesiophobia during the post-acute or acute phase in COVID-19 patients. Nearly 60% of COVID-19 survivors experienced post-COVID-19 pain associated with kinesiophobia. Furthermore, higher levels of kinesiophobia are associated with pain catastrophizing, symptoms related to sensitization, and anxiety levels [37]. Sixty percent of our patients with post-COVID-19 syndrome also presented with kinesiophobia. Increased fear of movement was an expected finding in the post-COVID-19 group, with accompanying pain and anxiety symptoms. The lack of detailed knowledge among patients about COVID-19 and the effectiveness of exercise during the post-COVID-19 period, along with an increased perception of breathlessness in daily life, may also have contributed to kinesiophobia.

Our previous data showed that the PCFS score is associated with the mMRC dyspnea score and personal care, housework, physical activity, and leisure time daily life activity scores in post-acute COVID-19 patients without ICU admissions. In total, 63.1% of patients had negligible, 14.4% had mild, 2% had moderate, and 0.5% had severe functional limitations [14]. A study with patients with post COVID-19 syndrome reported that those with PCFS 3-4 had meaningful lower functional capacity, impaired quality of life and especially negative effects on pain, and social aspects, higher need for ICU admission and prolonged hospitalization stays compared to those with PCFS 1-2 [38]. In addition, 65% of patients with mild/moderate disease severity had negligible functional limitations. This could be related to the relatively younger age and dyspnea/fatigue symptoms and any need for ICU in the post-COVID-19 group. Anxiety and depression disorders were observed in 52.2% and 47.8% of post-COVID-19 patients, respectively, according to HADS [7]. Although depression levels were similar, anxiety levels of post-COVID-19 patients were greater than those in the current data [5,7,35]. The higher proportion of female participants and dyspnea and pain intensity levels could have led to these findings [7]. The negatively affected quality of life and participation limitations in both physical and emotional roles in our patients could be a result of increased and ongoing dyspnea, fatigue, pain, anxiety symptoms, cognitive decline, and impaired exercise capacity, which confirms previous data [5,31].

Limitations

The main limitation of our study was that despite the reasonable post-power value of our study, the fact that we reached a limited number of individuals who had never had a COVID-19 infection and volunteered to participate during the study period limits the generalizability of the results. Nonetheless, it stands as the pioneering research conducted at

the pandemic's onset, evaluating exercise capacity, muscle function, balance, and cognitive status in post-COVID-19 patients with mild-to-moderate symptoms and uninfected healthy individuals during the chronic phase.

CONCLUSION

In conclusion, our study revealed diminished long-term exercise capacity and quality of life in post-COVID-19 patients compared with uninfected individuals. Anxiety, pain, fatigue, and dyspnea perception increased in post-COVID-19 cases, yet muscle strength, balance, cognitive function, and depression remained similar to those in healthy subjects. Effective rehabilitation post-COVID-19 should integrate pulmonary programs addressing pain, fatigue, dyspnea, and psychosocial factors, alongside tailored exercise regimens and multidisciplinary care reflecting individual capacities and needs.

Ethical Approval: *2021/03-03 Non-Interventional Clinical Research Ethics Committee of Hacettepe University*

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THE EFFECT OF INCENTIVE SPIROMETRY AND OSCILLATORY POSITIVE EXPIRATORY PRESSURE THERAPIES ON FUNCTIONAL CAPACITY, DYSPNEA, AND SATURATION IN BURN PATIENTS WITH INHALATION INJURY: A RANDOMIZED CONTROLLED STUDY

İNHALASYON HASARI OLAN YANIK HASTALARINDA İNSENTİF SPİROMETRE VE OSİLASYONLU POZİTİF EKSPİRATUAR BASINÇ TEDAVİLERİNİN FONKSİYONEL KAPASİTE, DİSPNE VE SATÜRASYON ÜZERİNE ETKİSİ: RANDOMİZE KONTROLLÜ ÇALIŞMA

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ABSTRACT

Objective: The aim of this study is to investigate the effects of incentive spirometry (Triflo) and oscillatory positive expiratory pressure therapy (use of Acapella) in addition to standard pulmonary physiotherapy exercises on functional capacity, dyspnea, and saturation levels in burn patients with inhalation injury.

Method: A total of 24 patients hospitalized in the intensive care and service units of the Gaziantep City Hospital Burn Center were included in the study. Patients were divided into three groups using stratified randomization method. The first group received standard physiotherapy exercises in addition to medical and surgical treatment, the second group received incentive spirometry (Triflo) in addition to this standard treatment, and the third group received standard treatment+oscillatory positive expiratory pressure therapy (Acapella). All groups were followed for 4 weeks. Six-minute walk test (6MWT), dyspnea modified medical research council (MMRC) scale, and saturation values were compared for all groups before and after treatment.

Results: A total of 24 patients, 22 males and 2 females, aged 19-63 (38.66±16.77), were included in the study. When the initial and final week measurements of the six-minute walk test, dyspnea scale (MRC), and saturation values of all groups were compared, no difference was found (p>0.05).

Conclusion: Oscillatory positive expiratory pressure therapy (Acapella Use) and incentive spirometry (Triflo) can be given in addition to standard physiotherapy exercises in burn patients with inhalation injury. These exercises are equally effective in the functional capacity, dyspnea, and saturation levels of burn patients with inhalation injury.

Key Words: Burns, Inhalation, Exercise

ÖZ

Amaç: Bu çalışmanın amacı inhalasyon hasarı olan yanık hastalarında standart pulmoner fizyoterapi egzersizlerine ek olarak verilen insentif spirometre (triflo) ve osilasyonlu pozitif ekspiratuar basınç tedavisinin (acapella kullanımı) fonksiyonel kapasite, dispne ve satürasyon üzerine etkilerinin incelenmesidir.

Yöntem: Çalışmaya Gaziantep Şehir Hastanesi Yanık Merkezi yoğun bakım ve servis ünitelerinde yatan toplam 24 hasta dahil edildi. Hastalar tabakalı randomizasyon yöntemiyle 3 gruba ayrıldı. Birinci gruba medikal ve cerrahi tedaviye ek olarak standart fizyoterapi egzersizleri, ikinci gruba bu standart tedaviye ek olarak insentif spirometre (triflo) ve üçüncü gruba da standart tedavi+osilasyonlu pozitif ekspiratuar basınç tedavisi (Akapella) verildi. Tüm gruplar 4 hafta boyunca takip edildi. Tüm grupların tedavi öncesi ve tedavi sonrası olmak üzere altı dakika yürüme testi, dispne modified medical research council (MMRC) skalası ve satürasyon değerleri karşılaştırıldı.

Bulgular: Çalışmaya yaşları 19-63(38.66±16.77) arasında değişen 22 erkek 2 kadın toplam 24 hasta dahil edildi. Tüm grupların altı dakika yürüme testi, dispne skalası (MRC) ve satürasyon değerlerinin ilk ve son hafta ölçümleri karşılaştırıldığında bir fark olmadığı belirlendi (p>0.05).

Sonuç: İnhalasyon hasarı olan yanık hastalarında standart fizyoterapi egzersizlerine ek olarak osilasyonlu pozitif ekspiratuar basınç tedavisi (acapella kullanımı) ve insentif spirometre (triflo) verilebilir. Bu egzersizler inhalasyon hasarı olan yanık hastalarının fonksiyonel kapasiteleri, dispne ve satürasyon düzeylerinde benzer derecede etkilidir.

Anahtar Kelimeler: Yanıklar, İnhalasyon, Egzersiz

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INTRODUCTION

According to the American Burn Association, inhalation injury occurs in one out of every three burn patients, increasing mortality rates tenfold [1]. Inhalation injury causes direct cellular damage, changes in regional blood flow and perfusion, airway obstruction, as well as local damage through toxin and proinflammatory cytokine release [2]. Inhalation injury associated with burns typically results from thermal injury to the face and upper respiratory tract due to inhalation of vapour and/or hot gases, as well as trauma from inhalation of toxic gases causing local and systemic chemical damage to the trachea, bronchi, alveoli and endothelial tissues [3,4].

Inhalation injury is classified in two ways according to the injury site in the respiratory tract and injury mechanism/cause [2,5]. When examined in terms of injury sites, acute upper airway or supraglottic injury and lower airway or subglottic injury are accepted [5]. When analysed according to the mechanism of injury, it is defined as toxic or irritating injuries resulting from thermal burns, drowning or inhalation of various gases-chemicals [2,5].

As a result after inhalation injury: the upper and lower airways become characteristically hyperemic. Blood flow in the lungs increases 4-6 times. This increase in bronchial blood flow causes airway oedema, fluid exudation and the release of inflammatory mediators. The circulation of inflammatory mediators increases the permeability of the bronchial vasculature and pulmonary transvascular fluid flow [1-6].

In recent years, respiratory characteristics of burn patients have been compared with healthy individuals in the literature, and new evidence on how inhalation injury changes these characteristics has been demonstrated. When the respiratory parameters of major burn patients were compared with healthy individuals with similar demographic and physical characteristics, it was found that although the mean values of FEV1/FEVC of burn patients were evaluated as 80%, this ratio decreased to 70-75% in burn patients accompanied by inhalation damage [7,8]. Additionally, recent research by El-Sayed Attalla et al. has provided further insights into the impact of inhalation injury on respiratory function. Their study demonstrated that inspiratory muscle training significantly improved respiratory muscle strength and lung function in burn patients with inhalation injury. They reported marked increases in maximal inspiratory pressure (MIP), forced vital capacity (FVC), and forced expiratory volume in one second (FEV1) in patients who received inspiratory muscle training compared to those who did not. These findings suggest that targeted respiratory interventions can mitigate some of the respiratory deficits associated with inhalation injuries in burn patients, emphasizing the importance of including such training in their rehabilitation protocols [9].

It has been reported that inhalation injury also restricts the diffusion of carbon monoxide in the lungs (DLco: a parameter indicating the gas exchange ability of the lungs in general), causes a decrease in maximal voluntary ventilation (MVV) and lung endurance is also adversely affected. This decrease in respiratory functions is thought to cause decreases in diaphragm movements and exercise capacities [7-10]. When all effects are taken into consideration, decreased respiratory function, increased secretion, decreased functional capacity and dyspnoea are frequently observed in burn patients with inhalation injury [7-12].

In the literature, the use of incentive spirometer (triflo), positive expiratory pressure (PEP) and vibration devices (acapella) in the field of physiotherapy is frequently encountered [13-17]. However, there are no studies in the literature in which such assistive respiratory devices were used in burn patients with inhalation damage. The aim of this study was to investigate the effects of incentive spirometer (triflo) and oscillatory positive expiratory pressure therapy (use of acapella) on functional capacity, dyspnoea and saturation in burn patients with inhalation injury in addition to standard physiotherapy exercises.

METHOD

Study Design and Participants

This study was planned as a randomised controlled study. The randomisation model used in the study was the covariate adaptive randomisation model. With this randomisation model, the groups were divided into three [18]. Burn patients hospitalised in the Burn Centre, ward and intensive care unit of Gaziantep City Hospital were included in this study. Throughout the study, there were no dropouts due to non-compliance with treatment protocols, and no patients were recorded to have experienced compliance issues during the study period.

Inclusion Criteria:

- Patients with a Glasgow Coma Scale score of E4M6V5, indicating open consciousness and cooperation (spontaneous eye opening: 4, obeys motor commands: 6, oriented verbal response: 5).
- Patients receiving enteral nutrition.
- Patients diagnosed with inhalation injury by the unit's burn specialist physician (all patients with inhalation injury were included without consideration of injury mechanisms).
- Patients aged between 18 and 65 years.
- Patients with a burn percentage of 25% or more (major burns) [19].
- Patients with stable hemodynamic values and vital signs, without the need for inotropic medication.

Exclusion Criteria:

- Patients with additional traumas (fractures, limb loss, etc.) in addition to the current burn trauma.
- Patients with organ dysfunction or multiple organ failures.
- Patients with chronic diseases such as COPD, heart failure, or respiratory/neurological/orthopedic diseases that may affect respiratory muscle strength, peripheral muscle strength, and respiratory function, as well as chronic conditions such as diabetes, cholesterol, and hypertension.
- Patients on mechanical ventilation.

Interventions

All patients included in the study received the following exercise protocols in addition to routine medical care, medical treatments, and surgical treatments:

Group 1-Standard Treatment Program: Standard physiotherapy exercises in addition to medical and surgical treatment (provided by the expert physician and nurses in the burn unit): Four sessions per week, lasting 30-45 minutes each, including exercises for normal joint movement, general respiratory exercises, bronchial hygiene techniques, ankle pumping exercises, in-bed isometric exercises, isotonic strengthening exercises, and early mobilization (from the first day onwards) (Table 1) [20].

Group 2-Standard Treatment Program+Incentive Spirometer (Triflo): In addition to standard treatment, patients were provided with education on the incentive spirometer. Respiratory exercises and the incentive spirometer device were practiced in 2 sets of 5 repetitions. Patients were instructed to control their tidal volume during breaths between exercises to prevent respiratory muscle fatigue and hyperventilation. It was encouraged to combine all respiratory exercises with pursed lip breathing. The use of Triflo® was defined as maintaining the maximum inspiratory maneuver following maximum expiration. Patients were taught relaxation positions, both sitting, in-bed, and standing, particularly for application during episodes of increased perception of dyspnea. To enhance the effectiveness of coughing and facilitate the easy removal of secretions, patients were instructed to cough with simultaneous abdominal pressure applied over the abdomen during the expiratory phase following maximum inspiration [21].

Group 3-Standard Treatment Program+Oscillatory Positive Expiratory Pressure Therapy (Use of Acapella): In addition to standard treatment, patients received oscillatory positive expiratory pressure therapy (Acapella). Respiratory exercises and the Acapella device were practiced in 2 sets of 5 repetitions. Patients were instructed to control their tidal volume during breaths between exercises to prevent respiratory muscle fatigue and hyperventilation. For proper use of the Acapella device, patients were instructed to ensure that the mouthpiece is fully sealed with the lips and pressed against the cheeks with the hands to prevent air leakage, and to perform a long and forceful expiration [16].

Table 1. Exercises delivered as part of standard treatment [20]

Features	Treatment properties	Scope of treatment
Duration of treatment	30–45 min	Adjusted based on patient's tolerance and response.
Number of sessions per week	5 days	*Regular sessions for optimal recovery and mobility*
Mobilization	From the first day of admission onwards	*Early mobilization to improve circulation and prevent muscle loss.*
Ambulation	From the first day of admission onwards	Early ambulation to encourage independence and reduce complications.
Post-graft exercise	Active mobilization after day 3	Normal joint mobility (NJM) exercises for non-graft sites for the first 3 days. Breathing exercises
Respiratory physiotherapy	Breathing exercises based on burn size	Bronchial hygiene techniques, coughing training 45° optimal position Diaphragmatic breathing
Exercises	From the first day of admission onwards	Active or passive NJM exercises depending on the patient's condition Distal joint mobility exercises In-bed isometric exercises for all upper and lower extremities Isotonic strengthening exercises Posture exercises

Outcome Measures

Patients were subjected to treatment protocols five days a week, starting from the day of hospitalization until the fourth week.

Functional Capacity: Functional capacity was assessed using the 6-minute walk test. The American Thoracic Society considers the 6-Minute Walk Test (6MWT) as a gold standard for measuring functional exercise capacity. The 6MWT measures the distance an individual can walk on a 30 m, straight, hard surface with two 180° turns during a six-minute period. The 30-meter corridor of the Gaziantep City Hospital Burn Center was utilized for the 6-minute walk test. Patients were instructed to walk as quickly as possible, maintaining the same pace, without running, for 6 minutes [22]. The distances walked at six minutes were recorded for both pre- and post-treatment assessments.

Dyspnea: The Modified Medical Research Council (MMRC) scale was employed. The dyspnea questionnaire, originally developed by a researcher, was modified by the British Medical Research Council. This questionnaire consists of a 0-4 point scale where individuals select the statement that describes their level of dyspnea from five questions related to breathlessness. Patients' saturations were assessed using the Adecon DK-8000S monitor device [23].

Ethical Approval

The study received approval from the Non-Interventional Research Ethics Committee of Hasan Kalyoncu University, Faculty of Health Sciences, with decision number 2024/42 dated 26.03.2024. Informed consent forms, detailing the purpose and content of the study, were provided to each participant who is a citizen of the Republic of Turkey, and information was also provided to foreign nationals through interpreters. Participants who agreed to participate in the study confirmed their participation by signing the voluntary informed consent form.

Statistical Analysis

Statistical analyses were conducted using the Windows-based SPSS (Statistical Package for the Social Sciences) 22.0 statistical package program. A significance level of $p<0.05$ was considered for all statistics. In the research, which was conducted with three groups followed for 4 weeks, with 8 individuals in each group (Group 1=8 individuals, Group 2=8 individuals, Group 3=8 individuals), the power of this study was found to be 85% for n=8 based on the six-minute walk test value (d=2.38) [24]. Descriptive analyses for numerical variables determined by measurement were expressed as mean and standard deviation (X±SD). The Kolmogorov-Smirnov test was used to examine the normal distribution of the parameters investigated in our study. The Kruskal-Wallis test was used to compare the three groups in the study. The Mann-Whitney U test was used for pairwise comparisons between groups, and the Wilcoxon test was used for comparisons within groups. The power of the study was calculated using the programme "G. Power-3.1.9.2". As a result of the analysis applied to 24 people, 8 in the first group, 8 in the second group and 8 in the third group, the effect size was found to be 0.6818 at $\alpha=0.05$ level and the power of the study was calculated as 0.819. P In this case, the power is at an acceptable level, the number of data is sufficient [25].

RESULTS

The study included a total of 24 patients, comprising 22 males and 2 females, with ages ranging from 19 to 63 years. The descriptive characteristics of the individuals are presented in Table 2.

Table 2. Comparison of descriptive characteristics among groups

	1st group n=8 (X±SD)	2nd group n=8 (X±SD)	3rd group n=8 (X±SD)	χ^2	p
Age	35.13±20.55	39.13±12.54	41.75±17.86	0.688	0.709
Height	175.12±10.79	172.75±4.43	175.63±13.31	0.009	0.996
Weight	75.13±16.77	75.13±13.44	84.13±23.57	0.919	0.632
BMI	24.21±2.91	25.18±4.30	26.79±4.68	1.674	0.433
% Burn	31.13±19.83	27.13±14.31	34.63±13.39	1.818	0.403

1st Group: Standard Treatment Program, 2nd Group: Standard Treatment Program + Incentive Spirometer (Triflo), 3rd Group: Standard Treatment Program + Oscillatory Positive Expiratory Pressure Therapy (Acapella Usage), χ2:Kruskal-Wallis Test, BMI:Body Mass Index.

When comparing the initial and final week measurements of the six-minute walk test, dyspnea scale (MRC), and saturation values across all groups, no difference was observed ($p>0.05$) (Table 3). When evaluated the measurements of six-minute walk test (6MWT), Modified Medical Research Council (MMRC) dyspnea scale, and saturation levels within each group during the first and last weeks, it was determined that dyspnea decreased in all groups ($p<0.05$) (Table-4). In the second group, where incentive spirometry (Triflo) was used in addition to standard treatment, it was observed that the data improved compared to the initial measurements ($p<0.05$) (Table 4).

Table 3. Comparison of functional capacity, dyspnea, and saturation values among groups

Variables	1st group n=8 (X±SD)	2nd group n=8 (X±SD)	3rd group n=8 (X±SD)	χ^2	P
6MWT_PRE	274.00±89.61	205.00±80.19	345.00±62.45	5.358	0.069
6MWT_POST	305.00±143.53	410.38±85.88	353.75±136.27	3.014	0.222
MRC_PRE	2.38±1.06	2.75±0.71	2.63±1.19	0.548	0.760
MRC_POST	1.25±1.28	0.63±0.92	0.88±0.64	1.336	0.513
SpO2_PRE	95.63±1.92	95.00±2.45	95.00±2.14	0.279	0.870
SpO2_POST	96.00±2.93	97.13±1.13	96.25±1.28	1.447	0.485

1st Group:Standard Treatment Program, 2nd Group:Standard Treatment Program + Incentive Spirometer (Triflo), 3rd Group:Standard Treatment Program + Oscillatory Positive Expiratory Pressure Therapy (Acapella Usage), 6MWT_PRE:Six-minute walk test pre-treatment, 6MWT_POST:Six-minute walk test post-treatment, MRC_PRE:Dyspnea scale pre-treatment, MRC_POST:Dyspnea scale post-treatment, SpO2_PRE:Oxygen saturation n level pre-treatment, SpO2_POST:Oxygen saturation level post-treatment, χ2:Kruskal-Wallis test.

Table 4. Comparison of within-group initial and final measurements

Variables	1st group n=8		2nd group n=8		3rd group n=8	
	Z	p	Z	p	Z	p
6MWT_POST-6MWT_PRE	-1.483	0.138	-2.201	0.028*	-1.826	0.068
MRC_POST-MRC_PRE	-2.460	0.014*	-2.588	0.010*	-2.392	0.017*
SpO2_POST-SpO2_PRE	-0.702	0.483	-2.032	0.042*	-1.667	0.096

1st Group:Standard Treatment Program, 2nd Group:Standard Treatment Program + Incentive Spirometer (Triflo), 3rd Group:Standard Treatment Program + Oscillatory Positive Expiratory Pressure Therapy (Acapella Usage), 6MWT_PRE:Six-minute walk test pre-treatment, 6MWT_POST:Six-minute walk test post-treatment, MRC_PRE:Dyspnea scale pre-treatment, MRC_POST:Dyspnea scale post-treatment, SpO2_PRE:Oxygen saturation n level pre-treatment, SpO2_POST:Oxygen saturation level post-treatment, Z: Wilcoxon Signed Ranks Test

DISCUSSION

In burn patients with inhalation injuries, standard physiotherapy exercises and incentive spirometry (triflo) and oscillatory positive expiratory pressure treatments (acapella) given in addition to these exercises have healing effects on functional capacity, dyspnea and saturation parameters. These three treatment protocols show similar improvements in functional capacity, dyspnea severity and oxygen saturation levels in patients. According to the results obtained, in burn patients, standard physiotherapy exercises and incentive spirometry (triflo) and oscillatory positive expiratory pressure treatments (acapella) given in addition to these exercises can be evaluated as effective treatment options in the rehabilitation of burn patients. We believe that physiotherapists working in this field can prefer all three protocols depending on the compliance of the patients.

In a study conducted in 2018, the effectiveness of breathing exercises and incentive spirometry was compared. Malik et al. reported that both treatments were equally effective in improving blood gas levels in burn patients with inhalation injury [26]. Abazarnejad et al. 2022, it was emphasised that improving respiratory muscle strength could be an effective method in the treatment of burn patients [27]. In another study conducted by Malik et al., it was reported that breathing exercises were more effective in reducing the risk of pneumonia in burn patients with second-degree inhalation damage than exercises performed with an incentive spirometer [28]. In our study, it was observed that exercises performed with an incentive spirometer given in addition to standard physiotherapy exercises were similarly effective. Despite this similar effect, we believe that improvement in functional capacity, dyspnoea and saturation levels may be faster in the group using an incentive spirometer. However, the 4-week follow-up period may not have been sufficient to draw definitive conclusions.Since there are no studies investigating the effects of different exercise protocols on functional capacity, dyspnoea and oxygen saturation levels in burn patients with inhalation injury, we believe that our study will contribute to the literature in this respect.Further research is needed to investigate the long-term effects of different exercise protocols on functional capacity, dyspnea, and oxygen saturation levels in burn patients with inhalation injury.

In a review investigating the effects of incentive spirometry in patients undergoing coronary artery bypass surgery, it was reported that exercises performed with an incentive spirometer had more favourable effects on oxygenation and haemodynamic values [29]. In another study conducted in 2021, it was observed that incentive spirometer exercises given in the preoperative period prevented post-operative complications in patients who were decided to undergo coronary artery bypass surgery [30]. In the literature, it has been reported that exercises performed with an incentive spirometer in patients with chronic lung disease (such as cystic fibrosis, chronic obstructive pulmonary disease) may be more effective in improving lung capacity than standard physiotherapy programme [31,32]. While incentive spirometry is more effective than standard physiotherapy in chronic lung diseases after cardiovascular surgery, the fact that this effect was not observed in burn patients with inhalation damage in our study suggests that the mechanisms of the pulmonary system may be different in both disease groups. Studies investigating these mechanisms may contribute more to the literature.

In a study conducted in 2020, it was stated that the use of vibrating devices with oscillation effect such as a cappella in chronic obstructive pulmonary disease (COPD) patients and/or chronic bronchitis patients is important in the clinical care of patients and may reduce the frequency of exacerbations [33]. In a review published in 2023, it was emphasised that a cappella application given in addition to standard physiotherapy exercises was effective in improving the clinical status of COPD patients and reducing secretion [34]. In our study, improvement in functional capacity, dyspnoea and saturation parameters were similar in the three groups. In patients with inhalation injury, only standard physiotherapy exercises may be sufficient. The levels of inhalation injury were not examined in the burn patients included in our study. Patients with all degrees of inhalation injury were included in the study. In addition, the secretions of the patients were not evaluated in isolation. This aspect of our study can be considered as a limitation. Studies with a larger number of patients, including patients with certain degrees of inhalation damage (first and/or second degree) may provide clearer evidence of the effects of incentive spirometry and acapella on these patients. Studies in this direction will contribute more to the literature.

Limitations

The study had a short follow-up period, limiting the ability to assess long-term recovery and treatment outcomes comprehensively. Short-term follow-up may not capture how treatment outcomes evolve over time. Conducting the study at a single center may not reflect potential variations in treatment outcomes that could be observed across different healthcare settings. Generalizability of the findings may be limited as the patient population at a single center may not represent patients from other centers.

CONCLUSION

This study is one of the first to compare the effectiveness of incentive spirometry (Triflo) and oscillatory positive expiratory pressure (OPEP) treatments in burn patients with inhalation injuries. This innovative approach may provide significant contributions to the literature. The results of the study may help standardize incentive spirometry and OPEP treatments in the treatment of inhalation injuries in burn patients. Standardization of these treatments may contribute to the development of more effective and safe treatment approaches in clinical practice. In particular, in addition to standard pulmonary physiotherapy exercises, oscillatory positive expiratory pressure therapy (acapella use) and incentive spirometry (triflo) can be given to burn patients with inhalation injuries. These exercises are similarly effective on functional capacity, dyspnea, and saturation levels in burn patients with inhalation injuries. Clinicians working in this field can use all 3 exercise protocols.

Ethical Approval: *2024/42 Non-Interventional Clinical Research Ethics Committee of Hasan Kalyoncu University*

Conflict of Interest: *The authors have no conflicts of interest to declare.*

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EXAMINING THE RELATIONSHIP BETWEEN LATERAL VENTRICLE VOLUMETRIC INDEX AND LINEAR INDEXES IN CHILDHOOD AND ADOLESCENCE: A RETROSPECTIVE MRI STUDY

ÇOCUKLUK VE ERGENLİKTE LATERAL VENTRİKÜL HACİMSEL İNDEKSİNİN DOĞRUSAL İNDEKSLER İLE İLİŞKİSİNİN İNCELENMESİ: RETROSPEKTİF MRG ÇALIŞMASI

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ABSTRACT

Objective: Indexes obtained from two-dimensional and three-dimensional measurements are used to evaluate the brain's lateral ventricle (LV) structure. However, there were limited studies on how well the Evans index (EI) and the Bicaudate index (BI), which estimate LV volume, represent the LV volumetric index (LVVI) in the childhood and adolescence period. This study investigated the relationship between LVVI and linear indexes (EI and BI) in the pediatric period regarding age and sex factors.

Method: This study was performed retrospectively in 588 individuals (267 [45.4%] females) aged 1-18 years with normal brain magnetic resonance images (MRI) between 2012 and 2021. LVVI was obtained by segmenting three-dimensional T1-weighted MRIs with volBrain1.0. LVVI was obtained by dividing the LV absolute volume by the total intracranial volume. We made linear measurements for EI and BI with the 3D Slicer. In this study, we compared the data obtained from individuals in 16 different age ranges between 1-18 years old with SPSS (ver.28).

Results: In our study, we found the mean value of LVVI to be 0.656±0.372%. The mean values of EI and BI were 0.242±0.025 and 0.070±0.022, respectively. In the pediatric population, we found that mean values of EI and BI were significantly higher in males than in females ($p<0.05$). In the pediatric period, LVVI had a positive correlation with EI at a moderate level (r:0.443) and with BI at a high level (r:0.624) ($p<0.001$).

Conclusion: In this study, we presented LVVI data to evaluate LV in the pediatric period. This study showed that using BI instead of EI is more effective in estimating LV volume when LVVI information is unavailable in the pediatric period.

Key Words: Lateral ventricles, Index, Three-Dimensional Imaging, Child, Adolescent

ÖZ

Amaç: Beyinde lateral ventrikül (LV) yapısının değerlendirilmesinde iki boyutlu ve üç boyutlu ölçümlerden elde edilen indekslerden yararlanılmaktadır. Ancak LV hacmini tahmin eden Evans indeksinin (Eİ) ve Bicaudate indeksin (Bİ) LV hacimsel indeksini (LVVİ) çocukluk ve ergenlik dönemlerinde ne kadar temsil ettiği ile ilgili sınırlı çalışma vardı. Bu çalışma pediatrik dönemde LVVİ ile doğrusal indeksler (Eİ ve Bİ) arasındaki ilişkiyi yaş ve cinsiyet faktörleri açısından araştırdı.

Yöntem: Bu çalışma, 2012 ile 2021 yılları arasında beyin manyetik rezonans görüntüleri (MRG) normal olan 1-18 yaş arası 588 bireyde (267 [%45,4] kadın) retrospektif olarak gerçekleştirildi. LVVİ, T1 ağırlıklı volümetrik MRG'lerin volBrain1.0 ile segmentasyonu ile elde edildi. LV hacminin total intrakranial hacme oranlanması ile LVVİ elde edildi. Eİ ve Bİ için doğrusal ölçümler 3D Slicer ile yapıldı. Bu çalışmada 1-18 yaş arası 16 farklı yaş aralığındaki bireylerin verileri SPSS (ver.28) ile karşılaştırıldı.

Bulgular: Çalışmamızda LVVİ ortalama değerini % 0.656±0.372 bulduk. Eİ ve Bİ ortalama değerleri ise sırasıyla 0.242±0.025 ve 0.070±0.022 idi. Pediatrik popülasyonda, ortalama Eİ ve Bİ değerleri erkeklerde kadınlara göre istatistiksel olarak anlamlı yüksekti ($p<0.05$). Pediatrik dönemde LVVİ, Eİ ile orta seviyede (r: 0.443), Bİ ile yüksek seviyede (r: 0.624) pozitif bir korelasyona sahipti ($p<0.001$).

Sonuç: Bu çalışma ile çocukluk ve ergenlik dönemlerinde LV'nin değerlendirilmesinde kullanılacak LVVİ verileri sunuldu. LV hacim bilgisine çeşitli nedenler ile ulaşılamaması durumunda Eİ yerine Bİ'nin kullanılmasının LV hacmini tahmin etmede daha efektif olduğu gösterildi.

Anahtar Kelimeler: Lateral ventriküller, İndeks, Üç Boyutlu Görüntüleme, Çocuk, Ergen

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INTRODUCTION

The lateral ventricle (LV) is a structure deep in both cerebral hemispheres filled with cerebrospinal fluid (CSF). The LV, limited by the anatomical structures around it, can be compared to a wide letter "C" with its opening facing forward. The upper parts of these spaces in both brain hemispheres are adjacent through the septum pellicidum. However, their lower parts are separated from each other in both temporal lobes. The LV has parts within the frontal, temporal, and occipital lobes called "horns" and a body within the parietal lobe. The triangular-shaped region at the junction of the body of the LV and the temporal horn and occipital horn is called the collateral trigone (atrium) [1].

It has been reported that the structure of the LV is affected by brain maturation, aging, and various diseases [2]. It is challenging to distinguish the pathological structure of the LV from its normal anatomy during brain maturation that continues throughout childhood and adolescence. In this process, indexes created by linear measurements from various regions of the LV were used as biomarkers. The Evans index (EI) was the most commonly used of these indices [3]. EI was calculated as the ratio of the LV's frontal horns' maximum width to the skull's maximum internal diameter on the same line in pneumoencephalograms. EI was also examined with cross-sectional images, and its diagnostic reliability was confirmed [3]. Later, the bicaudate index (BI) was proposed as an alternative to EI [4]. BI is the ratio of the width of the narrowest area between the head of caudate nuclei to the distance between the inner diameter of the skull on the same line.

Various studies have reported that three-dimensional (3D) volumetric measurements provide more sensitive and accurate results than two-dimensional (2D) linear measurements in evaluating LV pathologies [5,6]. Today, LV volume data can be easily obtained thanks to fully automatic segmentation software. However, this software utilizes specialized 3D imaging modalities for LV volume data instead of conventional MRI. For this reason, indexes obtained from 2D images, which give faster results, are still frequently used in the clinical practice. The ability of indexes obtained with 2D measurements to represent changes in 3D structure is controversial. In addition, correlation studies between volume measurement, the best method for evaluating LV, and linear indices were limited. Reinard et al. reported that the correlation and inter-rater reliability of ventricular volume and measurements made from the frontal horn of the LV were high [7]. Various studies have investigated to what extent the indexes calculated through the frontal horn region of the LV represent the ventricular volume of the LV [8-10]. Ambarki et al. [8] investigated the relationship between EI and total ventricular volume in elderly individuals, and Bourne et al. [10] investigated in adults. Ragan et al. compared the volume data of the entire ventricular system with various linear indexes in 22 hydrocephalus patients and 22 controls in the pediatric period [9]. We think that since these linear indexes are made from measurements between the frontal horn regions of the LV, it would be more accurate to compare them with the volume of the LV instead of the total ventricular volume. Therefore, unlike other studies, this study aims to investigate the relationship between LV volumetric index (LVVI) and linear indexes (EI and BI) in a large pediatric cohort. In this way, we will investigate how effective EI and BI, frequently used in clinical practice, are in predicting LV volume.

Some studies, including small numbers of pediatric individuals, had different results regarding the sexual dimorphism of EI and BI [11-15]. Studies investigating normal EI and BI values in large pediatric cohorts did not investigate sex differences [16,17]. For these reasons, the second aim of this study was to look for evidence of sexual dimorphism in EI, BI, and LVVI.

METHOD

Study Design and Participants

In this study, we took advantage of children and adolescents from different research to evaluate the association of LVVI with EI and BI during childhood and adolescence [18]. We retrospectively examined patients aged 0-18 who had MRIs between 2012 and 2021 using the radiological picture archiving and communication system (PACS). The first criterion for inclusion in this study was that patients had a 3D T1-weighted sequence in the MRI protocol to measure volumetric and linear indexes. The second criterion was that the pediatric radiologist reported that the patients had “normal radiological anatomy.” The third criterion was that pediatric individuals were not followed up with any definitive neurological or psychiatric disease diagnosis, according to radiology and hospital information system records.

We excluded pediatric patients with cerebral or cerebellar pathology who did not have normal radiological anatomy. However, the group we used for normative data included pediatric individuals who underwent MRI to rule out headache, convulsions, and epileptogenic pathology.

To determine normative data of LV indexes specific to age groups, we determined 16 different age groups between the ages of 1-18. We created six subgroups during six months of infancy and early childhood (between the ages of 1-3), the fastest period of brain development. In addition, we created five subgroups in 12-month periods between the ages of 4-8 and 5 subgroups in 24-month periods between the ages of 9-18.

Magnetic Resonance Imaging Method and Analysis

This study used the 3D-T1 weighted Fast Field Echo (FFE) MRI sequence obtained from a 3 Tesla MRI device (Achieva 3.0 T TX; Philips Medical Systems, Best, Netherlands). The voxel size of this sequence is isotropic (1 x 1 x 1 mm^3), and the slice thickness is 1 mm (FOV: 250 mm; TR: 8.2 ms; TE: 3.8 ms; FA: 80; image matrix: 240 x 240).

Linear Measurement Analysis for Evans Index and Bicaudate Index: For linear measurements, we used the 3D Slicer v.4.10.2 program (Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA). These measurements were made by a single observer (SI) with ten years of experience in medical imaging techniques. The first author (SI), an anatomist, remeasured the MRIs of three randomly selected pediatric individuals from each age group (48 individuals) to analyze intraobserver reliability. The second author (DS), a pediatric radiologist, remeasured these pediatric individuals to analyze interobserver reliability.

For each pediatric individual, we made linear measurements parallel to the anterior commissure – posterior commissure (AC-PC) plane and in the first section where the LV meets the foramen of Monro. We detected this cross-section with the help of 3D Slicer's "slice intersections" and "reformat widget" (Figure 1). We made all the linear measurements in our study with the electronic caliper of the 3D Slicer on this axial section. We found the EI by rationing the maximum width of the frontal horns of the LV to the maximum internal diameter of the skull, which we measured in the same section (Figure 1b) [3,19]. We found the BI by proportioning the width of the narrowest area between the head of caudate nuclei to the distance between the inner diameter of the skull on the same line (Figure 1b) [4]. We used Microsoft Office Excel 2016 (Microsoft Windows) to calculate the indexes

The Lateral Ventricle’s Volumetric Analysis: We obtained LVVI data from volBrain1.0, a fully automatic segmentation software. volBrain1.0 is a free online platform located at https://volbrain.net/. volBrain1.0 provides LVVI information by rationing LV to total intracranial cavity volume (TIV) and does not require any installation or training [20]. This software provides LVVI information as a percentage (%).

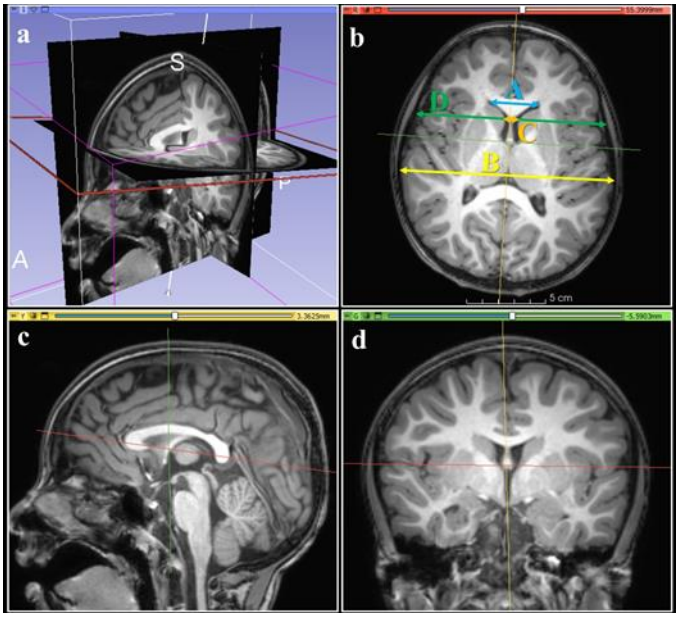

Figure 1. Determination of the axial section where linear measurements are made for Evans Index and Bicaudate Index with 3D Slicer. We detected the axial cross-section (b) with the help of 3D Slicer's "slice intersections" and "head reformat widget" (a). With the help of the mid-sagittal section (c), we ensured that the axial section was parallel to the anterior commissure - posterior commissure (AC-PC) plane. With the help of coronal section (d), we detected the first axial section where the lateral ventricle meets the interventricular foramen (Monro). Measurements made on this axial section (b); The maximum width measurement of the lateral ventricle anterior horns is demonstrated by the blue line (A). The measurement of the maximum internal diameter of the skull is demonstrated by the yellow line (B). The orange line (C) shows the measurement of the width of the narrowest area between the head regions of the caudate nucleus. The green line (D) shows the measurement of the inner diameter of the skull parallel to the measurement line between the caudate nuclei

We converted DICOM format (Digital Imaging and Communications in Medicine [.dcm]) images to NIFTI format (Neuroimaging Informatics Technology Initiative [.nii]) to obtain LVVI data using volBrain1.0. We submitted the NIFTI format files to volBrain1.0 by adding sex and age information. volBrain1.0 presented the volumetric analysis results and segmentation map (native) in the job status section. The volBrain1.0 report included several snapshots of labeling results of axial, coronal, and sagittal images of brain structures for quality control. We examined the pediatric individuals whose segmentation accuracy we doubted by uploading the native file of VolBrain1.0 to ITK Snap (ver. 3.8) software (Figure 2) [21]. We excluded those whose 2D and 3D parcellation images did not match the radiological cross-sectional images without any manual adjustments to keep the results unbiased.

Ethical Approval

The local ethics committee approved the conduct of this study (Bursa Uludag University Faculty of Medicine Clinical Research Ethics Committee, Approval Date: 19.09.2023 Decision Number: 2023-17/20). We conducted our study in accordance with the Declaration of Helsinki.

Statistical Analysis

All statistical analyzes were performed with IBM SPSS ver.28.0 (IBM SPSS Statistics for Windows, Version 28.0. [Released 2021] Armonk, NY: IBM Corp.). Our study first investigated "Is there a significant difference between the normative values of EI, BI and LVVI in 16 different periods between the ages of 1-18?" Therefore, we used One-Way Analysis of Variance (ANOVA) and Tukey Honestly Significant Difference (HSD) tests. Secondly, we examined the issue of "Is there a significant relationship between linear indexes (EI and BI) and LVVI in the pediatric period" using the Spearman rank correlation test. Thirdly, we used Student's t-test (in parametric data) or Mann-Whitney U (in non-parametric data) tests to investigate the issue of "Is there sexual dimorphism in the normative values of EI, BI, and LVVI?" Finally, we used the intraclass correlation coefficients (ICC) test to investigate the question "Is there intra-observer or inter-observer agreement in linear measurements?" In the statistical tests we used, the significance value was accepted as $p<0.05$.

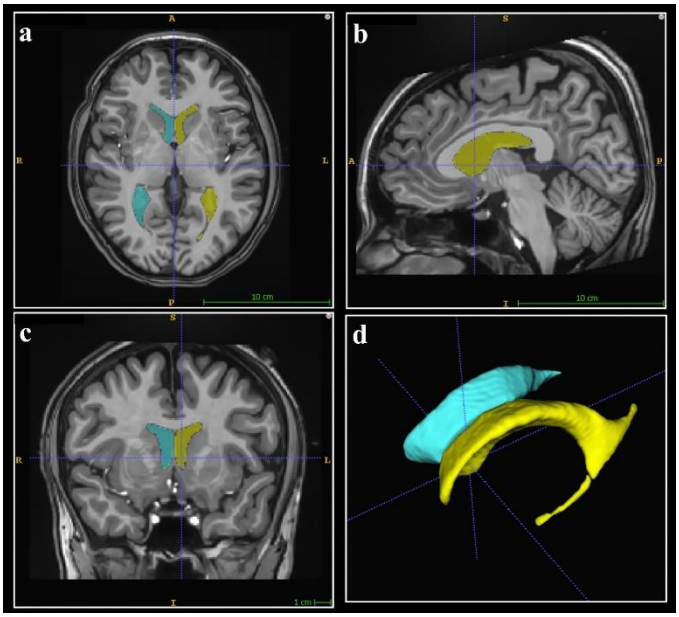

Figure 2. Examination of axial (a), sagittal (b), coronal (c), and three-dimensional (d) segmentation of the lateral ventricle using ITK Snap. The right lateral ventricle is represented in blue, and the left lateral ventricle in yellow

RESULTS

We conducted this study with 588 pediatric individuals (mean age: 6.99±5.37) who had MRIs between 2012 and 2021 and met the inclusion criteria of our research. Males participated in our study at a rate of 54.6% (321 individuals; mean age: 5.20±0.29) and females at a rate of 45.4% (267 individuals; mean age: 5.56±0.34). The quantitative status of pediatric individuals in 16 different age groups in our study according to sex was presented in Figure 3.

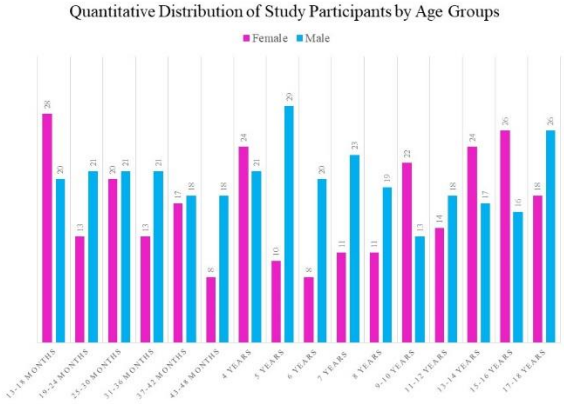

Figure 3. Quantitative distribution of pediatric individuals included in the study according to sex in 16 different age ranges

We presented the mean values of LVVI, EI, and BI data in age groups, regardless of the sex factor, in Table 1. We reported the sex comparison of index values across age groups in Table 2. In this study, we found LVVI mean values in the 1-18 age group 0.656 ± 0.372%. The mean values of EI and BI were 0.242 ± 0.025 and 0.070 ± 0.022, respectively. The highest values of all the indexes we examined were between 13-18.99 months. The lateral ventricle volumetric index had

its lowest values at 7 years of age, EI at 43-48.99 months, and BI at 9-10 years of age (Table 1). We did not find a statistically significant difference between sexes in LVVI (p: 0.474; Table 2). In the pediatric population, we found that the mean values of EI and BI are significantly higher in males than females ($p<0.05$). In the sex comparison in the age groups, we found a significant difference in EI's 31-36.99 months, eight years, 11-12 years, and 15-16 age groups. We found that BI showed sexual dimorphism in 13-18.99 months, 5, 7, and 11-12 age groups ($p<0.05$; Table 2).

Table 1. Comparison of sex-independent Lateral ventricle volumetric index, Evans index, and Bicaudate index in 16 age group between 1-18 years

Age Groups	Lateral Ventricle Volumetric Index (%)		Evans Index		Bicaudate Index	
	Mean	±SD	Mean	±SD	Mean	±SD
13-18.99 m	0.794 β	0.424	0.248 β	0.030	0.084 β	0.025
19-24.99 m	0.641	0.301	0.243	0.018	0.075	0.019
25-30.99 m	0.713	0.421	0.246	0.024	0.072	0.022
31-36.99 m	0.592	0.288	0.239	0.020	0.070	0.025
37-42.99 m	0.547	0.267	0.244	0.018	0.062	0.019
43-48.99 m	0.661	0.319	0.234*	0.030	0.072	0.018
4 y	0.597	0.248	0.244	0.022	0.068	0.018
5 y	0.607	0.332	0.245	0.020	0.067	0.019
6 y	0.669	0.396	0.248	0.024	0.071	0.025
7 y	0.538*	0.291	0.242	0.030	0.064	0.017
8 y	0.599	0.344	0.236	0.020	0.062	0.021
9-10 y	0.562	0.385	0.236	0.023	0.061*	0.018
11-12 y	0.661	0.415	0.242	0.022	0.065	0.022
13-14 y	0.741	0.468	0.243	0.027	0.071	0.021
15-16 y	0.731	0.405	0.238	0.032	0.076	0.021
17-18 y	0.739	0.431	0.245	0.023	0.077	0.022
1-18 y (Total)	0.656	0.372	0.242	0.025	0.070	0.022

m: months; y: years; Descriptive statistics were given as mean and standard deviation (SD). The highest mean values are indicated in the table with an upper sign "β," and the lowest mean values are indicated with an upper sign ""*

In the ANOVA test, we found a significant difference in other variables except EI between the ages of 1-18 ($p<0.05$). In the Post Hoc Tukey HSD test, only BI had two significant clusters between 13-18.99 months and other age groups ($p<0.05$). The correlation test did not find a significant difference between the age factor and EI, BI, and LVVI ($p<0.05$).

In the pediatric period, LVVI had a moderate positive correlation with EI ($p<0.001$; r:0.443). There was no statistically significant correlation between 37 – 42.99 months, 9-10 years, and 13-14 age groups between LVVI and EI in age groups ($p>0.05$). We detected positive correlations between low (r: 0.298) and high (r: 0.688) in other age groups (Table 3). LVVI had a high positive correlation with BI in the pediatric period ($p<0.001$; r: 0.624). In age groups, we found LVVI had a moderate-high positive correlation ($p<0.001$; $0.513 < r < 0.769$) in all age groups with BI (except 19-24.99 months) (Table 3). Intraobserver ICCs ranged from 0.93 to 0.99, and interobserver ICCs ranged from 0.89 to 0.97.

DISCUSSION

Meese et al. examined changes in the width of the CSF spaces throughout life on CT images of 170 healthy individuals. They noted that values in the first twenty years of life differ significantly from all other ages and that separate studies should be conducted for younger age groups [22]. Bourne et al. reported that the volume index was the gold standard in the quantitative evaluation of LV [10]. Neikter et al. reported that ventricular volume was a more accurate method of evaluating changes in ventricular structure than the Evans index [6]. Therefore, our study presented LVVI data specific to age groups that can be used in the clinical evaluation of LV between the ages of 1 and 18. However, LVVI data may not be available from conventional MR images. Therefore, we examined the relationship between two linear indexes commonly used in the clinic and LVVI and found that BI had a higher correlation than EI. For this reason, we recommend using BI instead of EI in LV volume estimates using the anterior horn of the LV.

LVVI change between ages 1-18: In diagnostic radiology, visual examination of the volume and shape of the ventricles is a standard procedure [8]. Giedd et al. stated that an increased ventricular/brain volume ratio is an integral part of normal pediatric development [23]. In this study, we found that LVVI has the highest value in early childhood, decreasing until the beginning of adolescence and increasing until the age of 18. Karacan et al. found that the ratio of LV to brain volume was highest between the ages of 6-9 (1.04%) and lowest between the ages of 10-13 (0.89%). They also found an increase between the ages of 14-17 (0.98%) compared to the previous period [24]. Barron et al. reported that the relative volume of LV was lower in childhood (0-9 years: 1.8%) than in adolescence (10-19 years: 3.3%) [25]. Our study supported studies that found the absolute volume of the LV in adolescence to be higher than in childhood [24-26]. The most important reason why the LVVI values we found in this study are lower than those of other authors may be because other authors did not include individuals in early childhood and the difference in their pediatric cohorts. Additionally, the volume measurement software we used and the ratio of LV to intracranial cavity volume instead of brain volume may also impact the results.

Relationship between linear indexes and LVVI between the ages of 1-18: EI, defined in encephalography by Evans in 1942, is widely used in cross-sectional imaging methods today. Although this index has various criticisms, it helps detect ventriculomegaly due to cerebral atrophy and hydrocephalus. Evans et al. reported the mean value of this index to be 0.23±0.04 (normal range: 0.20-0.25) [19]. Sarı et al. found that EI was between 0.23 and 0.28 between 0 and 18 [16]. They reported the highest EI values in the first year of life in males and in the second year (1 year of age) in females. Wilk et al. reported mean EI values ranging from 0.247 to 0.263 (range: 0.218-0.312) in radiodiagnostically normal individuals aged 0-18 [17]. The mean values of EI (0.234 to 0.248) in this study's 1-18 age group were within the range reported by other authors [14,16,17]. Furthermore, our study agreed with Wilk et al., who reported that EI weakly decreased with age, but the changes between consecutive age groups were not statistically significant [17].

Pelicci et al. reported that the mean BI in pediatric individuals aged 0-15 years was 0.11±0.03 (range: 0.00 to 0.20) and that BI did not increase with age [27]. Wilk et al. reported that BI had mean values between 0.081 and 0.113 (range: 0.059-0.152) between 0-18 and decreased with age (r: -0.26) [17]. Kumbar et al. found that BI was 0.0958 between the ages of 1 and 10 and 0.1036 between the ages of 11 and 20. [14]. The mean BI values (0.052 - 0.076) in this study's 1-18 age group were within the range of values stated by other authors, but our mean values were lower [14,17]. The highest BI (0.0836) we found in our study was between 13-18.99 months and differed significantly from other age groups. Although this index had lower results between the ages of 2 and 14 (0.0612-0.0750) than between the ages of 15 and 18 (0.0764-0.0772), this difference did not reach statistical significance. Doraiswamy et al. found a positive correlation (r: 0.59) between the age factor and BI in adults (between 22 and 82 years old) [28]. However, our study has shown that the age factor is insignificant for BI in the pediatric period.

Table 2. Comparison of Evans index, Bicaudate index, and Lateral ventricle volumetric index between sexes in 16 age groups between 1-18 years of age

Age Groups	Evans Index					Bicaudate Index					Lateral Ventricle Volumetric Index (%)				
	Female		Male		p	Female		Male		p	Female		Male		p
	Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD	
13-18.99 m	0.242	0.034	0.257	0.021	0.081	0.076	0.024	0.095	0.021	**0.006**	0.794	0.466	0.794	0.369	1.000
19-24.99 m	0.236	0.018	0.248	0.016	0.058	0.068	0.018	0.079	0.019	0.100	0.690	0.334	0.611	0.283	0.468
25-30.99 m	0.246	0.022	0.245	0.026	0.893	0.070	0.023	0.075	0.020	0.528	0.714	0.435	0.711	0.418	0.985
31-36.99 m	0.228	0.017	0.246	0.018	**0.006**	0.061	0.018	0.076	0.028	0.082	0.591	0.319	0.592	0.275	0.988
37-42.99 m	0.242	0.018	0.246	0.019	0.456	0.060	0.020	0.063	0.018	0.619	0.497	0.268	0.595	0.265	0.285
43-48.99 m	0.238	0.016	0.232	0.035	0.700	0.064	0.014	0.076	0.019	0.133	0.680	0.322	0.653	0.326	0.845
4 y	0.247	0.023	0.241	0.020	0.339	0.068	0.016	0.067	0.019	0.865	0.609	0.246	0.583	0.257	0.731
5 y	0.244	0.024	0.245	0.019	0.914	0.055	0.017	0.071	0.019	**0.027**	0.514	0.328	0.639	0.333	0.310
6 y	0.242	0.024	0.251	0.024	0.396	0.058	0.016	0.076	0.026	0.081	0.480	0.286	0.745	0.414	0.112
7 y	0.233	0.015	0.245	0.034	0.270	0.056	0.021	0.068	0.014	**0.050**	0.478	0.237	0.567	0.315	0.416
8 y	0.226	0.016	0.243	0.020	**0.022**	0.052	0.016	0.067	0.022	0.058	0.528	0.208	0.640	0.402	0.400
9-10 y	0.238	0.016	0.231	0.032	0.399	0.059	0.017	0.065	0.019	0.350	0.520	0.252	0.633	0.549	0.408
11-12 y	0.232	0.020	0.249	0.021	**0.029**	0.056	0.015	0.073	0.024	**0.023**	0.563	0.297	0.737	0.483	0.247
13-14 y	0.245	0.029	0.241	0.025	0.625	0.071	0.023	0.071	0.019	0.985	0.847	0.569	0.591	0.204	0.085
15-16 y	0.230	0.036	0.251	0.021	**0.047**	0.074	0.021	0.080	0.022	0.438	0.749	0.454	0.701	0.320	0.714
17-18 y	0.238	0.026	0.250	0.021	0.093	0.071	0.021	0.082	0.022	0.097	0.613	0.281	0.827	0.497	0.106
1-18 y (Total)	0.239	0.025	0.246	0.024	**0.001**	0.066	0.021	0.074	0.022	**0.000**	0.644	0.378	0.666	0.367	0.474

m; months; y: years; Descriptive statistics were given as mean and standard deviation (SD). The "p" significance values indicate whether index variables differ between the sexes in 16 developmental periods between 1-18 years of age. The statistical significance level was determined as p<0.05. The "p" values of age groups with statistically significant sex differences in the index variables are shown in bold in the tab

Table 3. Results of the correlation of Evans and Bicaudate indexes with Lateral ventricle volumetric index between the ages of 1-18 in age groups

Age Groups	Evans Index		Bicaudate Index	
	r	p	r	p
13-18.99 m	0.492	**0.000**	0.567	**0.000**
19-24.99 m	0.548	**0.001**	0.228	0.194
25-30.99 m	0.449	**0.003**	0.638	**0.000**
31-36.99 m	0.541	**0.001**	0.662	**0.000**
37-42.99 m	0.294	0.087	0.581	**0.000**
43-48.99 m	0.517	**0.007**	0.597	**0.001**
4 y	0.298	**0.047**	0.659	**0.000**
5 y	0.506	**0.001**	0.677	**0.000**
6 y	0.688	**0.000**	0.769	**0.000**
7 y	0.605	**0.000**	0.600	**0.000**
8 y	0.612	**0.000**	0.747	**0.000**
9-10 y	0.312	0.068	0.595	**0.000**
11-12 y	0.335	0.061	0.559	**0.001**
13-14 y	0.243	0.125	0.513	**0.001**
15-16 y	0.356	**0.021**	0.710	**0.000**
17-18 y	0.643	**0.000**	0.703	**0.000**
1-18 y (Total)	0.443	**0.000**	0.624	**0.000**

m; months; y: years; In the Spearman rank correlation coefficient was indicated with "r". p<0.05 is defined as significant. The "p" values of the age groups statistically significant in the correlation test are shown in bold in the table

Toma et al. reported that EI showed a high correlation (r: 0.619) with the ratio of ventricular volume to intracranial volume [5]. Our study showed a moderate (r: 0.443) correlation between EI and LVVI in the 1-18 age group. We think that the reason for this difference may be that we examined the correlation of LVVI data with EI instead of the entire ventricular system in our study. Ambarki et al. reported a stronger correlation (r: 0.94) between EI and total ventricular volume in healthy elderly individuals than in our study [8]. We think this difference arises from the fact that the population in their study consisted of elderly individuals and the different volume measurement software (QBrain v2) they used.

Some authors have used BI as quantitative data in MRI scoring in various diseases [29]. However, studies on BI were mainly conducted in adults, and the relationship between BI and parenchymal brain changes was investigated [30]. Studies investigating the relationship between BI and ventricular volume in the pediatric period were rare. Ragan et al. aimed to find the linear index that best describes the disease with 22 hydrocephalus patients in the pediatric period [9]. They reported that the ratio of ventricular volume to intracranial volume had a low correlation with BI (r^2: 0.328) and EI (r^2: 279). Our study found a high correlation between LVVI and BI (r: 0.624) and a medium correlation between EI (r: 0.443). Therefore, we think that BI can give more sensitive predictions to changes in LV. We think that we reached results different from those of Ragan et al. due to changes in the materials and methods of our study. Garbade et al. reported that age-related changes in BI are the combined result of changes in brain and ventricular volume [30]. Therefore, evaluations with BI may be affected not only by changes in the ventricular but also in the caudate nucleus.

Sex Differences: In our study, the LVVI value was higher in men (0.67±0.37%) than in women (0.64±0.38%), but there was no statistical difference. In the study conducted by Karacan et al. in 90 healthy children between the ages of 6 and 17 using the stereological method, they did not detect a significant difference between the sexes (0.94% in males, 0.99% in females) in the ratio of LV to brain volume, similar to our study [24]. We think that the quantitative difference is due to the different materials and methods used in Karacan et al.'s study and the reasons we have mentioned before.

Some studies, including a small number of pediatric individuals, reported that EI did not differ between sexes [11,12]. However, various studies have found sexual dimorphism in both EI and BI [13-15]. Unlike others, our study was conducted in a large cohort that included only pediatric individuals and supported studies reporting male>female EI and BI values [13-15].

Some authors have compared EI and LV volume in the evaluation of ventricles in adults and recommended performing volumetric analyses [5,8]. However, Von Bezing et al. reported that linear measurements were more reliable than volumetric ratios in hydrocephalus patients [31]. Therefore, we examined both volumetric and linear indexes of the lateral ventricle in our study. Reinard et al. reported that EI was a reliable and reproducible method for determining ventricular dilatation, having the highest ICC among reviewers [7]. However, in our study, we found that BI represents LV volume better than EI.

Limitations

Radiological imaging, especially during childhood, is a challenging process for both the child and the parents. In addition, prospective studies requiring large numbers of participants are extremely costly and time-consuming. For these reasons, our study was conducted retrospectively. The participants of this study were a group of patients who underwent follow-up MR imaging to exclude headache, convulsions, and epileptogenic pathology. This patient population, which we used in a different study, was selected according to strict inclusion criteria [18]. These patients represented the population most likely to undergo MRI scanning during childhood and adolescence.

CONCLUSION

In our study, we reported the mean value of LVVI in 16 different age ranges between 1 and 18 years. We think that these data will help in the anatomical-pathological distinction of LV. We concluded that since there is sexual dimorphism in the mean values of EI and BI in the pediatric population, values specific to men and women should be used. We found that in the pediatric period, LVVI had a moderate positive correlation with EI and a high positive correlation with BI. For this reason, we showed that using BI instead of EI is more effective in estimating LV volume if LV volume information cannot be accessed for various reasons.

As a result, characterizing the age- and sex-related changes in LV morphology in typically developing pediatric individuals is important for neurological evaluation. Knowing the normal values of LV indexes helps to distinguish various pathologies. For these reasons, the data we present in this study will contribute to creating reference data.

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"WE HAVE LEARNED TO SPEAK WITH OUR EYES": REFLECTIONS OF THE PEDIATRIC PALLIATIVE CARE PROCESS ON FAMILY LIFE

"GÖZLERİMİZLE KONUŞMAYI ÖĞRENDİK" PEDİATRİK PALYATİF BAKIM SÜRECİNİN AİLE YAŞAMINA YANSIMALARI

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ABSTRACT

Objective: This study was conducted to examine in detail the experiences regarding the care process of family members providing pediatric palliative care.

Method: A qualitative research method was adopted for the study. The reason for choosing this method was to understand the phenomenon of the reflections of the experiences of family members who care for children (0-18 years old) in the palliative care process in family life. Data were collected using a semi-structured interview form from the primary caregivers of 10 pediatric patients hospitalized in the pediatric palliative care unit of a children's hospital in Ankara. The data obtained was subjected to descriptive analysis through the "Maxqda 2020 Analytics Pro" analysis software.

Results: Themes created regarding the reflections of the palliative care process on family life are examined and grouped under four headings. These are: "Perception of Palliative Care", "Difficulties in the Palliative Care Process", "Coping Mechanisms of Families" and "Effects of the Palliative Care Process on Family Life". Regarding their socio-demographic characteristics, the caregivers' education levels were low and their income levels were moderate. In terms of the characteristics of the caregiving process, the families were primarily aware of what palliative care is, spent much time during the day for care, and experienced various difficulties (psychological, social, economic) with the care process, causing changes in family ties.

Conclusion: Multidisciplinary teamwork is needed to manage the many difficulties that the palliative care process brings to the lives of caregivers and to increase the coping capacity of caregivers and their quality of life by taking into account all psychosocial and economic contexts of their lives.

Key Words: Pediatrics, Palliative Care, Life Experience

ÖZ

Amaç: Bu araştırma pediatrik palyatif bakım veren aile üyelerinin bakım sürecine dair deneyimlerini derinlemesine incelemek amacıyla yapıldı.

Yöntem: Araştırmada, nitel araştırma yöntemi benimsendi. Bu yöntemin seçilme nedeni palyatif bakım sürecinde olan çocuk grubu (0-18 yaş) hastalara bakım veren aile üyelerinin, bakım sürecine dair deneyimlerinin aile yaşantılarına yansımalarına ilişkin fenomenin anlaşılmasıydı. Araştırma kapsamında, Ankara ilinde hizmet veren bir çocuk hastanesinin pediatrik palyatif bakım servisinde yatmakta olan 10 çocuk hastanın primer bakım verenleri ile yarı yapılandırılmış görüşme formu kullanılarak veriler toplandı. Elde edilen veriler, "Maxqda 2020 Analytics Pro" analiz programı aracılığıyla betimsel analize tabi tutuldu.

Bulgular: Palyatif bakım sürecinin aile yaşamına yansımalarına dair oluşturulan temalar araştırmada dört başlık altında toplandı. Bu başlıklar; "Palyatif Bakım Algısı", "Palyatif Bakım Sürecindeki Zorluklar", "Ailelerin Baş Etme Mekanizmaları" ve "Palyatif Bakım Sürecinin Aile Yaşamına Etkileri" olarak belirlendi. Sosyo-demografik özelliklerine göre bakım verenlerin eğitim düzeylerinin düşük, gelirlerinin orta seviyede olduğu görüldü. Bakım verme sürecine ilişkin özelliklerine göre ailelerin çoğunlukla palyatif bakımın ne olduğuna dair farkındalıkları olduğu, gün içerisinde bakıma fazla zaman ayırdıkları, bakım süreci ile birlikte çeşitli zorlukların (psikolojik, sosyal, ekonomik) yaşandığı, aile içi ilişkilerde değişimlere neden olduğu görüldü. Bunun yanı sıra ailelerin psiko-sosyal destek ihtiyacının olduğu ve aldıkları hizmetlerden kısmen memnun kaldıkları ortaya çıktı.

Sonuç: Palyatif bakım sürecinin bakım verenlerin yaşamına getirdiği birçok zorluğu yönetmelerinde, bakım verenlerin baş etme kapasitelerinin artırılmasında, yaşamlarının psiko-sosyal, ekonomik tüm bağlamlarının dikkate alınarak yaşam kalitelerinin artırılmasında multidisipliner ekip çalışmasının gerekliliği ortaya çıkmaktadır.

Anahtar Kelimeler: Pediatri, Palyatif Bakım, Yaşam Deneyimi

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INTRODUCTION

Palliative care is the active, holistic care of individuals with progressive and incurable diseases, especially those nearing the end of life. It aims to improve the quality of life of patients, their families, and caregivers [1]. The World Health Organization (WHO) made great progress in this field by defining palliative care for the first time in 1986. WHO defined palliative care in 1986 as "active total care of patients who do not respond to curative treatment." It is important to control pain, other symptoms, and social, psychological and spiritual problems [2]. With many major and minor changes made in 2002, palliative care was defined as an "approach" rather than "active total care" [3]. In short, this new definition of WHO emphasizes the importance of improving the quality of life of the patient and the caregiver by starting palliative care in the early stages of the disease.

Both children and adults can benefit from palliative care. Approximately 35% of the world's population and 40% of underdeveloped countries are adolescents and children under 20. It is estimated that the number of children (newborns, infants, children and adolescents up to 19 years of age) needing pediatric palliative care each year is up to 21 million. In addition, approximately 2.5 million children die every year due to serious health problems and various diseases, and more than 98% of these children die in low- and middle-income countries. According to 2011 data, pediatric palliative care services were unavailable in 65.6% of countries [4]. Connor et al. (2016) emphasize that of the more than 21 million children with health problems who will benefit from palliative care services yearly, more than 8 million need specialized children's palliative care worldwide [5].

Palliative care uses a multidisciplinary and interdisciplinary team approach to protect the bio-psycho-social health of patients and their relatives [3,6,7]. The palliative care team comprises physicians, nurses, social workers, psychologists, physiotherapists, dietitians, therapists (occupational, occupational physical, etc.) and clergy [8]. Caregivers have a significant role in palliative care. The primary caregiver is important in the pediatric palliative care process and is usually a family member. Considering the complex process of palliative care, the caregiver takes on an extra burden with the responsibility of the patient.

For this reason, health professionals contact palliative care patients' relatives as companions and as a part of the treatment. In addition, the focus of the services related to coping with the problems of the disease is physical symptoms, psychiatric/spiritual /socio-economic problems, end-of-life needs and mourning period [9]. The palliative care team focuses on both the child and their caregivers. It contributes to improving their psychosocial well-being and quality of life. It must have sufficient expertise to address the child's and family's physical, psychological, emotional, spiritual and social needs. Based on this, this study examined the parents providing pediatric palliative care and their experiences regarding the care process, considering the psychosocial and economic contexts of their lives.

METHOD

Study Design and Participants

This study used the phenomenological approach, one of the qualitative research designs. The phenomenological approach focuses on phenomena we are aware of daily but do not have a deep and detailed understanding of [10]. In phenomenological studies, data sources are individuals or groups who experience the phenomenon that the research deals with and can express or reflect this phenomenon. This study examined the exploratory aspects of an existing situation to understand the families' perception of palliative care and their coping mechanisms with the difficulties experienced in this process.

In the study, answers were sought to the following questions:

1-What are families' perceptions of pediatric palliative care?

2-What are the difficulties experienced by families during the pediatric palliative care process?

3-What are the mechanisms families use to cope with the difficulties experienced in the pediatric palliative care process?

4-What are the main situations that affect families during the pediatric care process?

The study data was collected from family members who provided primary care to pediatric patients receiving treatment in the pediatric palliative care unit of a children's hospital in Ankara and participated in the study voluntarily. The interviews were held in the interview rooms of the services, considering the sensitivity of the children's care. During the interviews, no deficiencies regarding the care of the children were mentioned, and the nurses on duty in the ward were asked for help regarding the care of the child receiving treatment during the interview. The researchers had no prior contact with any of the study participants. The study's participants are parents whose child was receiving inpatient treatment in the pediatric palliative care service and who volunteered to participate in the study. A total of 10 people were interviewed, including nine mothers and one father. The research included all the participants who cared for children receiving treatment in the department. Data were collected from the participants by in-depth interviews. The interviews were audio recorded and the participants were informed about the subject in the "Informed Consent Form".

The study was conducted on 09/08/2023 with the approval of pediatric palliative care unit of a children's hospital in Ankara, Clinical Research Ethics Committee. Before the interview, written consent was received from each participant, including the ethical rules and other study elements. The researchers observed a high desire to participate, with the idea that this study would benefit the relatives of the patients treated in the pediatric palliative department. The research data was collected between 15/09/2023 and 15/11/2023 after completing all preliminary preparations. After the data was collected, the organized data sets were edited and transcribed. Moreover, the data analysis procedure started.

Before the interview, a meeting was held with the chief of the pediatric palliative clinic and other healthcare professionals working there, and the development of the questionnaire to be used in the study was worked on. After the questionnaire took its final form, it was implemented. Additionally, a pilot interview was conducted to check the understandability of the questions. In the research, in-depth interviews were conducted using semi-structured interview forms. If questions were needed in other interviews, care was taken to take notes and add them to the next interview form. However, since no questions could change the study's course, no additions or deletions were made to the questionnaire. A voice recorder was used to access the evidence accurately and reliably during data collection. Information about using the voice recorder was given to the participants and included in the consent form.

In determining the participants, criteria were sought: providing primary care to a patient in pediatric palliative care, being Turkish Citizen, and being a first-degree relative. For this reason, criterion sampling and homogeneous sampling were used. In this sampling method, a small and homogeneous sample is taken and studied in detail [11]. In the analogous sampling method, the sample may include a homogeneous subgroup in the population, or a highly specialized situation related to the problem of the research [12].

Thematic analysis was used in the data analysis. Thematic analysis is a method used to identify, analyze, and report patterns (themes) in data. It allows to organize data set at the smallest size and describe it in depth (richly) [13]. MAXQDA 2020 program was used to process the data. The audio recordings were deciphered by the researchers and digitalized. The digital data were then added to the analysis

program. The researchers reviewed the data before coding. To ensure the reliability of the data, they were printed out and read to the participants before the analysis, and the accuracy of the data obtained was confirmed. The inductive method was followed to code the data, and the obtained data was freely coded. Categories were created by taking into account the standard features of the coded data.

The study's data were obtained by face-to-face interviews with the parents of 10 patients hospitalized in the pediatric palliative care service. The names of the patient's parents were coded as flower names, and their confidentiality was protected. In the study, participants' important statements regarding the findings were taken, and the participants' code names, ages, and genders were added to the end of the statements (e.g., Bougainvillea, 28, K.). All the researchers were involved in every phase of the study. Miles-Huberman formulation was used to ensure the validity and reliability of the research. Coding was done by a person other than the researchers who were not involved in the study, and the code similarity rate between the researchers and the researchers was calculated as 87.5%. In this regard, it was understood that the coding system was valid and reliable. Since the research was conducted with a qualitative design, it was checked within the scope of the Standards for Reporting Qualitative Research (SRQR) checklist. As a result of coding, four themes and 15 categories were created (Table 1).

Table 1. The distribution of the created themes and categories

Subject	Themes	Categories
Pediatric Palliative	Challenges in the Palliative Care Process	Psychological Challenges
		Physical Challenges
		Difficulties in Social Life
		Economic Challenges
	Perception of Palliative Care	Palliative Care Definition
		Expectations for Palliative Care
		Shortcomings of Palliative Care
		Benefits of Palliative Care
	Coping Mechanisms of Families	Emotional Coping Methods
		Strengthening with Social Support
		Spirit
	Effects on Family Life	Adverse Effects
		Positive Effects
		Neutral Effect

Ethical Approval

The study protocol was approved by the Etlik City Hospital Clinical Research Ethics Committee for the implementation of the study (Decision Number: AEŞH-EK1-2023-232). The study was carried out in Declaration of Helsinki. Before the data collection, all participants provided written informed consent.

Content Analysis

Maxqda 24 Program was used to content analysis. After the coding was done by the researchers, codes, categories and themes were reached with the inductive method. Four themes and 15 categories were obtained in the coding.

RESULTS

According to the findings obtained as a result of the data analysis, four themes were created: the perception of palliative care regarding the reflections of the palliative care process on family life, the difficulties encountered in the palliative care process, the method of coping with difficulties and the effects of the palliative care process on family life. Further, an analysis of demographic findings is included.

Socio-Demographic Characteristics of The Patient's Parents

A total of 10 people, nine women and one man, participated in the study, the youngest being 21 years old and the oldest being 41 years old. This shows that there was age and gender diversity in the study group. Most participants had an education level below the undergraduate level, and only one had a postgraduate level. Considering the participants' income status, only one had no income, while the other participants had sources of income (Table 2).

Findings Regarding the Perception of Pediatric Palliative Care

Within the scope of the Palliative Care Perception theme, four categories were created: the definition of palliative care, the shortcomings of palliative care, the benefits, and expectations about palliative care. Information about categories and coding is presented below.

Findings Regarding the Definition of Palliative Care: According to the data obtained, participants defined palliative care as quality of life, preparation for life at home, incurable conditions, tests, services and needs. In addition, some participants described palliative care from the perspective of a process and a unit where incurable diseases were treated. Some critical statements of the participants on the subject are given below.

"Palliative care is, of course, a process of preparing the child and the family a little bit for life at home. Frankly, palliative care gives me the impression that it is a preliminary preparation for me to be able to care for my child more safely at home as if someone is observing me and if I do something wrong, they will teach me the right thing." (Bougainvillea, 28, K.)

Palliative Care Gaps: "The palliative care gaps" category consisted of codes such as wrong medical guidance, failure to relieve the child's pain, lack of doctors, the harsh attitude of health professionals, and boredom of companions. Participants who observed doctors experiencing burnout stated that these caused deficiencies in palliative care. Participants who stated that the staff generally behaved well also stated that they might have difficulties in communication due to some professional disinformation. Families who were afraid to leave their children alone said that they had difficulties meeting their own needs, needed information in emergencies, and could not reach the service personnel in emergencies.

"Doctors are very "……" and I don't want to say anything bad about them. But sometimes I come across such doctors that I go home and cry. For example, I have seen them scold me ".....". Sometimes nurses say something that makes me sad, their words sound very different, sometimes they say a word, for example, that will make me sad for months. (...) We have so many patients. "Are we going to deal with them?" he said. This made me so sad, we were really on palliative. "I was the only patient" (Petunia, 30, F.)

Benefits of Palliative Care: As a result of the analysis, the codes of learning about medical care, receiving quality care, recovery, rooms being private for the family, knowing that you are not alone, and realizing your capacity and care money support was created. The discourse analysis showed that the participants generally preferred to stay in the ward in order to access health services easily, that they were happy to be with their children even though they were dependent on life support units, that the healthcare professionals empathized with them and tended to help them, and that they were relieved with the treatments their children received.

"We cannot go anywhere else, no other hospital will accept us. They push us with their hands. We don't know the child and his treatment. But at least this place knows the child, they know what to do immediately when I bring him. I have been here for a long time because they know that they can immediately intervene and tell the mother that we are starting this medicine on the baby, it feels better." (Daffodil, 36, F)

Table 2. Sociodemographic analysis

Name	Age	Gender	Education status	Income status
Rose	21	Woman	High School Dropout	Minimum wage
Violet	27	Woman	Primary School Dropout	No Income
Daisy	28	Woman	High school	Above Minimum Wage
Magnolia	23	Woman	Middle school	Above Minimum Wage
Petunia	30	Woman	Middle school	Minimum wage
Bougainvillea	28	Woman	Postgraduate	Above Minimum Wage
Daffodil	36	Woman	Middle school	Minimum wage
Tulip	28	Woman	High school	Uncertain
Lotus	26	Woman	Associate degree	Above Minimum Wage
Evening primrose	41	Male	Primary school	Above Minimum Wage

Expectations for Palliative Care: This category has codes for support teams at home, raising awareness, psychological support for parents, and moderate attitudes of health professionals. On the other hand, five of the participants stated that they did not have any expectations. The "unexpected" coding created accordingly was included in this category.

The analysis indicated that the participants expected to have palliative support teams outside the hospital. In addition, participants' expectations include the creation of various support mechanisms to continue their children's care when they want to take care of their daily work and take a break. In addition, the importance of creating an effective psychosocial support system was emphasized.

"It would have been great for me if there had been a psychologist when I was first diagnosed. "If I had someone with me in distress, I would like to express my troubles like this, but that is not possible right now." (Daffodil, 36, F)

Challenges in the Palliative Care Process

Within the theme of Challenges in the Palliative Care Process, there are categories of psychological difficulties, physical difficulties, economic difficulties and social difficulties. Information about categories and coding is presented below.

Psychological Challenges: Within the scope of the Psychological Difficulties category, fear of harm, psychological fatigue, traumatic effect of sibling death, inability to bear the child's suffering and intense emotional reactions were coded. In the analysis carried out, the statements of the participants who stated that they had a difficult time due to the uncertainties during the disease process and that they were quite worn out during the hospital period attracted attention. The families who make future plans for their children stated that they felt hopeless when they learned about this situation, that they became worried in case of any call or news about the health status of their children, and that this situation caused deep sadness and various psychological disorders in themselves and their ecological environment. Participants also stated that although they initially panicked about their children's seizures or health problems, they later accepted this situation and were able to act calmly in their interventions.

"I had a really hard time at first. He's bleeding slightly, and he's in pain because of the irritation. If you look at his hand, there are holes everywhere. I mean, they put a lot of pressure on us, I'm having a hard time with them. I mean, I don't want my child to suffer, frankly." (Lotus, 26, F)

Physical Challenges: A result of the analysis created codes for dependence on the device, difficulty in medical care, neglecting one's health, inability to provide personal care, physical inadequacy of the home, weariness of the hospital environment and parental exhaustion. Focusing on the codes in question, the Physical Difficulties category was created. The participants stated that children who continued their treatment mainly depending on machines due to physical difficulties had problems in their self-care. They stated that the burden of care increased depending on the characteristics of their illness, that they also had difficulty in medical care, and that they experienced many physical problems while taking care of their children when they took them home. However, they said physical problems occurred in the children and themselves.

"If he wasn't always connected to oxygen, we would take him outside and take it for walks. Once he is connected to the second machine, we cannot disconnect him at all. Before, I put the oxygen tube in the stroller and walked around the neighborhood, as the children were walking around. But after that, when he couldn't sit down and do anything, he stayed like that." (Daisy, 28, K.)

Economic Challenges: As a result of the analysis of participant statements, device/medication costs, hotel expenses, travel expenses, excess electricity bills and lack of medical supplies at home were coded. These codings were combined under a standard roof and the theme of Economic Challenges was created. The participants stated they fell into an economically difficult situation because some maintenance materials were imported products, and the machines' financial burden was high. In addition, people coming from outside the province had a problem with accommodation, and people living in the village had concerns about maintenance devices being turned off due to a possible power outage.

"We live in the village. There are constant power cuts. We were connecting him to an oxygen tube. My wife would take me to a place an hour and a half away, fill the oxygen tank and bring it back. It's all about money after all. "We had a little difficulty." (Daisy, 28, F)

Challenges in the Social Field: Within the scope of the "Difficulties in the Social Field" category, codes for social isolation, adapting life to care, being away from the home environment, not receiving support, being dependent on others and third-person discourses are included. One of the striking findings is that the difficulties in the palliative care process were caused by limitations and emotional burdens rather than medical care. As a result of the analysis, it was understood that among the factors affecting the participants, not only the disease process but also negative environmental discourses were important negative factors.

"So, in fact, your social life is shaped according to the needs of the child. If he has a feeding time, you can adjust it according to his feeding time, and if he is sleeping, you can hear and rest, and when he is up, you are also up. If the general stabilization is good, that is, you always act according to the child's needs and care. " (Bougainvillea, 28, K.)

Coping Mechanisms of Families

Within the scope of the Families' Coping Mechanisms theme, emotional coping methods, empowerment with social support and spirituality categories were created.

Emotional Coping Mechanisms The participants stated that they felt relieved that their children had now entirely accepted the situation as part of their coping mechanism and that they were trying to show patience by getting used to it. The families who need emotional motivation said that they always tried to keep their hope for recovery fresh for their children, that they would not lose their upright stance no matter what, and that conscience was the most critical factor in this process. Although emotional relief methods generally appear to be crying and not overthinking about the issue, it can be said that emotional trauma is experienced in the development of emotional coping mechanisms. In addition, it was learned that the participants, who stated that they held on to life with their children, effectively volunteered to care for their children and that this situation was kept in an extraordinary place for their families.

"I don't want to get into too deep thoughts. So right now the process requires me to be in the hospital. I'm in the hospital. Of course, I don't feel very happy about this, but accepting the process is the most important factor that strengthens me." (Bougainvillea, 28, F)

Social Support: In this study, social support is an important factor in the participants' coping mechanisms. Emphasizing that social support is an important empowerment mechanism, participants mainly stated that social support mechanisms are vital in cases where they are inadequate.

It was observed in the interviews that family support came to the fore. In this regard, the participants frequently emphasized the importance of spouses' involvement in the care process, and it was understood that family support was an important factor in resting and taking a break. At the same time, it was observed that economic assistance from stem families had an easing effect on the care burden. Some participants stated the importance of taking time for themselves, which is one factor that reduces the psychological pressure they are exposed to, and stated that their neighbors also helped with this situation. In addition, the research found statements that technological conveniences reduced psychological pressure.

"I think that people can heal themselves. In normal life, I tried to do things that made me happy whenever I had the chance. Drinking coffee is important to me. Reading a book, drinking coffee, taking short walks." (Bougainvillea, 28, F)

"I installed a camera in the house, I monitor it from my mobile phone. When we go somewhere, I check the saturation device, heart rate, and oxygen level. I went out one day. Relatives write, "You are traveling." What if you go and enjoy it 100 percent, I get 10 percent of it." (Evening primrose, 41, M)

Spirit: It is understood from the participants' statements that spiritual elements have an important role in families' coping mechanisms. It was understood that the participants who saw this situation as a spiritual test were prepared for death by emphasizing their spiritual side and had a fatalistic perspective.

"My child has been entrusted to me by God. That's why I'm chosen and no matter what I do, this is a situation I can't prevent. I see it as a gift to myself. So, I was chosen to take care of him." (Bougainvillea, 28, F)

Effects on Family Life

Within the theme of "Effects on Family Life" are categories of positive and negative effects. Some participants stated that no factor in the family order had changed.

Negative Effects on Family Life: The main issue that negatively affected families whose children were receiving treatment in the palliative ward was the deterioration in the relationships between spouses. It is seen that there are conflicts arising from psychological tension between spouses, loss of communication between spouses, ruptures in relationships, and, finally, spouses blaming each other for this issue.

"For example, when my child's condition is bad, I may feel nervous and worried that something will happen at that moment. Because we are so afraid. If he doesn't understand my situation for a moment, either I will snap at him or he will snap at me. "It happens more in emergencies." (Violet, 27, F)

Another situation that negatively affects family life is the negative behaviors of the root family or family circle. The participants who stated that there was a disintegration in the family structure stated that there were problems in the family of origin and their own families. They even faced situations such as being thrown into the sand.

"During that time, my daughter said: "Mom, do you have to go every day? Don't forget to go today. "How is my brother lying there?" he was asking questions. "He needs me. I have to go." When I said "we need you too." "You leave us every day." he said. "I think he has jealousy." (Tulip, 28, F)

Positive Effects on Family Life: The families stated that developing a special communication with their children during this process contributed positively to the family and that this strengthened family ties. It is understood that families who communicate with their children make an effort to make them look good, and therefore they make an effort to make both their children and themselves look good.

"It would be safe to say that my daughter taught us how to talk with our eyes. I understand everything from your eyes. You know, when you're lying down, I understand your desire to "turn me around, I'm tired" or that you're hungry. After that, he said he wanted to be held, etc. I can understand it all. I sit down. I hold you in my arms. "I'll talk to him." (Daisy, 28, F)

In addition to its positive and negative effects, some participants state that it does not affect their family life. Some participants stated that there was no change in family interaction or social life.

"I can't lie, at first I made the decision saying "being a disabled mother would hinder my social life". I thought I couldn't spare time for myself. But the most important thing was family support." (Daisy, 28, F)

DISCUSSION

Palliative care directly affects not only the child receiving palliative care services, but also all members of the family [14,15]. This effect can start when the child is diagnosed with the disease and continues indefinitely. This study aims to deeply examine the experiences of parents providing pediatric palliative care regarding the care process, considering their lives' psychosocial and economic contexts. According to the findings of this study, four themes were created regarding the reflections of the palliative care process on family life: palliative care perception, difficulties in the palliative care process, families' coping mechanisms and the effects of the palliative care process on family life.

The first significant finding of the study is that women generally take the caring role. In some similar studies conducted with relatives of people with diseases requiring care [16-18], it was found that a high percentage of women undertake caregiving tasks. As a result of the findings, gender-based division of labor puts women as primary caregivers.

During the interviews, when family caregivers were asked what palliative care meant to them, it was observed that families mostly tried to explain palliative care with sentences depicting the situation they experienced. Although families defined palliative care using

different concepts in the interviews, most agreed that palliative care was an incurable condition, a test, preparation for life at home, service, and need. At this point, this typical sentence expressed by families shows that palliative care is defined as "a process and a unit where the treatment of incurable diseases is carried out".

The caregivers mentioned incorrect medical guidance regarding palliative care deficiencies, inability to relieve the child's pain, lack of doctors, and harsh attitudes of health professionals. Supporting this finding, Robinson, Gott, and Ingleton (2014) reported in their study that patients and families had difficulty understanding the language used by healthcare professionals when receiving information about the disease and that the communication between healthcare professionals and caregivers was weak during the care process [19]. Some studies have emphasised that open, honest and authentic communication is necessary to build trust in the professional relationship between health professionals and caregivers during the palliative care process [14,20]. In this study, communication skills between family caregivers are very important with health professionals during the palliative care process.

Another important finding is that caregiver families face many psychological, physical, economic and social difficulties during the palliative care process. Studies on the difficulties faced by families during the palliative care process show that both mothers and fathers have psychological problems during the palliative care process [18,21,22], economic [14,22,23], physical [24-26] and social challenges [14,23]. Our study is consistent with the results of these studies.

Qualitative interviews indicate that caregiver families can overcome the difficulties they experience during the caregiving process with various coping methods. In this study, the coping mechanisms used by families converged on different themes, including emotional coping mechanisms, social support and spirituality. It has been found that the methods of coping with the difficulties of families providing pediatric palliative care have similarities and differences. Similar studies support our findings. For example, in their study, Darlington et al. (2020) reported that families providing palliative care used various coping strategies such as humor, staying positive, defending others and staying strong, expressing emotions and preparation, and social support during the caregiving process [27]. In the study conducted by Verberne et al. (2019), palliative care families' caregiving process has been found to use coping strategies such as suppressing emotions by keeping the loss of their child at bay, seeking social support, taking control to arrange optimal child care, and adapting to and accepting ongoing change(s) [28]. Özdemir (2016), in his study, determined that 90.8% of the patient's relatives saw caregiving as a religious obligation, and 67.1% turned to religion more during caregiving [29]. This result provides a finding parallel to our research.

Another critical issue that families mention in their coping mechanisms is social support. In this study, the support system of families providing pediatric palliative care was provided by spouses, root family, environmental support (neighbor), economic support, spiritual beliefs, and technological developments to make life easier. Therefore, it has been seen that "social, economic, emotional, psychological and internal resources and strengths of the family" are the social support resources of families, and these social support resources are vital in determining the quality of life of families. In line with the findings in our study, parents providing pediatric palliative care appear to adopt more social support and a submissive approach as a method of coping with difficulties. Çetin (2018) found that the areas caregivers use most to cope with stress are seeking social support, a self-confident approach and an optimistic approach, respectively [30]. The submissive approach and the helpless approach were the areas that caregivers used least frequently to cope with distress. However, Gün (2017), investigating the coping situations with stress in caregivers of stroke patients, identified the most frequently used areas as self-confident approach, helpless approach and optimistic approach, respectively [31]. In a similar study conducted on nurses, Kopuz (2013) listed the most frequently used areas as self-confident, optimistic, and helpless [32]. In addition, some studies have reported that psychosocial intervention and social support during the caregiving process of palliative care families have a significant positive impact on the quality of life of caregivers [33,34]. Rutkowski et al. (2018) stated that the social support sources of families providing palliative care are "spouse, family, close friends, palliative care team members and spiritual beliefs." However, interdisciplinary care team members also reported providing "emotional" and "informational" support to patients and their families [35]. Therefore, it can be said that the studies conducted in the literature are similar to the results of the current study.

The palliative care process significantly affects the family's daily, social, cultural and economic life, especially marriage and family life [14,19,22,36-39]. In parallel with the literature, it is noteworthy that the findings, especially relationships between spouses, and the roles and functions of the family have been reshaped throughout the palliative care process.

Limitations

The research was limited to 10 families whose children were treated in pediatric palliative care unit of a children's hospital in Ankara. Regarding the study, by paying attention to the number of samples, an attempt was made to determine the time period during which the service provided the most service, and for this purpose, information about hospital planning was obtained. Accordingly, the time period in which the study was conducted constituted another limitation of the research. Due to the obligation to care for children in the study, interviews lasted a maximum of 60 minutes. Another limitation of the study was the lack of time for families who carry out the care burden of their children.

CONCLUSION

Four themes were created from our study: perception of palliative care, difficulties in the palliative care process, families' coping mechanisms and the effects of the palliative care process on family life. In the theme of palliative care perception, it was concluded that families were aware that services were generally provided to seriously ill and incurable patients and evaluated the process as learning medical care. Perception as a test is also frequently mentioned. According to the caregivers, the most critical deficiency is the negative attitude of health professionals, and the most crucial benefit is receiving quality care. In this case, considering the skills of the personnel in medical services, communication skills need to be improved as well. Additionally, caregivers' lack of expectations regarding the process and their need for support are noteworthy.

It is seen that psychological difficulties predominate in the theme of difficulties in the palliative care process. It is observed that intense emotional reactions such as sadness, stress, panic, shock and anxiety are prevalent. The other most frequently mentioned problem was not being able to bear the child's pain. At the same time, since pediatric palliative care is not widespread, coming to a limited number of palliative care services from surrounding provinces causes extra financial burdens such as hotel and travel expenses. Dependence on the device is shown to be the cause of social restrictions as well as physical strain.

Submissive approach methods are mostly used to cope with difficulties. However, the social support approach is more effective. Parents of the patient, who state that there are no problems in their family and social life, emphasize social support. Unfortunately, the negative effects of the palliative care process, which inevitably has repercussions on the family, have been frequently expressed. While only two of the patient's parents emphasize that it strengthens family ties, conflicts between spouses are among the most apparent

negativities. Frequent hospitalizations, long discharge times, and stress due to care burden deeply affect family dynamics. The most important result of the research is that patients' relatives with solid social support mechanisms experience the process less distressingly.

Based on the research findings, it is necessary to develop home care support services regarding the palliative care process, share the burden of care, and raise awareness of the burden of care to increase the quality of life of patients and family caregivers. It is essential that psychosocial support systems continue to be provided both in the hospital and at home during the care process and that multidisciplinary practices are developed regarding case follow-up in sensitive processes such as the hospital process. In addition to raising awareness among families about social adaptation and life, it is recommended that communication-oriented training be provided to healthcare personnel and that studies be carried out to promote public awareness. Moreover, it is vital to determine job descriptions for the coordinated, effective and efficient work of multidisciplinary professions within the framework of care burden, medical care and social care.

Further studies should ask parents about their experiences at the moment they are first diagnosed, the mourning process and adaptation to social life, how to provide palliative-oriented support systems to parents of patients from different nationalities and cultures, researching effective support mechanisms that can be developed for families during the diagnosis and treatment stages, and adding literature to this field.

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