ISSN: 2651-4451 • e-ISSN: 2651-446X

Turkish Journal of Physiotherapy and Rehabilitation

2022 33(3)154-164

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Received: *7.10.2021 (Geliş Tarihi)*
Accepted: *7.04.2022 (Kabul Tarihi)*

ACTIVITIES OF DAILY LIVING AND PARTICIPATION LIMITATION IN ADOLESCENTS WITH OBESITY

ORIGINAL ARTICLE

ABSTRACT

Purpose: Childhood obesity is one of the most severe public health problems in recent years. We aimed to compare physical fitness and activities of daily living (ADL)-participation limitations in adolescents with obesity and peers without obesity and investigate whether the differences in these parameters are affected by gender in this study.

Methods: Fifteen adolescents with obesity and 16 adolescents without obesity included in this cross-sectional study. Physical fitness was determined using the Munich Physical Fitness Test (MFT) and Modified Shuttle Walk test (MSWT). ADL were determined using the TGlittre-P test, quality of life and participation was assessed using the Pediatric Outcomes Data Collection Instrument (PODCI).

Results: The MSWT distance, peak oxygen consumption, and MFT total score were decreased in adolescents with obesity regardless of gender ($p<0.05$). TGlittre-P test time was significantly longer in girl adolescents with obesity than girls without obesity ($p=0.019$). PODCI-physical function and sports, happiness/satisfaction, and global function scores were decreased in adolescents with obesity compared to peers without obesity ($p<0.05$).

Conclusion: Peripheral muscle strength, endurance, power and cardiorespiratory/physical fitness are negatively affected by obesity in adolescents. Gender affects the ADL performance and participation limitations increase due to restriction in sports and physical function, happiness, and global function in adolescent obesity. Further studies need to focus on the effectiveness of enjoyable and suitable activities or exercise interventions on these parameters and also cardiovascular risk levels in adolescents with obesity.

Key Words: Adolescent Obesity, Activities of Daily Living, Physical Fitness, Quality of Life, Adolescent Health

OBEZİTESİ OLAN ADOLESANLARDA GÜNLÜK YAŞAM AKTİVİTELERİ VE KATILIM LİMİTASYONU

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Çocukluk çağı obezitesi, son yılların en ciddi halk sağlığı sorunlarından biridir. Bu çalışmada; obezitesi olan adolesanlarda ve obezitesi olmayan akranlarında fiziksel uygunluk ve günlük yaşam aktiviteleri (GYA)-katılım limitasyonlarını karşılaştırmayı ve bu parametrelerdeki farklılıkların cinsiyetten etkilenip etkilenmediğini araştırmayı amaçladık.

Yöntem: Bu kesitsel çalışmaya obezitesi olan 15 ve obezitesi olmayan 16 adolesan dahil edildi. Fiziksel uygunluk, Münih Fiziksel Uygunluk Testi (MFT) ve Modifiye Mekik Yürüme Testi (MMYT) kullanılarak belirlendi. GYA, TGlittre-P testi kullanılarak belirlendi, yaşam kalitesi ve katılım Pediatrik Veri Toplama Aracı (PVTA) kullanılarak değerlendirildi.

Sonuçlar: Obezitesi olan adolesanlarda cinsiyetten bağımsız olarak MMYT mesafesi, zirve oksijen tüketimi ve MFT toplam skoru azalmıştı ($p<0,05$). TGlittre-P test süresi, obezitesi olan adolesan kızlarda, obezitesi olmayan kızlara göre anlamlı olarak daha uzundu ($p=0,019$). Obezitesi olan adolesanlarda, obezitesi olmayan akranlarına göre PVTA- fiziksel fonksiyon ve spor, mutluluk/memnuniyet ve global fonksiyon skorları azalmıştı ($p<0,05$).

Tartışma: Adolesanlarda periferik kas kuvveti, dayanıklılık, güç ve kardiyorespiratuar/fiziksel uygunluk obeziteden olumsuz etkilenmektedir. Adolesan obezitesinde cinsiyet GYA performansını etkilemekte ve fiziksel fonksiyon ve spor, mutluluk/memnuniyet ve global fonksiyonda kısıtlama nedeniyle katılım limitasyonu artmaktadır. Obezitesi olan adolesanlarda eğlenceli ve uygun aktivitelerin veya egzersiz müdahalelerinin bu parametreler ve ayrıca kardiyovasküler risk düzeyleri üzerindeki etkinliğine odaklanan ileri çalışmalar gereklidir.

Anahtar Kelimeler: Adolesan Obezite, Günlük Yaşam Aktiviteleri, Fiziksel Uygunluk, Yaşam Kalitesi, Adolesan Sağlığı

INTRODUCTION

Obesity is a multifactorial syndrome, including physiological, biochemical, metabolic, anatomic, psychological, and social factors and growing a health problem in both developed and non-developed countries (1). According to the research of the WHO European Childhood Obesity Surveillance Initiative (or COSI-Turkey), increased obesity and overweight were observed in students of the 2nd grade of primary school in Turkey from 2013 to 2016 (2).

Increased prevalence of childhood obesity causes comorbid diseases as hypertension, dyslipidemia, insulin resistance, dysglycemia, fatty liver disease, and psychosocial complications (3). As a consequence of these problems, obesity threatens health status and causes an enormous burden on the health system. Therefore, it is essential to prevent childhood obesity and identify overweight/obese children at an early stage (4).

Obesity is closely related to disorders in physical function and performance of daily life activities. Cardiorespiratory fitness of adolescents with obesity decreases compared to lean peers, but the cardiopulmonary responses of maximal exercise are also exactly unknown (5). There is limited data about the physical fitness of adolescents with obesity (5,6). Although The Glittre-ADL test which is a performance-based test of ADL was shown to be reproducible and valid in patients with obesity and post-bariatric surgery and ADL performance was poorer in individuals with obesity compared to controls (7), same difference was not shown for elderly population with obesity (8). Although scarce data show that functional capacity and quality of life are negatively affected in adolescents with obesity compared to peers without obesity (5,9), no data evaluates activity and participation with objective performance-based tests and compare these parameters based on the gender in adolescents with obesity. Therefore, we aimed to investigate ADL performance, physical fitness, maximal exercise capacity, quality of life and participation in adolescents with obesity compared to peers without obesity. Our primary research question was whether there was a difference in ADL performance between the adolescents with and without obesity. The second research question was whether there was a difference in physical fitness and maximal exercise capacity and the last question was whether a difference in quality of life and participation between the adolescents with and without obesity. We especially aimed to investigate whether the differences in these parameters are affected by gender. We suggest that findings of this study can increase the usefulness of performance-based the Glittre-ADL test adapted for children for adolescents with obesity and guide rehabilitation professionals for focus on the physical fitness, activity and participation problems of this population in clinical practice.

METHODS

Study Design, Setting and Participants

This cross-sectional study was carried out at Hacettepe University Faculty of Physical Therapy and Rehabilitation between June 2019 and April 2020. The research was performed on adolescents with obesity between 12 and 18 years old according to the BMI percentile reference system diagnosed by Hacettepe University Faculty of Medicine Department of Pediatrics Division of Adolescent Medicine and healthy adolescents compatible with their age and gender. The exclusion criteria for cases was the absence of any comorbidities, cardiovascular problems, musculoskeletal and neurological diseases, cognitive or motor limitations, or other chronic diseases that may affect exercise performance and other physical tests. After the diagnosis, eligible adolescents with obesity were referred to our department. Adolescents without obesity who were willing to participate and invited via social media/posters were included and assessed for eligibility. The total duration of the assessments was approximately one hour. The study was approved by the Hacettepe University Non-Interventional Clinical Researches Ethics Board with approval number GO 19/60 on 05.02.2019. All adolescents and their parents signed an informed consent form. The trial is registered with ClinicalTrials.gov: NCT04201158.

Testing Prosedures

Age, body weight, height, background, and family history of the cases, presence of obesity in first de-

gree relatives, and participation in a regular sports activity were recorded. Weight, height, body mass index (BMI) z scores were calculated, and after BMI was calculated, the reference values of Neyzi et al. for Turkish children and adolescents were used to calculate the BMI percentile values. Adolescents were identified as obese if the BMI percentile ≥95th percentile (6).

Waist and hip circumference were measured, and waist/hip ratio and waist/height ratio were calculated as anthropometric measures. The cut-off value for showing any obesity-related cardiovascular disease (CVD) risk factors was found to be 27.1% for FM (%) and 0.59 for waist/height ratio for the Turkish population aged 6-17 years (10).

Bioelectrical impedance analysis (BIA) was analyzed using the instrument (Tanita MC 780 MA Body Composition Analysis, Amsterdam, Netherlands). Body fat percentage (FM%), body muscle percentage (FFM%), body fat weight as kg (FM), and body muscle weight as kg (FFM) were analyzed and recorded (11).

Jamar hand dynamometer (Jamar®, California, USA) was used to evaluate maximal isometric handgrip strength. The highest value of the three measures on each side was recorded. Handgrip strength measurements are expressed as actual values and percentage of expected values by age and gender (12).

Peripheral muscle endurance was assessed with a sit-ups test, a modified push-ups test, and a squat test. In the sit-ups test, patients were asked to lift the trunk from the supine position until the lower the angle of the scapula with the arms stretched forward consecutively as quickly as possible. For the modified push-ups test, patients were requested only to lift their trunk performing consecutive elbow flexions and extensions in the push-up position as promptly as possible. The squat test required the patient to move as quickly as possible from a standing position to a squatting position. Each test was performed for 30 seconds, and the numbers of sit-ups, push-ups, and squats were recorded for analysis (13).

Activities of daily living (ADL) were evaluated by the Glittre-ADL test adapted for children (TGlittre-P). TGlittre-P consists of completing a circuit five times as quickly as possible while carrying a backpack that changes between 0.5–2.5 kg depending on the children's weight. The test begins when the participant stands up from the sitting position. Then, the child walks along a 10m-long flat course by crossing the two-step ladder placed in the middle and reaches a pre- set two-shelf bookshelf at the eye level and umbilicus level for removing the objects from top to ground shelf and then in the opposite direction. The child walks back along the same route by crossing the two-step ladder and reach the chair, sits down, and immediately starts the next lap. The total time of five laps was recorded (14). In addition, the expected TGlittre-P time according to age and gender were calculated according to the following formula [time spent on the TGlittre-P = 3.781 - 0.083 × age (girls), and time spent on the TGlittre-P = 4.025 - 0.123 × age (boys)] and percentage of expected values was given (15).

Cardiorespiratory fitness was evaluated using the Modified Shuttle Walk Test (MSWT). The test was performed in a 10 m course that was identified by two cones at the endpoints. The MSWT has 15 levels, and participants must walk or run as necessary at speed dictated by an audio signal. Each level in the test lasts for one minute, with the speed of the test increasing by 1.61 km/h each minute (16). The number of shuttles, total distance, and reason for termination of the test was recorded. Peak oxygen consumption (VO_2) was calculated with the following equation: Peak VO_2 (ml/kg/min)= 6.83 + (0.028 × MSWT distance) (17). The MSWT was shown to be a valid, reliable test and responsive to improvements of aerobic fitness with interventions sensitive in adolescents with obesity (18).

The Munich Fitness Test (MFT) was used to evaluate the physical fitness of adolescents. The MFT is a valid and reliable test for assessing physical fitness in children aged 6-18 and adolescents in schools in Germany. Peers' comparison and interpretation of motor performance by age and gender can be made with objective scores. It is a six-step test consisting of balancing and bouncing, accurate throw, trunk flexibility, standing vertical jumping, hanging, and step test. According to the Munich score, the physical fitness level is classified

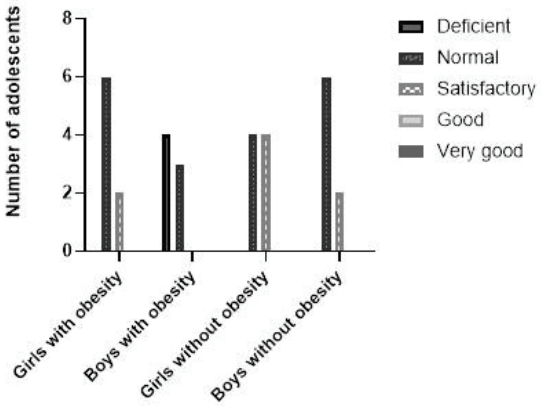

Figure 1. Distribution of Adolescents With and Without Obesity According to the Munich Fitness Test Classification

as deficient (35 and below), normal (36-45), satisfactory (46-55), good (56-65), and very good (66 and above) (19). Quality of life was evaluated using the Pediatric Outcome Data Collection Instrument (PODCI)-adolescents form. The PODCI form consists of six subdimensions: upper limb function, physical function and sports, transfer and essential mobility, pain/comfort, happiness/satisfaction, and global function. Scores for all subdimensions range from 0 to 100, and higher ratings indicate less impairment in quality of life or higher level of function or participation (20).

Statistical Analysis

The statistical evaluation was performed using the SPSS 18.0 statistical packet software for Windows (Version 18.0, IBM Inc., Armonk, New York, USA). Variables were descriptively expressed as mean-standard deviation, median (minimum-maximum), frequency, and percentage. The variables were investigated using visual (histograms/probability plots) and the Shapiro-Wilks test to determine whether or not they were normally distributed. The Mann Whitney-U test for non-normally-distributed parameters and Student-t-test for normally distributed parameters were conducted to compare parameters between adolescents with and without obesity. A two-way ANOVA test was used to examine the effect of gender on the continuous data determined by measurement in the presence of obesity. Tukey HSD test was used for posthoc analysis. A Chi-square test was used to analyze qualitative variables. The level of significance was set to $p<0.05$. A post hoc power analysis was performed using the G*Power statistical program (G*Power 3.0.10 Software) according to MSWT distance results. The post hoc power of the trial was 99% (21).

RESULTS

Eight girl and eight boy adolescents with obesity and eight girl and eight boy adolescents without obesity participated in the study. While age, gender, height, and z scores for height were similar between groups ($p>0.05$), there was a significant difference in body weight, BMI, z scores of body weight and BMI ($p=0.000$) (Table 1). Seventy-five percentage of girls with obesity' first degree relatives and 57.1% of boys with obesity' first degree relatives had obesity. When the regular sports habits of adolescents were examined, only 12.5% of girl adolescents with obesity had proper sports habits (resistant exercise); 25% of healthy girl adolescents (kickboxing, football) and 12.5% of healthy boy adolescents (basketball) had regular sports habits.

The waist circumference, hip circumference, waist/hip ratio, and waist/height ratio of adolescents with obesity were significantly higher than those of the adolescents without obesity ($p=0.000$), and there was no effect of gender on these parameters ($p>0.05$, Table 1). According to BIA results, there were significant differences in FM, %FM, FFM, and %FFM between two groups ($p=0.000$, Table 1). The 85.7 percentage of boy adolescents with obesity and 50% of girl adolescents with obesity had increased obesity-related CVD risk according

Table 1. Comparison of Physical Characteristics, Anthropometric Measurements and Bioelectrical Impedance Analysis Results Between Adolescents with and without Obesity Based on Sex Differences

Parameters	Adolescents with Obesity (n=15)		Adolescents without Obesity (n=16)			p
	Girl (n=8)	Boy (n=7)	Girl (n=8)	Boy (n=8)		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Age (years)	16.0±0.92	14.29±1.60	15.50±1.19	14.62±1.92		0.808
Height (cm)	164.25±6.48	166.79±5.60	161.87±6.15	168.12±8.37		0.864
Body weight (kg)	89.78±12.33	86.19±8.82	50.43±7.63	55.21±7.39		**0.000***
BMI (kg/m^2)	33.23±4.00	30.90±1.51	19.19±2.28	19.42±0.90		**0.000**^{y}
Height z score	0.21±1.29	0.25±0.70	0.03±0.96	0.34±1.23		0.914
Body weight z score	3.52±1.42	2.23±0.21	-0.82±1.20	-0.36±0.87		**0.000***
BMI z score	2.98±0.68	2.28±0.16	-0.99±1.22	-0.56±0.48		**0.000***
BMI classification	**n (%)**	**n (%)**	**n (%)**	**n (%)**		
<5th percentile	-	-	2 (25)	-		
5-10th percentile	-	-	2 (25)	1 (12.5)		
10-25th percentile	-	-	-	2 (25)		
25-50th percentile	-	-	3 (37.5)	4 (50)		
50-75th percentile	-	-	-	1 (12.5)		
75-85th percentile	-	-	1 (12.5)	-		
>95th percentile	8 (100)	7 (100)	-	-		
					Group	**Group* Gender**
Waist circumference (cm)	105.43±22.20	101.21±4.56	64.31±4.51	71.50±1.58	**0.000**$^{\&}$	0.189
Hip circumference (cm)	118.56±9.05	111.79±5.84	91.93±6.80	91.62±4.84	**0.000**$^{\&}$	0.201
Waist/hip ratio	0.88±0.14	0.90±0.05	0.69±0.03	0.78±0.03	**0.000**$^{\&}$	0.337
Waist/height ratio	0.64±0.13	0.60±0.03	0.39±0.02	0.42±0.01	**0.000**$^{\&}$	0.222
FM (kg)	37.43±9.79	30.51±1.96	11.70±4.19	8.77±1.80	**0.000**$^{\&}$	0.360
%FM	41.05±6.74	36.30±3.45	23.02±5.24	15.93±2.77	**0.000**$^{\&}$	0.531
FFM (kg)	49.93±5.43	53.88±9.64	35.87±4.06	44.06±6.30	**0.000**$^{\&}$	0.134
%FFM	55.96±6.43	51.31±7.50	73.0±5.0	79.72±2.69	**0.000**$^{\&}$	0.528

Abbreviations: BMI: Body mass index, FM: Fat mass, FFM: Fat free mass. *p<0.05, Student-t test, ^{y}p<0.05, Mann Whitney U-test: Difference between adolescents with and without obesity. $^{\&}$p<0.05, A two-way ANOVA test.

to waist/height ratio cut-off values. The 85.7 percentage of boy adolescents with obesity and all girl adolescents with obesity had increased obesity-related CVD risk, according to %FM cut-off values.

The %handgrip strength values of adolescents with obesity were significantly lower than those of group without obesity (p=0.006, Table 2). The repetition numbers of modified push-ups and sit-ups were significantly lower in adolescents with obesity than their peers without obesity (p=0.000, p=0.005 respectively, Table 2), the repetition numbers of squats were similar, and gender did not affect these parameters (p>0.05, Table 2).

The MSWT distance and peak VO_2 values of adolescents with obesity were significantly lower than adolescents without obesity (p=0.000, Table 2). No significant difference was found between adolescents with and without obesity in terms of the percentage of maximal HR achieved during the test (p>0.05, Table 2). There was no significant difference in responses of physiologic variables and dyspnea, leg, and general fatigue perceptions change between adolescents with and without obesity during the MSWT (p>0.05, Table 2).

The standing vertical jump, hanging, and MFT total scores of adolescents with obesity were significantly lower than adolescents without obesity, and the gender did not affect MFT parameters and the overall score (p=0.028, p=0.000, p=0.000 respec-

Table 2. Comparison of Physical Fitness Parameters of Adolescents with and without Obesity and Effect of Gender on Physical Fitness

Variables	Adolescents with Obesity (n=15)		Adolescents without Obesity (n=16)		Group	Group* Gender
	Girl (n=8)	Boy (n=7)	Girl (n=8)	Boy (n=8)		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Peripheral muscle strength and endurance						
Right hand grip strength (kg)	29.25±4.26	28.86±6.09	26.25±2.91	33.00±6.76	p=0.762	p=0.067
Left hand grip strength (kg)	26.50±4.50	27.14±6.82	23.50±3.50	29.00±5.65	p=0.763	p=0.206
% Hand grip strength	89.42±14.76	75.00±11.90	98.60±8.41	101.86±25.89	**p=0.006***	p=0.154
Modified push-up (n)	6.75±7.90	8.50±5.26	9.29±5.15	21.25±8.61	**p=0.000***	p=0.432
Sit-up (n)	8.25±4.65	12.00±3.41	14.00±4.75	15.00±2.50	**p=0.005***	p=0.343
Squat (n)	16.25±5.25	17.60±13.90	18.75±3.01	22.50±2.26	p=0.170	p=0.649
Aerobic fitness						
MSWT distance (m)	530.00±122.59	568.60±226.82	817.50±141.90	836.25±165.95	**p=0.000***	p=0.870
Peak VO_2 (ml/min/kg)	21.67±3.43	22.80±6.35	29.72±3.97	30.24±4.64	**p=0.000***	p=0.870
%HRmax	91.04±10.59	90.95±4.30	92.18±6.19	89.75±6.92	p =0.894	p=0.579
ΔHR (beats/min)	81.12±25.57	91.62±4.20	93.12±15.04	90.12±13.08	p=0.144	p=0.745
ΔSBP (mmHg)	32.00±15.18	36.29±21.60	38.00±11.08	33.12±14.12	p=0.804	p=0.425
ΔDBP (mmHg)	10.00±14.06	5.14±9.30	11.37±3.20	11.25±12.78	p=0.342	p=0.546
ΔSpO_2 (%)	0.87±1.12	-1.57±3.40	0.75±1.28	-0.25±1.03	p=0.390	p=0.300
ΔDyspnea (M.Borg)	2.87±1.12	3.10±3.60	2.56±2.06	1.75±1.55	p=0.315	p=0.533
ΔLeg fatigue (M.Borg)	2.68±1.03	2.00±2.84	1.68±1.68	2.18±1.60	p=0.550	p=0.384
ΔGeneral fatigue (M.Borg)	2.31±1.57	2.79±2.41	1.81±1.13	1.62±1.30	p=0.173	p=0.582
Physical fitness						
Bouncing a ball (n)	41.50±15.71	36.14±11.40	41.75±5.36	46.62±10.19	p=0.139	p=0.155
Bouncing score	42.00±14.40	32.14±3.67	47.87±5.40	38.12±7.14	p=0.058	p=0.952
Throwing sandbag (total)	-2.00±11.69	5.14±3.57	-7.75±14.65	-4.37±12.45	p=0.783	p=0.131
Throwing sandbag score	43.00±13.97	31.14±2.00	38.62±9.13	43.25±13.48	p=0.637	p=0.131
Trunk flexibility (cm)	-2.00±11.69	-10.43±11.00	-7.75±14.65	-4.37±12.45	p=0.973	p=0.203
Trunk flexibility score	43.00±13.97	35.71±8.50	38.62±9.13	43.25±13.48	p=0.709	p=0.167
Standing vertical jumping (cm)	18.37±9.42	24.14±6.91	23.12±4.29	35.25±9.03	**p=0.005***	p=0.193
Standing vertical jumping score	34.87±9.84	35.00±5.80	36.12±8.33	46.00±6.84	**p=0.028**	p=0.071
Hanging (s)	3.62±5.42	9.43±19.80	19.50±6.98	24.75±17.51	**p=0.002***	p=0.959
Hanging score	38.50±11.31	35.43±12.70	62.37±6.20	49.25±9.91	**p=0.000***	p=0.199
Step test	3.62±7.94	12.14±16.00	4.37±7.96	2.25±4.80	p=0.255	p=0.179
Step test score	58.12±7.47	49.43±11.53	58.87±7.23	54.25±4.86	p=0.319	p=0.463
MFT score	249.62±30.67	218.86±20.20	278.62±18.16	262.75±25.49	**p=0.000***	p=0.316

Abbreviations: MSWT: Modified shuttle walk test, VO2: oxygen consumption, HR: Heart rate, SpO2: Oxygen saturation, M.Borg: Modified Borg (0-10), SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MFT: Munich Fitness Test.

*p<0.05, A two-way ANOVA test: Difference between adolescents with and without obesity.

Table 3. Comparison of Activity and Participation of Adolescents with and without Obesity and Effect of Gender on Physical Fitness

Variables	Adolescents with Obesity (n=15)		Adolescents without Obesity (n=16)		Group	Group* Gender
	Girl (n=8) Mean±SD	Boy (n=7) Mean±SD	Girl (n=8) Mean±SD	Boy (n=8) Mean±SD		
TGlittre-P test						
ΔHR (beats/min)	73.25±21.16	55.90±27.64	65.25±13.64	57.75±20.38	p=0.690	p=0.519
ΔSpO_2 (%)	-0.50±1.06	-1.00±1.83	0.12±0.64	-0.62±1.18	p=0.268	p=0.779
ΔDyspnea (M. Borg)	2.81±0.99	0.79±0.86	1.31±0.92	0.52±0.87	**p=0.013***	p=0.071
ΔLeg fatigue (M. Borg)	1.87±1.38	1.93±1.48	0.75±0.80	0.56±1.01	**p=0.007***	p=0.781
ΔArm fatigue (M. Borg)	0.56±0.90	1.00±1.80	0.37±0.44	0.25±0.37	p=0.208	p=0.446
ΔGeneral fatigue (M. Borg)	1.31±0.79	0.86±0.90	0.62±0.87	0.50±0.70	p=0.088	p=0.581
Glittre ADL test-time (min)	2.15±0.11	2.07±0.40	1.74±0.25	2.09±0.24	p=0.050*	**p=0.026****
%TGlittre-P test time	87.91±4.12	91.50±16.70	70.46±12.84	95.04±14.46	p=0.142*	**p=0.030****
PODCI						
Upper extremity	95.87±5.56	97.14±3.80	96.37±6.13	97.50±4.24	p=0.816	p=0.969
Transfer and mobility	97.87±4.35	98.71±1.60	100.00±0.00	100.00±0.00	p=0.053	p=0.623
Physical function and sports	75.25±17.61	86.86±6.59	96.12±1.88	97.75±4.46	**p=0.000***	p=0.169
Pain/comfort	68.62±24.18	83.29±14.37	94.50±8.31	84.00±20.79	p=0.051	p=0.064
Happiness/satisfaction	60.00±30.70	85.71±12.39	91.25±9.16	94.37±6.78	**p=0.004***	p=0.087
Global function	83.12±10.96	91.14±4.30	96.12±2.41	94.75±5.06	**p=0.002***	p=0.058

Abbreviations: TGlittre-P test: The Glittre-ADL test adapted for children, PODCI: Pediatric Outcome Data Collection Instrument, HR: Heart rate, SpO2: Oxygen saturation, M.Borg: Modified Borg (0-10). *p<0.05, A two-way ANOVA test: Difference between adolescents with and without obesity, **p<0.05, A two-way ANOVA test: Difference between groups according to gender.

tively, Table 2). According to MFT classification, distribution of adolescents in both group were given in Figure 1 and there was significant difference between groups (χ^2=18.384, p=0.005). There was a statistically significant difference between girl and boy adolescents with obesity (p=0.031) and between boy adolescents with and without obesity according to MFT classification (p=0.031, Figure 1).

Although the completion time of TGlittre-P test and %TGlittre-P test time were similar between adolescents with and without obesity (p=0.026, p=0.030 respectively, Table 3), TGlittre-P test was significantly longer in girl adolescents with obesity than girls without obesity (p=0.019). The girl adolescents without obesity also reached significantly lower percentage of expected TGlittre-P test time than boy adolescents with (p=0.018) and without obesity (p=0.003). There was a statistically significant difference in the increase of dyspnea and leg fatigue perception between adolescents with and without obesity (p=0.013, p=0.007 respectively, Table 3). Based on adolescents' participation and quality of life of evaluated with PODCI- adolescent form, adolescents with obesity had significantly lower subdimension scores of PODCI-sports and physical function, happiness, and global function than adolescents without obesity (p=0.000, p=0.004, p=0.002 respectively, Table 3).

DISCUSSION

The main findings of this study were that gender affects the daily living activities performance and ADL performance of girl adolescents with obesity is poorer than girl adolescents without obesity and the perceptions of dyspnea and leg fatigue increases during ADL in adolescents with obesity. Secondly, peripheral muscle muscle strength, en-

durance, power as physical fitness parameters and maximal exercise capacity are negatively affected in adolescents with obesity. In addition, it was determined that the participation of adolescents with obesity decreases due to restriction in their physical function, sports, happiness/satisfaction, and global functions.

The primary focus of the study was on differences in activity limitations between the adolescents with and without obesity. It has been found that obese and bariatric surgery patients spend a significantly longer time in the Glittre-ADL test than healthy controls (10). The TGlittre-P test time showed a moderately negative correlation with the 6-minute walk test (6MWT) distance in healthy pediatric individuals and elderly population (8,14). On the other hand, Glittre-ADL test was not changed between elderly individuals with overweight, obesity and controls (8). Monterio et al. also confirmed poor performance in the Glittre-ADL test in adults with obesity compared to controls and individuals with obesity had higher energy expenditure during tests, and most of the activity time was in low intensity (22). In the present study, we performed a performance-based ADL evaluation in adolescents with obesity and proved that TGlittre-P test time of girl adolescents with obesity is higher than age and sex matched peers without obesity. Otherwise, girl adolescents without obesity showed significantly better performance according to expected values for TGlittre-P test than boy adolescents with and without obesity. The higher test completion time and poorer ADL performance of girl adolescents with obesity can be due to their higher body weight and %FM, their lower speed, the exhibition of great effort for moving their body, and higher dyspnea and leg fatigue perception compared to girl peers without obesity. Our study showed that the TGlittre-P test is useful and feasible test in clinical practice to show ADL limitation of adolescents with obesity compared to sex matched peers without obesity.

The second research question was related to differences in physical fitness levels and maximal exercise capacity between the adolescents with and without obesity. An investigation in a large adolescent sample group between the ages of 12-15 determined that adolescents with normal- weight perform better than adolescents with overweight and obesity in most physical fitness tests (except throwing balls) (23). Ceschia et al. have shown that children with overweight and obesity have worse performance in aerobic capacity, speed, and agility and balance tests than their peers with normal-weight and have lower limb strength compared to their body mass (24). Deforche et al. have reported that adolescents with obesity exhibit worse performance on all fitness tests that need propulsion or lifting of the body mass like speed shuttle run compared with their peers without obesity (5). Our results confirmed the previous findings that power (standing vertical jump), strength, and endurance (hanging) parameters of adolescents with obesity were negatively affected compared to peers without obesity (5,23,24). According to the physical fitness level classification, the fitness level of boys with obesity was significantly lower than girls with obesity and healthy boys. It may be related to the fact that boys with obesity were less motivated than girls with obesity during the tests. The MSWT distance was shown to be decreased in children and adolescents with obesity aged 6-18 years compared to healthy peers. As the BMI value increase, The MSWT distance decreases in children and adolescents with obesity (16). In adolescents with obesity, aerobic fitness was directly proportional to their physical activity levels, while it was inversely proportional to %FM (259. It has also been shown that as body fat increases, running speed decreases (18,25). In our study, the reduction in MSWT distance and peak VO_2 in adolescents with obesity regardless of gender is compatible with the literature (18,25). Sedentary behaviors and deconditioning and decreased running speed may contribute to the decline in aerobic fitness.

It has been shown that handgrip strength can be used as an indicator of general muscle strength in healthy children and adolescents (26). In a study of 233 children and adolescents aged 10-17 years, higher BMI value was found to be significantly related to strong handgrip strength (27). Our results supported the literature that despite a significant slight decrease in % handgrip strength in adolescents with obesity, absolute handgrip strength as an indicator of general muscle strength is preserved in adolescents with obesity compared to

peers without obesity (5,24). It could be related to higher FFM in girls and boys with obesity despite higher %FM than peers without obesity in our study. In addition, sports habits of groups with and without obesity were similar, and excess fat mass in adolescents with obesity may also reveal a positive resistant training stimulus on skeletal muscles. Castro-Pinero et al. found that children and adolescents with overweight and obesity aged 6-17 years exhibited worse performance in push- up tests than thin and normal-weight peers (28). The number of sit-ups in 30 s and the number of push-ups in 60 s of adolescents (12-15 years) were significantly decreased in adolescents with obesity and overweight compared to regular weight peers (23). In our study, lower sit-ups and modified push-ups repetition numbers in the adolescents with obesity are compatible with the literature showing that peripheral muscle endurance in the upper and lower trunk decreases in adolescents with obesity regardless of gender (23,28). On the other hand, similar repetition numbers of squats can be attributed to the frequent use of lower extremities in daily life, such as climbing stairs and walking.

The third research question was related to differences in quality of life and participation level between the adolescents with and without obesity. Self-perception, peer bullying, pain, quality of food intake, physical activity, watching tv time, education level of parents, and weight status were found to affect the quality of life in children and adolescents with obesity (29). There was a significant negative impact on sports and pain in both genders in a study in which 50 adolescents with obesity were evaluated with the PODCI scale. There was no problem in happiness/satisfaction levels because adolescents with obesity do not want to accept functional limitations secondary to obesity (30). Another trial from Turkey showed that as BMI increases, balance, PODCI-happiness/satisfaction scores, and range of motions in joints are affected negatively in children with obesity aged between 6-15 years (12). Our results have shown that adolescents with obesity have difficulty in physical activity, and sports such as climbing stairs, competition sports and they are not satisfied with their appearance or activities. Their quality of life and participation are negatively affected globally (9,22,30). Contrary to Podeszwa et al. findings (30), the satisfaction/happiness levels of our cases were found to be significantly lower than those of peers without obesity. We thought that this was due to the negative body perception emphasized by the participants with obesity in our study. At the same time, we think that the PODCI scale may not be able to evaluate the satisfaction/happiness level well enough by focusing on specific areas with four questions.

The strength of our study was the detailed examination of activity limitations of adolescents with obesity objectively based on ADL performance. The TGlittre-P test was shown to be a useful test to detect ADL limitation in adolescents with obesity compared to healthy peers for the first time. The first limitation of the study was small sample size because of early termination of the study due to COVID-19 pandemic. Despite small sample size, post-power of this study was quite strong. The second limitation was that although differences may influence the variability in performance on the functional tests between adolescents with and without obesity in maturation level, unfortunately, the pubertal stage of the subjects in the present study was not recorded as a limitation.

In conclusion, our study showed that gender affects the daily living activities performance and ADL performance of girl adolescents with obesity is poorer than girl adolescents without obesity and the perceptions of dyspnea and leg fatigue increases during ADL in adolescents with obesity. Peripheral muscle strength, endurance, power and cardiorespiratory fitness parameters of physical fitness are negatively affected and the participation of adolescents with obesity decreases due to restriction in physical function and sports, happiness/satisfaction, and their global functions in adolescents with obesity. Our study will increase the usefulness of performance-based the Glittre-ADL test adapted for children for adolescents with obesity to determine sex differences on activity limitation and guide rehabilitation professionals for focus on the physical fitness, activity and participation problems of this population in clinical practice. In addition, this study may also help health professionals, education practitioners, and families of adolescents with obesity to promoting physical activity

and exercise interventions or sports focusing on strength, endurance, aerobic fitness improvement, and decreasing activity and participation limitation in family circles and schools. Physical education teachers should periodically evaluate adolescent students with obesity by using school-based fitness tests and identify impairments in fitness parameters of adolescents with obesity besides their healthy peers. Further studies need to focus on the effectiveness of enjoyable and suitable activities or exercise interventions on these parameters and also cardiovascular risk levels in adolescents with obesity.

Sources of Support: None.

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

Ethics Approval: The study was approved by the the Ethical Committee of Hacettepe University with approval number 2019/04-04 on 05.02.2019.

Informed Consent: All adolescents and their parents signed an informed consent form.

Author Contributions: Concept-ECK, CI; Design-ECK, CI, DII; Supervision-ECK; Resources and Financial Support-ECK, CI, DII; Materials-CI; Data Collection and/or Processing-CI, HSU, JD, MPK; Analysis and/or Interpretation-ECK, HSU, CI, MS, NVY, DII; Literature Research- HSU, ECK; Writing Manuscript-CI, ECK, HSU; Critical Review-ECK, JD, MPK, DII, NVY, MS, HSU.

Acknowledgments: The authors thank Profesor Mintaze Kerem-Gunel from Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Ankara, Turkey for her permission to use Turkish version of Pediatric Outcome Data Collection Instrument (PODCI).

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