ISTANBUL UNIVERSITY-CERRAHPAŞA
INSTITUTE OF GRADUATE STUDIES

M.Sc. THESIS

Determination of The Validity of Sit-to-Stand Test in Overweight and Obese Children and Adolescents

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THESIS ACCEPTANCE AND APPROVAL

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DECLARATION

I hereby declare that this thesis is my own work, I have not had engaged in any unethical behavior at any of the stages from planning to the writing of the thesis, I have obtained all the information in this thesis within the limits of the academic and scientific ethical rules, I have cited all the information and comments being obtained in this thesis study, and I have included these references in the list of references. During the analysis and writing stages of this thesis, I accept that I have abided by the patent and copyright rights and therefore I myself take all kinds of legal responsibility.

Nesrine Benkhalifa

(Signature)

DEDICATION

I want to dedicate my thesis to my father, Abdelkarim, my mother Monia, my brothers, my niece Khadija, and everyone who had faith in me me and supported in order to make this day possible.

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THESIS TITLE

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LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviations	Description
STS:	Sit to stand
WHO:	World Health Organization
1-min STST:	One minute-Sit-to-Stand test
STST:	Sit to Stand Test
CPET:	Cardiopulmonary exercise testing
CDC:	Centers for Disease Control and Prevention
T2DM:	Type 2 diabetes mellitus
OSAS:	Obstructive sleep apnea
FDA:	Food and Drug Administration
BWL:	Behavioral weight loss
FBT:	Family-based treatment
6MWT:	6 minute walk test
6MWD:	6 minute walk distance
WC:	Waist circumference
HC:	Hip circumference
BWL:	Behavioral weight loss
FBT:	Family-based behavioral weight loss programs
30s-STST:	30 second sit to stand test
10s-STST:	10 second sit to stand test
BMI:	Body mass index
COPD:	Chronic obstructive pulmonary disease
ILD:	Interstitial lung disease
CKD:	Chronic kidney disease
CF:	Cystic fibrosis
CHF:	Chronic heart failure

GENİŞLETİLMİŞ ÖZET

YÜKSEK LİSANS TEZİ

OBEZ VE FAZLA KİLOLU ÇOCUK VE ADÖLESANLARDA BİR DAKİKA OTUR KALK TESTİNİN GEÇERLİLİĞİNİN BELİRLENMESİ

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Obezite, dünya genelinde yaygın bir halk sağlığı sorunudur. Dünya Sağlık Örgütü obeziteyi ‘‘sağlık için risk faktörü oluşturan anormal veya aşırı yağ birikimi’’ olarak tanımlamaktadır. Günümüzde her yaş grubunda olduğu gibi obezite çocuk ve adölesanlar arasında da yaygın görülür. Obeziteye neden olan en önemli faktörler yanlış beslenme ve fiziksel inaktivitedir. Bunların yanı sıra birçok çevresel ve genetik faktör de etkili olmaktadır. Şehir yaşamı, teknolojik cihazların kullanımının artması, spor alışkanlığının olmaması gibi nedenlere bağlı sedanter davranışta artış, kalorisi yüksek yiyecek ve içeceklerin tüketimi son zamanlarda çocukluk çağı obezite riskini artırmıştır. Obezitenin sınıflandırılması yetişkinlerde genellikle vücut kütle indeksine (VKİ) göre yapılır. VKİ “Ağırlık (kg)/Boy (m2) formülü ile hesaplanır. Çocuk ve adölesanlarda VKİ, aşırı kiloluk ve obezitenin belirlenmesinde standart tanı

aracıdır. Çocuklarda aynı yaş grubu içinde 100 kişi arasındaki sıralama anlamına gelen persantil değeri kullanılır. VKİ persantiline göre %85-%95 arası fazla kilolu, ≥ %95 obez olarak tanımlanır. Obezite tedavisinde temel amaç vücut ölçülerinde değişiklik yaratmak ve sağlıkla ilgili risk faktörlerini azaltmaktır. Yaşam tarzı değişiklikleri, beslenme modifikasyonları, medikal tedavi ve cerrahinin yanı sıra fiziksel aktivite ve egzersizin obezite tedavisinde yeri büyüktür. Obez bireylerin egzersiz programları belirlenmeden önce kapsamlı değerlendirilmeleri gerekmektedir. Egzersiz intoleransının belirlenmesi fonksiyonel limitasyonların tespiti için önemlidir. Egzersiz kapasitesinin değerlendirilmesinde kardiyopulmoner egzersiz testleri (KPET) ya da saha testleri kullanılır. KPET egzersiz kapasitesinin değerlendirilmesinde altın standart olarak kabul edilir. Fakat KPET yüksek maliyetli ekipmanlar ve özel uzmanlık gerektirir. Saha testlerinde sıklıkla kullanılan testler ise altı dakika yürüme testi, mekik yürüme testleri gibi zamanlı yürüme testleridir. Bu testlerde de en az 20 ya da 30 metrelik alana ihtiyaç duyulur. Altı dakika yürüme testi test öncesi ve sonrasında yapılan değerlendirmelerle birlikte yaklaşık 10 dakika, mekik testleri hastanın kapasitesine bağlı olarak daha uzun sürebilmektedir. Son zamanlarda kullanımı giderek artan fonksiyonel kapasite testlerinden biri bir dakika otur-kalk (1dkOKT) testidir. Daha pratik, kullanımı kolay, hızlı uygulanabilir, geçerli ve güvenilir, küçük alanlarda bile uygulanabilir olması gibi özellikler açısından 1dkOKT diğer testler için bir alternatiftir. Ayrıca çocukların ihtiyaçlarına ve davranışlarına uygun basit bir değerlendirme olması ve kısa sürmesi çocuklarda kullanımını kolaylaştırmaktadır. Hem klinikte hem de evde kolay uygulanabilir.

Çalışmalar, 1dkOKT'nin kronik obstrüktif akciğer hastalığı (KOAH), kistik fibroz, interstisyel akciğer hastalığı ve sağlıklı çocuk ve ergenlerde geçerli bir test olduğunu göstermiştir. Sağlıklı çocuklarda kalp hızı yanıtının ölçülmesinde geçerli ve güvenilir olduğu belirlendi. Ayrıca, kistik fibrozisli çocuk ve ergenlerde kardiyorespiratuar yanıtları ölçmenin geçerli ve güvenilir olduğu bulunmuştur. Literatürde 1dkOKT performansı ile diz ekstansör kuvveti, altı dakika yürüme mesafesi, akciğer hastalığı şiddet skorları, egzersiz kapasitesinin laboratuvar testleri ve kişinin bildirdiği fiziksel fonksiyonlar gibi parametreler arasında anlamlı korelasyonlar bulunduğu bildirilmiştir. Ayrıca 1dkOKT performansı nefes darlığı, kan laktatı ve kalp hızı gibi fizyolojik değişikliklerle de korele bulunmuştur.

Altı dakika yürüme testi (6DYT) obez çocuk ve adölesanlarda geçerliliği yapılmış, egzersiz kapasitesinin değerlendirilmesinde kullanılan bir testtir. Modifiye mekik yürüme testi de obez çocuk ve adölesanlarda egzersiz kapasitesinin değerlendirilmesinde kullanılan, vücut kütle

indeksi ile ilişkili bulunmuş bir testtir. Literatürde 1dkOKT'nin obez çocuk ve adölesanlarda kullanımının geçerliliğiyle ilgili bir çalışmaya rastlanmamıştır. Bu bilgiler doğrultusunda çalışmanın amacı, aşırı kilolu ve obez çocuk ve adölesanlarda fonksiyonel kapasitenin ve kardiyorespiratuar yanıtların ölçülmesinde 1dkOKT'nin geçerliliğinin ve güvenirliğinin belirlenmesidir.

Çalışmaya İstanbul Üniversitesi-Cerrahpaşa, Çocuk Sağlığı ve Hastalıkları Çocuk Endokrinolojisi Bilim Dalı'nda takip edilmekte olan 8-18 yaş arası toplam 39 fazla kilolu ve obez (17 erkek ve 22 kız) dahil edildi. Yaş, ağırlık, boy, VKİ gibi demografik bilgiler ile antropometrik parametreler (bel ve kalça çevresi) ve vücut kompozisyon analiz sonuçları (toplam vücut yağ, kas, yağsız kütleleri ve yüzdeleri, sağ-sol alt ekstremite ve üst ekstremite kas, yağ, yağsız kütleleri ve yüzdeleri, gövde kas, yağ, yağsız kütlesi ve yüzdesi, bazal metabolik hız, toplam vücut sıvı ve mineral oranları) kaydedildi. Fonksiyonel egzersiz kapasitesinin belirlenmesinde 1dkOKT ve 6DYT kullanıldı. Her iki test öncesi ve sonrası kalp hızı, oksijen satürasyonu (SpO2), solunum frekansı, kan basıncı, Modifiye Borg Skalası'na göre nefes darlığı, yorgunluk gibi kardiyorespiratuar yanıtlar değerlendirildi. Bir dakika otur kalk testinde tekrar sayısı, 6DYT'de toplam yürüme mesafesi kaydedildi. Geçerlik testi için 1dkOKT her hastanın ilk testinden bir saat sonra tekrar edildi. Verilerin analizi için SPSS versiyon 25.0 (SPSS Inc., Chicago, IL, USA) programı kullanıldı. Tanımlayıcı istatistikler ortalama±standart sapma ve frekans/yüzde olarak verildi. Normal dağılıma uygunluk Shapiro-Wilk testi ile analiz edildi. Güvenirlik testi için ICC korelasyon analizi yapıldı. Cronbach alpha katsayısı $0,00 \leq \alpha < 0,25$ güvenilir değil, $0,25 \leq \alpha < 0,50$ güvenirliği düşük, $0,50 \leq \alpha < 0,75$ orta güvenilirlikte, $0,75 \leq \alpha < 1,00$ güvenirliği yüksek olarak kabul edildi. Geçerlik testi için Spearman korelasyon analizi yapıldı. Korelasyon katsayısı değerleri için 0-0,25 ilişki yok ya da çok zayıf ilişki, 0,25- 0,50 orta güçte ilişki, 0,50- 0,75 güçlü ilişki ve 0,75- 1,00 çok güçlü ilişki olarak kabul edildi. Kalp hızı, oksijen saturasyonu, solunum frekansı, sistolik ve diastolik kan basıncı, nefes darlığı, yorgunluk, bacak yorgunluğu ve genel yorgunluk parametrelerinin 1dkOKT ve 6DYT test öncesi ve sonrası farkları hesaplandı, iki test arasındaki fark değerleri Mann Whitney-U testi ile karşılaştırıldı. Tüm analizler için istatistiksel anlamlılık $p<0,05$ olarak kabul edildi.

Katılımcıların 21'i çocuk (8-12 yaş) ve 18'i adölesandı (13-17 yaş). Kız katılımcıların (n=22) yaş ortalaması 11,95±2,08 yıl, boy ortalaması 154,90±10,73 cm ve ağırlık ortalaması 71,54±16,72 kg idi. Erkek katılımcıların yaş ortalaması 12,82±2,58 yıl, boy ortalaması

164,33±16,64 cm ve ağırlık ortalaması 87,70±33,44 kg idi. Güvenirlik analizinde 1dkOKT'nin yüksek güvenilir olduğu bulundu (α = 0,94, ICC=0,90, p<0,001). Geçerlik analizinde 1dkOKT tekrar sayısı ile 6 dakikalık yürüme mesafesi arasında anlamlı bir ilişki bulunamasa da (r= -0,06, p>0,05) iki testin kalp hızı, oksijen saturasyonu, solunum frekansı, sistolik ve diastolik kan basıncı, nefes darlığı, bacak yorgunluğu, genel yorgunluk parametrelerindeki değişimler benzerdi (p>0,05). Ayrıca kardiyorespiratuar yanıtların güvenilirliği sonuçlarında kalp hızı (α=0,55, ICC=0,38, p<0,007) düşük güvenilir, solunum frekansı (α=0,69, ICC=0,53, p<0,001) orta güvenilir, dispne (α=0,57, ICC=0,40, p<0,005) düşük güvenilir bulundu. Cinsiyetler arası test sonuçlarına bakıldığında 1dkOKT tekrar sayısı ve kardiyorespiratuar yanıtlar, 6DYT kardiyorespiratuar yanıtları benzerdi (p>0,05). Altı dakika yürüme mesafesi erkeklerde daha yüksekti (p=0,03). Yaş gruplarına göre bakıldığında 1dkOKT'de tekrar sayısı ve kardiyorespiratuar yanıtlar arasında, altı dakika yürüme testinde ise dispne değişimi hariç (p=0,01) diğer kardiyorespiratuar yanıtlar arasında fark yoktu (p>0,05).

1dkOKT tekrar sayısı ile boy (r=-0,41, p<0,001), ağırlık (r=-0,44, p<0,001), VKİ (r= -0,33, p= 0,03), bel çevresi (r=-0,44, p<0,001), kalça çevresi (r=-0,39, p=0,01), toplam vücut yağı kütlesi (r=-0,46, p= 0,03), bacak kas kütlesi (sağ, r=-0,34, p= 0,03; sol, r=-0,36, p= 0,03), kol kas kütlesi (sağ, r=-0,36, p=0,02; sol, r=-0,35, p =0,02), bacak yağ kütlesi (sağ, r=-0,47, p=0,02; sol, r =-0,48, p= 0,02), kol yağ kütlesi (sağ, r=-0,47, p= 0,02; sol, r=-0,47, p=0,02), bacak yağ oranı (sağ, r=-0,33, p=0,04; sol, r=-0,31, p=0,04), gövde yağ oranı (r=-0,42, p<0,001), bacak yağsız kütlesi (sağ, r =-0,35, p=0,02; sol, r=-0,33, p=0,03), ve kol yağsız kütlesi ile (sağ, r=-0,37, p=0,02; sol, r=- 0,34, p=0,02) arasında orta derecede negatif bir korelasyon vardı. Ayrıca, 1dkOKT tekrar sayısı, toplam sıvı oranı (r=0,40, p=0,01) ve toplam mineral oranı (r=0,34, p=0,03) ile pozitif orta düzeyde korelasyona sahipti. Altı dakika yürüme mesafesi ise sadece yağ oranı ile orta derecede negatif korelasyona sahipti (sağ, r=-0,33, p=0,03; sol, r=-0,32, p=0,04). Diğer antropometrik parametreler ile altı dakika yürüme mesafesi arasında korelasyon bulunamadı (p>0,05).

Fazla kilolu ve obez çocuk ve adölesanlarda 1dkOKT'nin ve teste kardiyorespiratuar yanıtların geçerlik ve güvenirliğinin ilk kez araştırıldığı çalışmamızda 1dkOKT güvenilir bulundu. Ayrıca 1dkOKT'nin kardiyorespiratuar yanıtlarında (kalp hızı, solunum frekansı, yorgunluk) kısa süreli test-tekrar testinde güvenilir olduğu gösterildi. Geçerliğin değerlendirilmesi için 6DYT kullanıldı ve 1dkOKT tekrar sayısı ile altı dakika yürüme

mesafesi arasında istatistiksel olarak anlamlı bir ilişki bulunamadı. Benzer şekilde, test öncesi ve sonrası değerlendirilen kalp hızı, oksijen saturasyonu, solunum frekansı, kan basıncı, dispne, yorgunluk, bacak yorgunluğu ölçüm sonuçlarının farkları 1dkOKT ile 6DYT arasında ilişkili değildi. Bir dkOKT'nin fonksiyonel kapasiteyi ve kardiyorespiratuar sonuçları değerlendirmede geçerli olmadığı görüldü. Bununla birlikte 1dkOKT ve 6DYT'ye kardiyorespiratuar yanıtlar karşılaştırıldığında iki test arasında sonuçlar benzerdi.

Fazla kilolu ve obez çocuklarda 1dkOKT, fonksiyonel kapasitenin değerlendirilmesinde 6DYT'ye alternatif olarak kullanılamasa da kardiyorespiratuar cevapların ölçülmesinde bir alternatiftir. Uygulaması kolay, pratik, az ekipman ihtiyacı olan bir test olduğu için klinikte ve araştırmalarda tercih edilebilir. Altı dakika yürüme testinin aksine VKİ ile 1dkOKT arasında anlamlı ilişki olması fazla kilolu ve obez çocuklarda fonksiyonel kapasitenin değerlendirilmesinde daha belirleyici bir test olabilir. Fazla kilolu ve obez çocukların fonksiyonel egzersiz kapasiteleri sağlıklı yaşıtlarının referans değerleri ile karşılaştırılığında daha düşük bulunmuştur.

Bir dkOKT'nin sağlıklı çocuklar, kistik fibrozisli hastalar, koroner arter hastaları, insterstisyel akciğer hastalığı olan kişiler ve kronik kalp yetmezliği hastalarında geçerli olduğu bildirlmiştir. Ancak çalışmamız, 6 DYT ile kıyaslandığında 1 dkOKT'nin fazla kilolu ve obez çocuklarda fonksiyonel kapasitenin belirlenmesinde geçerli bir değerlendirme yöntemi olmadığını göstermiştir. Bununla birlikte 6 DYT'de koridor gereksinimi, daha uzun zaman alması gibi dezavantajları ortadan kaldıran 1dkOKT testi, fazla kilolu ve obez çocuk ve adölesanlarda 6DYT ile benzer kardiyoprespiratuar yanıtlara sahipti. Bu açıdan bakıldığında kardiyorespitauar yanıtların değerlendirilmesinde daha pratik, küçük alanda bile uygulanabilir, kolaylıkla anlaşılabilir olan 1dkOKT fazla kilolu ve obez çocukların fonksiyonel egzersiz kapasitenin değerlendirilmesinde daha avantajlı bir tercih olabilir. Her iki test sonucunda da fazla kilolu ve obez çocukların sağlıklı yaşıtlarının referans değerlerine göre daha düşük kapasiteye sahip olduğu sonucuna ulaşılmıştır. Fazla kilolu ve obez çocuk ve adölesanların rutin takibinde fonksiyonel egzersiz kapasitesinin değerlendirilmesi ve egzersiz kapasitesinin artırılmasına yönelik egzersiz programlarının oluşturulması oldukça önem taşımaktadır. İleri çalışmalar fazla kilolu- obez çocuk ve adölesanlarda fonksiyonel test seçiminin daha doğru yapılabilmesi açısından, kas kuvveti, denge gibi fiziksel uygunluk parametrelerinin 1dkOKT gibi testlerin performansına olası etkilerine odaklanmalıdır.

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Anahtar kelimeler: fazla kilolu, çocuk obezitesi, adölesan obezitesi, geçerlilik, güvenilirlik, fonksiyonel kapasite, kardiyorespiratuar yanıtları.

ABSTRACT

M.Sc. THESIS

Determination of the Validity of One Minute Sit-to-Stand Test in Obese and Overweight Children and Adolescents

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Nesrine,B.(2023). Determination of The Validity of Sit to Stand Test in Overweight and Obese Children and Adolescents. Istanbul University-Cerrahpasa, Institute of Graduate Studies, Physiotherapy and Rehabilitation. Master Thesis. Istanbul.

The primary aim of this study is to determine the validity and reliability of the 1-min STST to measure functional capacity and cardiorespiratory responses in children and adolescents with overweight obesity, aged between 8 and 18 years old. A total of 39 overweight and obese children and adolescents (22 girls and 17 boys) were included in the study. Clinical and demographic characteristics of the patients were recorded. In the assessment, the 1-min STST was performed, and the number of completed repetitions, cardiorespiratory responses suchas heart rate, oxygen saturation (SpO2), respiratory rate, blood pressure, dyspnea, and fatigue according to the Modified Borg Scale were evaluated before and after the test. In determining the validity of the test, the 6MWT was selected as a reference test, and the walked distance was used to test the validity. As a result, the 1-min STS test was found to be highly reliable (α = 0,94). Intraclass Correlation Coefficient (ICC) was found to be (0,90) with the 95% confidence interval (0,90-0,97). In determining the validity of the test, the 6MWT was

selected as a reference test. No significant relationship was found between the repetition number of the 1-min STST and the 6MWD (r= -0,06; p>0,05). In addition, the reliability of 1-min STST for the measurement of cardio-respiratory responses was weak to strong, with a Cronbach alpha value of 0,55-0,69 and an ICC of 0,38–0,53, except in Δ SpO2, ΔSBP, ΔDBP no correlation was found between the two tests (p>0,05). In addition, no significant difference in the tests' results was found when comparing changes in the variables of heart rate, respiratory rate, oxygen saturation, dyspnea, blood pressure, leg fatigue, and total fatigue (p>0,05).

There was no significant difference between girls and boys (girls 28,05±4,34, boys 26,12 ±6,90) (p>0,005), but adolescents group performed relatively less well on average during 1-min STST (28,48 ±4,32 vs. 25,72 ±6,64) compared with children. The sit-to-stand number of repetitions was negatively related to body height, weight, and BMI. In conclusion, 1-min STST was found to be invalid in measuring functional capacity and cardiorespiratory responses (except in ΔRR, r=0,43; p=0,006) when compared with 6MWT. However, 1-min STST has a high short-term test-retest reliability in measuring functional capacity (α:0,94, ICC: 0,90) and weak to strong reliability in measuring cardiorespiratory responses (in HR, RR, dyspnea, and fatigue) (α:0,55-0,69, ICC:0,38-0,53). As well, it has similar cardiorespiratory responses as the 6MWT in children and adolescents with overweight and obesity. It is very important to evaluate functional exercise capacity in children and adolescents with overweight and obesity to establish exercise programs. Future studies are needed to identify physical fitness parameters such as muscle strength and balance which may affect the performance tests such as 1-min STST in overweight and obese children and adolescents.

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Keywords: overweight, childhood obesity, adolescent obesity, validity, reliability, functional capacity, cardiorespiratory responses

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1. INTRODUCTION

Overweight and obesity in children and adolescents have now become a serious public health concern on a global scale [1]. The World Health Organization (WHO) represents obesity as "abnormal or high deposits of fat that can be a risk factor for health" [2]. After smoking, obesity is the second most common cause of avoidable mortality. Nowadays, it is common among children and adolescents, as in all age groups [3, 4]. This global problem affects many low- and middle-income countries. In 2020, there were 39 million under-fives who were overweight or obese [2]. Obesity has become more common globaly [5]. If present patterns continue, the global population of overweight and obese young infants and children would reach 70 million by 2025 [6]. According to WHO, approximately 155 million children who are in school worldwide are obese or overweight. In addition, the prevalence has fastly increased in the last two to three decades [7]. Moreover, 16% of overweight youth aged 6 to 19 years old [8]. The rising frequency of childhood obesity leads to the increase of comorbid diseases associated to obesity which may negatively affect almost any organ system, often leading to serious consequences such as, dyslipidemia, insulin resistance, hypertension, and other diseases and complications [9-14]. At the same time, it threatens the health of those affected, also places a heavy burden on the healthcare system [15]. Moreover, childhood obesity is related to cardiovascular, musculoskeletal and respiratory systems morbidities. Any disorders of these systems can also affect functional exercise capacity. Consequently, children with obesity have reduced functional exercise abilities than their non-obese children [16, 17]. The purpose of obesity treatment is to reduce body size and health-related risk factors [18]. Besides lifestyle changes, dietary modifications, medical and surgical treatments, physical activities and exercises take an important place in the treatment of obesity [19]. To plan individual exercise programs and activities, exercise intolerance should be determined in order to define functional limits [20]. Cycle ergometers and treadmills are frequently used to measure exercise capacity, although they are expensive and difficult for exercising. There are field tests that do not need such equipment; the most popular ones are timed walk and step tests. The 6-min walk test (6MWT) is one of Timed walk tests, it should be performed on a lengthy corridor, and it's not always possible [21]. One of the functional capacity assessment tests, which has been increasingly used recently, is the one-minute sit to stand test (1-min

STST). It is another equivalent option to other tests in terms of features such as being more practical, simple to use, quick to apply, reliable, valid, and practical even in very small places [22, 23]. Studies have revealed that 1-min STST has showed its validity in children and adults with cystic fibrosis (CF), chronic obstructive pulmonary disease (COPD), interstitial lung disease, and healthy pediatric populations [23-27]. The 1min-STST was also determined to be valid and reliable in assessing measure heart rate (HR) outcome in healthy children [28]. Likewise, Children with cystic fibrosis were also evaluated for the validity and reliability of the assessment of the cardiorespiratory responses such as heart rate (HR), respiratory rate (RR), and pulsed oxygen saturation (SpO_2) [29]. However, no study has been found in the literature regarding the reliability and validity of the 1-min STST in children and adolescents with overweight and obesity. This study aims to determine the validity and reliability of the 1-min STST to measure functional capacity and cardiorespiratory responses in overweight and obese pediatric population.

The hypotheses of our study:

The first hypothese :

H0: (1-min STST) is not a valid and reliable test as functional exercise capacity test in overweight and obese pediatric population.

H1: (1-min STST) is a valid and reliable test as functional exercise capacity test in overweight and obese pediatric population.

The second hypothese:

H0: (1-min STST) is not valid and reliable to measure cardiorespiratory responses in overweight and obese pediatric population.

H1: (1-min STST) is valid and reliable to measure cardiorespiratory responses in overweight and obese pediatric population.

2. CONCEPTUAL FRAMEWORK

2.1. Definition and Classification of Childhood Obesity

Obesity is represented by WHO as "a high fat tissue in the body, which might affect emotional, physical, mental, and social health or raise the risk of condition and death" [30]. The obesity's incidence is typically calculated by dividing people into groups depending on their body mass index (BMI), which was first described by Quetelet in 1869, and is considered a generally established and inexpensive method for evaluating body composition in children and adults [31]. Internationally, obesity is frequently assessed using three categorization methods:

1. BMI cut offs for adult obesity (30 kg/m2) and overweight (25 kg/m2) have been raised in conformity with the standards of the International Obesity Task Force (IOTF).

2. The Centers for Disease Control and Prevention (CDC) method identifies obesity as a BMI > the 95th percentile, and overweight as a BMI > the 85th percentile of the reference population.

3. The WHO defines overweight as a BMI over than 1 standard deviation (SD) above the mean standard population of WHO, and obesity as a BMI above than 2 SD above the mean [32].

The IOTF has developed a global norm growth chart that allows for international comparisons of prevalence [33]. However, Several nations have maintained regional growth charts. The specific CDC Growth Charts related to gender are utilized to estimate (BMI) in pediatric population aged between 2 to 20 years old in the United States [34]. Because central obesity is an established indication of cardiovascular risk factors, "the waist-to-height ratio (WHtR)" is a better tool than BMI in determining central obesity. When it comes to predicting metabolic diseases including T2DM, hypertension, Mets, and dyslipidemia in adults and children , WHtR outperforms BMI and waist circumference (WC)[35-39].

2.2. Epidemiology of Childhood Obesity

2.2.1. Epidemiology of Childhood in the World

The last decades, the worldwide prevalence of pediatric obesity has rised [40]. In 2016, around 340 million of overweight of obese youth were aged between 5 to 19 years old. Weight gain has been observed in both gender, with 18% of girls and 19% of boys being overweight [2]. There is a discrepancy in the prevalence of youth obesity between countries, according to data from the various nations examined in 2018. For instance, compared to the least poor areas, childhood obesity is more common in the most devoid districts of England and Germany. Growing socioeconomic gaps in Sweden are important contributors to the nation's growth rates of obesity and overweight since less educated groups tend to consume unhealthy foods and exercise less. Even nations with low obesity rates, like France, which has an obesity prevalence of 1.3% in higher class children and 5.8% in children from lower class households, nonetheless have huge socioeconomic disparities [41]. In the United States, across 2017 and 2020, the obesity's prevalence was 19.7%, impacting over 14.7 million children and adolescents , 12.7% of obese children were between (2 to 5 years old) , 20.7% (6 to 11 years old), and 22.2% (12 to 19 years old) [42]. In 2025, 206 million children and adolescents aged between 5 and 19 years old, and 254 million in 2030, are predicted to be obese [43]. Among 42 nations, China is placed number one, with over 1 million obese children anticipated in 2030, accompanied with India, and the United States [44]. Obesity in childhood and adolescence is impacted more by social and cultural factors than by biological ones. The overall frequency of childhood obesity was higher in higher socioeconomic level nations than in lower socioeconomic level countries [45]. The incidence of childhood obesity varies among nations according to socioeconomic variables. In low to intermediate-income nations, children with higher socioeconomic status are inclined to experience the effects of overweight or obesity than children with lower socioeconomic status, whereas children living in economically disadvantaged communities are more probable to suffer from these effects in high-income countries [46-48].

2.2.2. Childhood and Adolescent Obesity in Turkey

Overweight and obesity have been more prevalent in Turkey during twenty years ago, and they have appeared as a major and alarming global health problem for both adults and children [49]. Olaya et al. [50] examined the obesity among primary school students in seven European nations. Turkey was the country with the second-highest percentage of overweight

problems after Romania. According to the results of the Turkish Health Survey (2008), one-third of the population above the age of 15 is overweight, and one-seventh is obese (TUIK, 2009). In 2009, Hacettepe University, the Ministry of National Education and the Ministry of Health undertook a study to determine the prevalence of childhood obesity in the country. The prevalence of obesity was 6.5% and overweight was 14.3% between children aged 6 to 9. According to this finding, obesity associated problems can affect one of every five youngsters. (MoH, 2011)[51]. In Turkey, 20 to 25% of children aged 6 to 19 are overweight or obese [52-54]. However, it is unclear how many children live in Turkey's main cities. Because of geographical disparities in eating patterns and physical activities environments, there may be large variances in childhood obesity's rate in Turkey [55]. It has raised from 17.9% (2001) to 23.4% (2009) among girls aged 6–16 living in Istanbul [56]. In 2010, it was found that 2.2% of the Turkish school children aged between 6 and 18 (2.1% of male and 2.3% of female) were obese. While childhood obesity was very uncommon before the age of nine and after the age of 15, it peaked in prevalence for boys during puberty and shortly before pubertal development. Girls were more likely to be overweight, and it was more common when they were pubescent [57]. Looking at the statistics, the rate of overweight over the age of 15, which was 19.9% in 2014, decreased to 19.6% in 2016 (Turkish Statistical Institute (TUIK), 2018) [58]. According to Turkey Childhood Obesity Research Initiative Research-2016 data, 14.6% of 7-8 years old of children in the 2nd grade of primary school in Turkey are overweight and 9.9% are obese (15.7% and 8.5% in girls, 13.6% and 11.3% in boys). Aegean Region has the highest obesity rate in the region. This rate is lowest in Southeast Anatolia [59]. According to a study published in 2019, Ankara appears to have a 1.5 times increased prevalence of childhood overweight and obesity than national estimates. The rates were respectively 21.2% and 14.6%, with a total rate of 35.8% [60].

2.3. Etiology of Childhood and Adolescent Obesity

The most frequent reason for childhood obesity is a positive relationship between calorie intake that and calorie expenditure combined with a hereditary propensity for obesity. Most obese children do not have a single genetic or endocrine factor contributing to their weight growth [15]. Parameters like gender and age minimize the effect of such risk factors. External factors such as educational policies, father or mather job , and demography may impact on nutrition and activity habits [16]. Genetic factor is considered as an essential factor of obesity. Based on a previous research, BMI is 25–40% from genetic causes. The hereditary

component accounts for fewer than 5% of childhood obesity incidents [18]. According to the ecological model, physical activity, nutritional consumption, and sedentary behaviors are considered childhood obesity's risk factors [61]. Increased consumption of fast food and sugar-sweetened drinks is directly related to the pediatric obesity pandemic; during the previous two decades, fast food consumption has tripled, coinciding with a rise in childhood obesity incidence [62, 63]. Frequent fast food eating (two times per week) was related to an increase in BMI [64]. A prospective research found that every extra sugar beverage raised obesity's risk by 1.6 times [65]. A canadian study revealed that using electronic equipement at night causes less hours of sleep, in addition, it correlates with excess body weight, poor physical activities and worse eating habits [66]. Familial factors also play a role in influencing childhood obesity [67]. Children learn through imitating their parents', friends' dietary choices and willingness to try different foods [68]. Parents' nutrition and physical activities have both positive and negative effects on the child's attitude [30]. Families play a fundamental role in avoiding childhood obesity, and their responsibilities change as their child grows [69]. Parents should provide healthy eating environments at home, give chances for physical activity and discourage sedentary behaviors such as watching television [70]. Infant nutrition has grown in popularity as a factor in the development of overweight or obesity and other disorders later. Breastfeeding is widely mentioned as giving defense against childhood obesity [71]. When compared to children who were provided high protein, young children who were administered low protein (breast milk) have been shown to maintain normal weight gain [72]. It was shown that breastfeeding during the first year of age was negatively correlated toa gain in weight, as well as, a rise in BMI [73]. Furthermore, children from poor- and middle-income nations are more stunted and underweight, but via adequate nutrition, they can achieve a healthy weight, whereas overnutrition might result in obesity [74]. In many nations, such as those with a high median income, middle or low incomes, children living in cities are more probable to be fat compared to those living in rural regions [75] .

2.4. Physiopathology of Childhood and Adolescent Obesity

Obesity is a longterm health problem marked by an abnormal buildup of adipose tissue, which often comes on by excessive calorie intake and/or inadequate consumption of energy [76]. A genetic disorder that comprises the physiological resistance of a high level of fat mass, this can be accounted for by inflammatory signaling, fatty metabolite buildup, homeostatic circuits and brain reward, or other mechanisms that impact hypothalamic neurons. [77]. The

hypothalamus region contains the core of the control of appetite and satiety. Some of them are designed to inhibit the activities of ghrelin, pancreatic polypeptide [78], neuropeptide Y, and peptide YY [79], and their receptors. Central defense to both insulin and leptin activities have been found to be associated with the majority of obese patients [80, 81]. Environmental modulators can also lead to obesity. Circadian clock changes are related to temporal changes in food behavior and increased weight gain [82]. Stress also has a behavioral impact by encouraging overeating and the consumption of high-fat, high-calorie foods or sweet meals, which reduce physical activity and shorten sleep [78]. Numerous hormones, the majority of which are released by the gastrointestinal system, have a role in the control of hunger and energy homeostasis. Two of the most crucial hormones involved in the control of physiological processes including satiety and appetite are ghrelin and leptin [83, 84].

2.5. Health Consequences of Childhood and Adolescent Obesity

Childhood and adolescent obesity is becoming increasingly widespread and severe, boosting awareness of the wide range of co-morbid disorders and consequences that can emerge as a result of obesity. These problems might arise in both the short and long term. Certain problems that were previously assumed to be chronic issues that only occurred in adults have recently been releaved to arise in pediatric population [11].

2.5.1. Cardiovascular Consequences

There are various cardiovascular disease (CVD)'s factors like excessive blood pressure, poor lipid profile, impaired glucose tolerance, and coronary diseases. One study predicted that 70% of overweight youth aged between 5 to 17 years old had at least one probability aspect for CVD [85]. The overweight adolescents have at least one probability risk factor for CVD [86]. Cardiovascular risk increases abnormally at the 85th percentile of body weight; at this level, a reduced ratio of cholesterol to elevated density lipoproteins (HDL-C), a higher level of triglycerides, and other associated risks have been observed [87]. Obesity in childhood was found to be the most accurate indicator of coronary calcium in the future [88]. Coronary calcium can appear early in adolescents life with familial hypercholesterolemia. A high (BMI) in adolescents was found to be a crucial factor for calcified coronary lesions when high low density lipoprotein cholesterol is present [89]. Many studies have been conducted in the past to determine the relation between childhood obesity and blood pressure . There is 35.4% of overweight children aged between 5 to 16 years old had high blood pressure (BP >95th

percentile) [90]. Furthermore, hypertension was diagnosed in non-obese children (10.10%), overweight children (17.34%), and children with obesity (18.32%) [91]. The associative risk of hypertension with obesity ranges from 2.5 to 3.7 in pediatric population [92]. A high BMI is related to increased left ventricular mass index in youth with hypertension [93]. Moreover, the prevalence of Left Ventricular Hypertrophy (LVH) is 30% in children with obesity and hypertension, and 18% in normal weight children with hypertension [94]. The associated risk of mortality from ischemic heart disease was found to be 2.9 for overweight or obese adolescent boys and 3.7 for normal weight adolescent girls [86].

2.5.2. Metabolic Consequences

In obesity, many of the metabolic consequences are assiciated to insulin resistance. The most prevalent biochemical anomaly detected in obesity is hyperinsulinemia. The first phase in the development of T2DM is insulin resistance with compensatory hyperinsulinemia. The next phase is impaired early insulin production, which results in postprandial and subsequently fasting hyperglycemia, at which point clinical diabetes manifests [12, 95, 96]. Obese children and adolescents frequently have a lack of glucose tolerance, with reported prevalence rates varying from 15% to more than 20% [97-99]. Insulin resistance was identified as a prevalent cause of metabolic syndrome (MetS) or syndrome X. There are currently no general definitions for MetS in youth; however, identifying children who are at risk of acquiring MetS, is a critical task owing to the prevalence of numerous cardiovascular threats that might persist into adulthood [100]. Early phases of atherosclerosis have been also detected in children with obesity. Dysfunction of endothelial cells is a vital early step in atherosclerosis's progress [101]. Cholesterol, low-density lipoprotein (LDL) and childhood BMI have been found to predict Intima-media thickness (IMT) in young adulthood [102].

2.5.3. Pulmonary Consequences

In the pediatric population, gaining weight is related to a global decline in lung volume outcomes, which could signal deteriorated lung function, an increase in respiratory symptoms, and a decline in functional status [103]. Obstructive sleep apnea (OSAS) may occur as much as 6 times more frequently in children with obesity than in lean children [104]. OSAS prevalence increased with high BMI (40 kg/m$_2$) among adolescents who were referred for bariatric surgery. There is 33% of children with severe obesity have symptoms of obstructive sleep apnea, with 5% having severe OSA [105]. Childhood obesity is related with a 4.7-fold increased risk of sleep disorder breath (SDB) [106]. Another study found that for every 1

kg/m2 increase in BMI (over the mean), the risk of sleep disordered breathing risk raised by 12% [107]. Overweight children have also an increased risk of asthma, regardless of gender, age, socioeconomic status, ethnicity, or smoke exposure [108]. According to a previous study, obesity is related with higher asthma prevalence and morbidity in girls but not in boys, regardless of fitness. Independent of weight status, high fitness is related to lower rates of asthma complications in boys but not in girls [109].

2.5.4. The Musculoskeletal System Consequences

Overweight or obese Youth are more likely than healthy children to experience a variety of musculoskeletal issues, including more fractures, knee pain, more mobility issues, and more lower-extremity problems such as malalignment. A developmental disease known as "Blount disease", is characterized by tibial bowing. It is more likely to affect obese children with a BMI of 35 kg/m2 and obese adolescents with a BMI of 41 kg/m2 [110-112]. The prevalence of axis malpositions caused by Blount's disease in overweight adolescents is 2.5% [113]. In fact, gait pattern changement can lead to pathological (asymmetric) force application in the tibial growth plate, resulting in malformations. For this reason ,if there are abnormalities in the lower extremities with increasing axis deviations in the first years of life, this must be assessed especially in overweight and obese youth. Children who are severely obese are also more likely to develop slipped capital femoral epiphysis (SCFE) , this is referred to a femoral dislocation head from the femoral neck through the growth plate and characterized by hip/knee pain and decreased hip internal rotation.They are also at a greater risk of obtaining bilateral slipped capital femoral epiphysis [114, 115]. Approximately 80.1% of patients who were undergoing epiphyseal cap removal were obese [116, 117]. Similarly, axial misalignment of the lower extremities with genu valgum and genu recurvatum is becoming more common in overweight adolscents comprared to normal weight adolescents [110]. Musculoskeletal pain is also common in children and adolescents.These symptoms are frequently associated with growth processes. High-frequency, high-physical stress can cause repair and adaptation issues, particularly during periods of high growth. Symptoms usually decrease after a brief reduction in physical activity. So in children and adolescents, as in adults, there is a strong correlation between musculoskeletal pain and the extent of obesity [118, 119]. Obesity is exacerbated by decreased physical activity, which also has an impact on bone mineral accumulation. Increased fracture rates may be due to decreased postural stability and increased falls. Any

excess weight and strength gained after puberty is a risk factor, particularly for the hip and knee joints. And this could occur for severe gonarthrosis and coxarthrosis in adults at an ever younger age [120].

2.5.5. Psychosocial Consequences

Obese youth may have psychosocial consequences such as depression, aggression, social isolation, low self confidence, behavioral disorders, body image dissatisfaction, and impaired life's quality [121, 122]. Overweight or obesity in pediatric popluations is one of the most prevalent causes of discrimination at school when compared to their normal-weight colleagues [123]. Childhood obesity stigma, aggression, and teasing are widespread and may have serious consequences for physical, emotional state and performance that can last a lifetime [121]. In children and adolescents, there has been a strong association between obesity and body-image problems [124]. Compared to normal-weight adolescents, obese adolescents reported considerably more body dissatisfaction, depressive symptoms, social isolation and low self-confidence [125]. Studies have also revealed that gender differences are related to to depression and anxiety in obese pediatric population, obese girls were showed to be more likely to develop depression and anxiety as their weight increased [126, 127]. Another important psychosocial outcome is the quality of life. Obese children and adolescents have poorer quality of life than their normal weight peers. Obese children with OSA had the lowest quality of life among obese children and adolescents [128]. However, given their developmental concerns and the social stigma that comes with obesity, screening each obese child and adolescents for psycho-social disorders is crucial.Comorbid social and mental problems have significantly impacted children's motivation and the outcomes of treatment [129].

2.6. Treatment of Childhood and Adolescent Obesity

2.6.1. Pharmacological treatment

2.6.1.1. Pharmacotherapy

It is a given that not all children can receive medical treatment for obesity, and their treatment options are limited. Orlistat is approved for children under 12 years old, but it is rarely used due to the side effects of abdominal distress and oily diarrhea. For over 16 years, the Food and Drug Administration (FDA) has authorized phentermine for weight loss. Topiramate has long been used off-label to treat childhood obesity in children as well as to

manage seizures in children. Although the FDA has only authorized metformin for use in T2DM in children and adolescents younger than 10 years old, it is frequently utilized in these groups. However, metformin has been prescribed for insulin resistance (with or without glucose intolerance), it has been demonstrated that losing weight is weakly related to metformin use, especially in the first months of medication initiation [130, 131].

2.6.1.2. Bariatric surgery

Childhood obesity is a progressive disease, with 50-75% of children maintaining obese throughout adulthood. With few useful non-surgical treatment alternatives for some, bariatric surgery has emerged as the dominant therapy strategy for these patients in recent years [132]. Although there is no consensus on pediatric indications, it might be a last-resort treatment for adolescents with severe obesity and substantial medical issues who have failed to respond to lifestyle modifications and drugs [133, 134]. In adolescents, three techniques are available: adjustable gastric banding (AGB) (6%), sleeve gastrectomy (SG) (28%), both restrictive surgeries, and Roux en Y gastric bypass (RYGB) (66%), a mix of restrictive and malabsorptive treatment [135, 136]. Laparoscopic procedures are preferable over open surgical techniques because they cause less damage in tissue, have less complications during and after the surgery and pain, and require less hospitalization and recovery time [135]. Although the majority of pediatric surgical patients are adolescents, there have been a few reports of children who were treated at younger ages. An excellent laparoscopic SG procedure is experienced by a 2.5-year-old child with significant obesity, OSA, and leg bending [137]. A child (10 years old) with Blount's disease and a high BMI (42 kg/m^2) underwent laparoscopic SG as well [134, 138].

2.6.1.3. Behavior modification

Behavior modification is a weight management method that includes motivating people to minimize their screen duration and improve their level of exercise. It also includes psychological counseling to help with eating habits changes or exercise, as well as family counseling to help with weight reduction objectives and school-based improvements to encourage healthy food and physical activity [139]. Behavioral weight loss (BWL) programs use behavior modification strategies to modify the behaviors of energy balance and enhance the state of weight [140]. At least 26 BWL sessions showed a reduction of 0.2 in BMI z-score associated with several health benefits [141]. Moreover, BWL treatment have showed an improvements in behavioral and physiological outcomes. BWL, for example, is related to

improved cardiometabolic measures (lipids, blood pressure, glucose) in children, [141] as well as, in adults [142], as well as good diet quality [143], physical activity [144], and sleep [145]. Furthermore, BWL has psychosocial benefits such as improvements in life quality [146] and decreased depressive symptoms [147]. Family-based behavioral weight loss programs (FBT) are great behavioral weight loss programs for reducing body weight and preventing chronic diseases related to obesity [148]. FBT alternates exercise education, diet with behavior therapy techniques [149-151], and a variety of parenting strategies, such as problem solving, stimulus control, positive reinforcement, and self-monitoring etc. Furthermore, this multicomponent program has been shown to result in significant improvements such as weight reduction behaviors in children [141, 152, 153]. FBT programs that concentrate primarily on changing the home eating environment and parental supervision may be adequate to produce improvements in the rate at which children lose weight, negating the need for a full complement of skills and necessitating less staff training and expense [154].

2.6.1.4. Nutritional therapy

Reduced caloric intake through increased consumption of fruits and vegetables, as well as reduced refined fats and carbohydrates may reduce the risk of obesity and T2DM [155]. Less than three portions of fruits and vegetables / day have been consumed by children and adolescents, which is less than the 5–7 servings per day suggested by the US Department of Agriculture. Inadequate dietary fiber consumption could be a factor in uncontrollable weight gain, emphasizing the importance of increasing vegetable and whole fruit consumption [156]. Water is commonly suggested as a healthy substitute for drinks with added sugar. A study has revealed a correlation between water intake and BMI decline as a result of losing weight in primary school children and a 0.6% to 0.9% for overweight; this may be associated to a 12.3% reduction in dairy products [157]. The United States Department of Agriculture and the American Academy of Pediatrics recommend some intake habits such as reducing sugar consumption, high-fructose syrups ,prepared meals or food rich in sodium, fresh fruit, and dietary fat consumption in pediatric population above the age of 2 years old [158]. In order to prevent and cure childhood obesity, the Task Force put a high importance on limiting youth access to sugar beverages and reiterating to parents that these drinks are a major cause of pediatric obesity [154]. In order to prevent and cure childhood obesity, the Task Force put a

high importance on limiting youth access to sugar beverages and reiterating to parents that these drinks are a major cause of pediatric obesity [158].

2.6.1.5. Exercises and Physical Activities

Regular physical exercise is critical for maintaining body composition while growing. Changes in children's bodies throughout growing, on the other hand, have an impact on motor strength and performance. Consequently,exercise ought to be adjusted to the characteristics, ages, and genders of children [159]. A relation between a low level of physical activity and being overweight or obese has been found. Walking, swimming, running, jogging, and aerobics are all examples of physical exercise, as well as outdoor activities (tennis, badminton, volleyball, soccer, and cricket). Physical activity is declining, particularly among children aged 11 to 15 years old [160]. Regular physical activity was comparatively weak in Turkey; 58.4% of children (6-11 years old), 67.6% of males aged 12 years old, and 76.5% of female aged around 12 years old were not physically active frequently (30 minutes or more everyday) [161]. According to a recent research on Sweden children and adolescents, just 14% of 11-years-old girls and 23% of 11 year old boys met the daily requirement of minimum one hour of moderate-to-vigorous activities. Furthermore, the amount of time spent being physically active appears to decline with the age. Only 9-15% of 13-15 years old adolescents met the recommendation [162]. Also, screen time is high in this population: 30% of 11-years-old reported more than four hours per day of screen time, while 51% of 15-years-old reported the same[163]. In general, boys had more screen time than girls [164].

Exercise model recommended for children and adolescents

The principles of exercise prescription are designed to be used in the construction of individually personalized exercise plans [165]. The American College of Sports Medicine, known as (ACSM), developed the FITT principles “Frequency “(how frequently), “Intensity” (how much or how hard), “Time” (the period or how long), and “Type” (mode or what kind)] concept as the gold standard of exercise prescription [166]. Exercise programs according to FITT principles are recommended for children and adolescents (Table2.1, Table 2.2) [167, 168]. The intensity levels of exercise programs are described below:

- For low intensity under 20 % of (MVC) , there is no impact on strength.
- Moderate intensity, between 20–50 % of (MVC), has a rehabilitating effect.

- High intensity, between 50–70 % of (MVC) ,which improves muscular strength to an appropriate degree.

- Very high intensity, >70(MVC), it improves muscular mass to an ideal level [167].

Table 2.1. Exercise programs for obese children and adolescents using the FITT principles [167].

Compatibility recommendations in exercise treatment in obesity (FITT)
Frequency: Every day of the week (Frequent) .
Intensity: 55–90% of maximum heart rate. Time: 30–80 minutes Beginning with a gradual increase; 10 minutes of walking per day, 3-5 days per week. Continued; 60-80 minutes, almost every day of the week. Type: Aerobic, resistant

FITT: Frequency, intensity, time, and type, MVC: maximum voluntary contraction.

Table 2.2. **Recommended exercise programs by applying FITT principles for obese children and adolescents [167, 168]**

FITT	**Cardiovascular (aerobic) program**	**Interval program**	**Muscle resistance program**
Frequency	≥3/week	≥3/week	2–3/week
Intensity	Moderate-severe exercise	3–5 min. Mild-moderate Interrupting for 6–8 times 1–3 min high intensity exercise	2–3/week High (50–70% MVC)
Time	20–60 min	Total 20–60 min	2–3 min. per muscle group (8–20 repetitions) Total ≥30
Type	running, jumping, biking swimming, soccer	running, jumping swimming, biking	push-ups, climbing paddle
Program duration	8–12 weeks	6–12 weeks	6–12 weeks

FITT: Frequency, intensity, time, and type, MVC: maximum voluntary contraction.

Physical Activity Guidelines recommend at least one hour of activity per day for children and adolescents, the lowest feasible amount of exercise that has positive benefits could be lower. In obese children and adolescents, shorter exercise periods—such as 20 minutes per day, three to five days per week—can improve metabolic measures in three to six months. These lower activity levels could also help avoid obesity [169]. Weekly 155–180 minutes of moderate-to-high intensity exercise resulted in a 0.4% reduction in body fat in overweight and obese children [170]. Exercise prescriptions for overweight adolescents should account for the limited exercise tolerance imposed by extra body mass, focusing on activities that maintain demands below the lactate threshold so that the exercise can be prolonged [171]. As a result, determining exercise intolerance is essential to identifying functional limits.

2.7. Functional Capacity in Childhood and Adolescent Overweight and Obesity

Physical activity levels in youth decline with an increased incidence of overweight and obesity. Youth are trapped by a vicious circle of inactivity, positive energy balance, and obesity [172]. Children with overweight may have poor cardiorespiratory function, this might restrict functional capacity and participation in activities [173]. Cardiopulmonary exercise test (CPET) is one of the objective methods of evaluating cardiorespiratory capacity in childhood and adolescent obesity [174]. The VO2max level gives multiple essential insights about the tolerance to physical activity of the circulatory, respiratory, musculoskeletal, and neurological systems. Reduced VO2max may be an early sign of health problems related to obesity. After adopting the Godfrey protocol for CPET, obese children and adolescents exhibited comparable absolute VO2max to overweight children but substantially higher peak values than non-obese children [175-180]. Furthermore, obese children have a lower degree of cardiorespiratory efficiency and aerobic power (max O_2 under maximal work load on a treadmill or bicycle ergometer) [171]. Exercise intolerance in overweight youth is caused by the higher metabolic demands of carrying an additional load, rather than a decline in cardiorespiratory abilities. Moreover, previous study revealed that 6 MWD achieved by obese children averaged 86% of the distance normal weight children walked and that obese children had a lower functional exercise capacity and a lower dyspnea score in the postwalk assessment, which was an unexpected finding [181]. Because of decreased mass specific lower limb strength, obesity may raise the cost of bearing body weight [182]. Although obesity had no effect on upper extremity strength in these activities, it did impair the ability of children to do tasks requiring lesser limb strength and power in which the obese children had to lift their extra bodily mass against gravitation [183]. Obesity inhibited 8-9-year-old children's functional capacity when they were required to move their larger body mass against gravity to perform this basic daily task, according to recent research. In fact, 69% of children, who experienced obesity, needed the researchers’s assistance to stand up [184]. The researchers hypothesized that the obese children's difficulty rising was due to a lack of lower extremity strength to move their high body mass. The difficulty of the movement may contribute to the obesity spiral by enhancing sedentary behaviors [185].

2.8. Assessment of Functional Capacity in Childhood and Adolescent Obesity

Since the different human systems' reserves must be understood in order to give a greater recognition of the patient's functional capabilities, exercise tests have become widely accepted as a straightforward way to assess pulmonary function [186]. In the early 1970s, a simple test existed to assess a subject's functional capacity as determined by the distance performed in a specific period of time [21]. For the reason that walking is one of the most important activities of daily life, walk tests have been proposed to assess patients' health or functional capacity [186]. The 6MWT is a good functional capacity assessment for people with moderate to severe impairment [187]. The 6MWT has been selected because it is simple to administer, more tolerated, and more accurately reflects normal daily activities than other walk tests. Because of the pandemic of COVID-19, physiotherapists have recently had to strike a balance between the need to evaluate a patient as they perform a 6MWT in order to measure their response to exercise with the pandemic-related restrictions like lock-downs, the need for personal protective equipment, and physical distancing. Due to these limitations, many services have moved to telerehabilitation, which has increased the dependence on assessment tests such as the 1-min STST [188].

2.8.1. CPET

There are several approaches for completing a CPET, and aerobic exercise is measured using a variety of standard methods in children who have a higher BMI. Children and adolescents are subjected to CPET using two main methods: treadmill testing and the cycle test. Although each has benefits and drawbacks, bicycle ergometry is more beneficial for overweight children. [189]. The test is determined by considering the objective of the test and the participant's characteristics (for example, health state, age, and physical level). The gold standard of exercise for determining the capacity for aerobic exercise is the incremental exercise test for children. Furthermore, ramp incremental protocols with 1 minute stages are more effective in acquiring maximal VO_2 in a short duration and are easy to apply for cycle ergometry, which is very important for evaluating youths. Moreover, many previous studies have recommended the Godfrey cycle ergometer technique for exercise assessment in children above the age of ten [189, 190]. The Godfrey cycle ergometer has three ramp bike ergometer protocols with nonsteady states (10, 15, and 20 Watt per min) that may be used on girls and boys of various weights, heights, and ages [174].

2.8.2. The 6MWT

The 6MWT is a useful test for evaluating functional exercise capacity and for therapy efficacy in a number of respiratory-related diseases. Since the previous American Thoracic Society (ATS) declaration on the 6MWT in 2002 [21], new information has emerged on the test's performance and methods for interpretation. The 6MWT is a straightforward, safe, and inexpensive test that may be utilized in healthcare settings [191]. In addition to the 6MWD, heart rate (HR), and dyspnea, the test offers insightful data on the youth's movement pattern, the position of ankle and knee joints, posture, level of pain, and endurance. This information is crucial in clinical practice because it may influence the recommendations made for children's and adolescents' physical activity [192]. Even among youth [192, 193], the 6MWT is the most well-known and effective in determining an individual's capacity to carry out Daily Life Activities (DLAs) [194, 195]. Clinically, the test provides also important information on blood pressure and SpO2 levels [196].

2.8.3.The 1-min STST

The 1-min STST is a useful option to the above mentioned tests that a patient may complete rapidly in a small space [197]. The 1-minute STST is an established surrogate for the 6MWT, with high concordance, validity, and test-retest reliability [198]. The 1-minute STST first described by Koufaki et al.[197] in 2002, is one such alternative because it just requires a chair, a timer, and <2 m of floor space. Children and adolescents must stand and sit on a chair without arm supports as many times as they can in one minute. The wooden chair must be adjusted to the children's heights to ensure the angle of their knee joints when sitting is roughly 90°. In addition, the height of the chair (in centimeters) from the sitting plane to the floor should be measured. During the test, participants must keep their feet parallel and their hands on their waist to avoid using their arms to assist the movement [199, 200] (Table 2.3). Exercise cardiorespiratory responses provide an indicator of exercise tolerance, which may be used to avoid negative consequences during exercise. The 6MWT is considered the standard test for determining functional capacity, Although, it takes time and cannot always be conducted. The 1-min STST may be done anywhere and has recently been proposed as a valid alternative for measuring the (HR) response during the 1-min STST in healthy children and valid for measuring cardiorespiratory outcomes in children with CF [28, 29].

Table 2.3. Recommended Procedures for Conducting the 1-min STST[22]

Component	Procedure
Seating	Use a slightly padded table or an armless chair that is stable and of standard height (45.0-48.0 cm) (preferably against a wall).
Preparation	Bring the individual being tested forward on the seating surface far enough so that their feet are flat on the floor and their calf is well forward of the seating surface. Cross arms over chest.
Practice	Ask the examined individual to complete one sit-to-stand-to-sit cycle.
Instructions	"When I say go, I want you to stand all the way up and sit down as quickly as you can." This will take one minute. You are free to rest if you need to. However, you should return as soon as possible because the goal is to complete as many sit-to-stand cycles in one minute as feasible." Encouragement is not permitted, although reminders to stand completely are permitted. When 10 seconds have passed, inform the child.
Timing and counting	Start the stopwatch on the command go. Count out loud each full stand.The score is determined by the number of complete sit-to-stand cycles accomplished in one minute. Only give credit for a complete sit-to-stand-to-sit cycle.

2.9. The validity and reliability of the 1-min STST

Finding out how well reliability and validity concerns have been addressed in a study is an important component of research critique since it influences the decision to put the study's results into practice [201].

2.9.1. The validity

Validity is the degree to which a scale can accurately measure the variable, or how effectively the tool measures what it is intended to measure. The validity level of a scale is determined by the validity coefficient . This coefficient ranges from -1.00 to +1.00. The closer the correlation coefficient is to 1 in both directions (positive or negative directions), the higher the validity of the measurement tool. The validity can be examined in the subheadings of content validity, criterion validity, construct validity and diagnostic validity [202].

“The content validity” of an instrument is determined by whether it sufficiently covers all of the content correlated to a variable. “Face validity” looks at whether an instrument measures the concept intended. In an undergraduate nursing course, “content validity” would apply to all content, with a higher focus on themes that had gotten more attention or depth [202].

“Construct validity” is the ability to draw inferences about test scores related to a concept being studied. For example, if a person has a high score on a survey measuring anxiety, they may not have a high degree of anxiety. Three sorts of evidence—“homogeneity”, “convergence”, and “theory evidence”—can be utilized to demonstrate the construct validity

of a research instrument. "Homogeneity" is when the tool evaluates a single construct, "convergence" is when the tool assesses ideas that are comparable to tools from other tools, and "theory evidence" is when behaviour is similar to theoretical propositions of the construct measured [202].

The degree to which multiple tools measure a comparable variable is known as "criterion validity", which can be determined through correlations." Criterion validity" is measured in three ways such as "convergent" , "divergent" , and "predictive validity" [202]. "Convergent validity" indicates that an instrument is well correlated to other instruments that measure comparable factors, whereas,"divergent validity" denotes a poor relationship between one instrument and other instruments used to measure distinct variables. "Predictive validity" requires that the instrument show good correlations with future criteria [202].

2.9.2. Reliability

When a measurement is reliable, participants should provide the same answers each time the test is administered. Internal consistency, item-to-total correlation, and homogeneity are the three characteristics of reliability. "Split-half" reliability involves splitting test data in half and identifying correlations between the halves. The split-half test has a more complex variant known as the Kuder-Richardson coefficient. With this method, a correlation is produced by computing the average of all conceivable "split half combinations" of 0–1, however, it can only be used for questions with two responses [203]. The most popular test to evaluate an instrument's internal consistency is Cronbach's alpha, which determines the average of all correlations in each combination of "split-halves". The range of Cronbach's alpha is 0 to 1. A reliability score of 0.7 or above appears to be sufficient [203, 204]. When evaluating stability of a test that repeated more than once, "test-retest" and "parallel" or "alternate-form reliability" testing are utilized. Furthermore, Similar to test-retest reliability, parallel form of reliability differs in that participants are given an updated version of the same instrument in subsequent testing [202]. A correlation of less than 0.30 is weak, 0.30-0.50 is moderate and greater than 0.50 is strong [205]. Inter-rater reliability is a test used to determine the equivalency of two or more observers [201].

2.9.3. The validity and reliability of the 1-min STST

Test validity was examined in several studies. Significant correlations were found between 1-minute STS performance and other measures included leg press [25, 206] and knee extension

[200, 207, 208] strength, 6MWT distance [25, 200, 208], lung condition severity scores [209, 210], laboratory tests of exercise capacity [211], and personal physical function [211] . The correlation of validity was also strong for physiologic changes associated with 1-minute STS performance, such as increased dyspnea [200, 208] , blood lactate [212], and heart rate [213]. Several investigations have confirmed the 1-minute STST validity in known groups. The 1-minute STS repeats have been reported to be greater for men than for women [199, 206, 210] for healthy controls than for COPD patients [200, 214] and for COPD patients who survived than for COPD patients who did not survive for 2 years after testing [210]. Studies also have showed that1-minute STST is a valid in Interstitial Lung Disease [26], in patients with coronary artery disease [215], chronic heart failure (CHF) [216], and in patients with pulmonary hypertension (PH) [217]. It was also determined to be valid and reliable to measure (HR) response in healthy children [28], and valid for the assessment of the cardiorespiratory responses (HR, RR, and SpO_2) in children with CF [29]. The 1-min STST appears to be reliable in terms of test-retest reliability [197, 206, 211, 212]. In accordance with studies, the ICC of 1-min STST is 0.90-0.98 in chronic patients [26, 211, 215, 218, 219], healthy children [28] and in children and adolescents with CF[29]. Although, no study has been found adressing the validity of its use in overweight and obese children and adolescents. The purpose of our study is to determine the validity and reliability of the 1-minute STST in measuring functional capacity and cardiorespiratory responses in overweight and obese children and adolescents.

3. METHOD

3.1. Study Design

It was an observational study, conducted in accordance to Helsinki Declaration and approved by institutional and ethical review board of Istanbul University- Cerrahpasa (Protocol No.: E-74555795-050.01.04-381025). This study has been registered at www.clinicaltrials.gov (identifier: NCT05392920).

3.2. Study Setting

The study was conducted at Istanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Department of Child Health and Endocrinology Diseases with Istanbul University-Cerrahpaşa, Faculty of Health Sciences, Division of Physiotherapy and Rehabilitation collaboration. Obese and overweight children and adolescents aged 8-18 years who were followed up were included. All the participants included in the study were informed about the purpose, outcome measures, duration of the study, the risks and benefits. Written Informed consent was obtained from all participants and their parents (Figure 3.1).

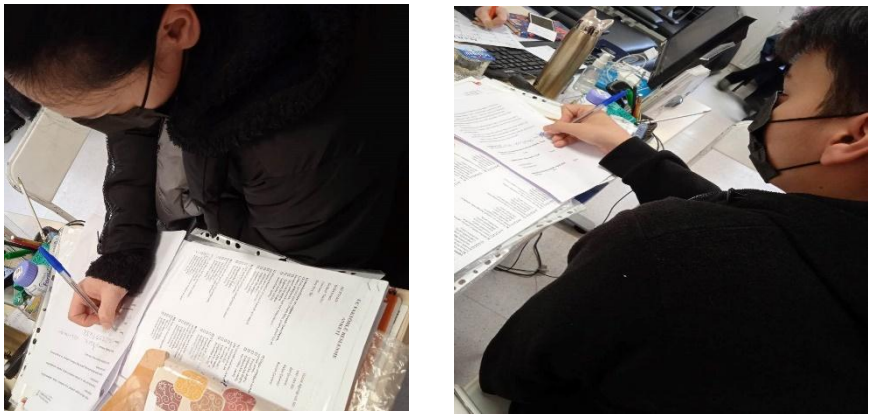

Figure 3.1.Consent form

3.3. Participants and eligibility criteria

A total of 39 overweight and obese children and adolescents aged 8-18 years were included in the study (Figure 3.2).

Inclusion criteria:

1) Being between the ages of 8 and 18 years old.
2) Children and adolescents should be overweight (BMI percentile between 85 and 95th) or obese (95th percentile or greater).
3) Avoiding vigorous physical activity two hours before the test.

Exclusion criteria

1) A recent hospitalization for a condition that might make it difficult to perform the test.
2) Being unable to do exercise tests due to a neurological or musculoskeletal condition.
3) Medical conditions that are uncontrollable (like lung or cardiovascular illness).
4) Dysfunction of the vestibular system or the eyes.

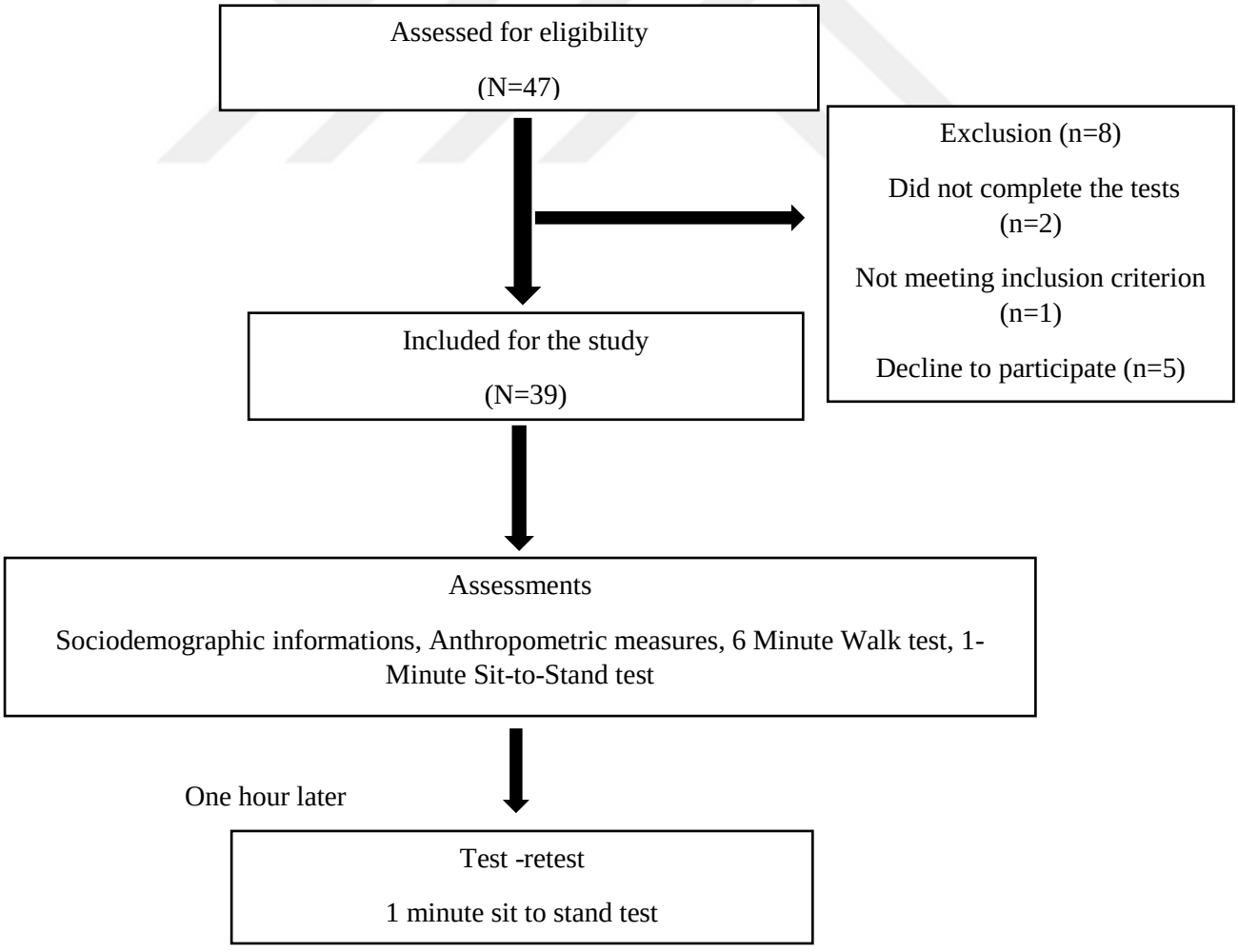

Figure 3.2.Consort flow chart of the study

3.4. The population and the sample size of the study

Children and adolescents who met the inclusion and exclusion criteria and, who were followed up at Istanbul University-Cerrahpaşa Hospital, were included in the studyThe minimal sample size was 33 when using a power of 90% and an alpha of 0.05, with an intraclass correlation coefficient (ICC) of 0.85 being the predicted reliability and an ICC of 0.65 being the least acceptable reliability. As a result, 39 people were selected as the sample size, with a dropout option included [220].

3.5. Outcomes

3.5.1. Demographic information

Gender, age, height, weight, BMI, antropometric parameteres, educational status, medical history of the participant, and family's medical history were recorded.

3.5.2. Anthropometric parameters

Waist and hip circumference were measured separately.The waist circumference was measured using a tape measure from the middle point between the lowest rib and the iliac crest in a standing position. From the alignment of the greater trochanter, Hip circumference was measured with the tape measure parallel to the floor. The WHtR was calculated as waist circumference (cm) / height (cm).

3.5.3. Body composition analysis

First, participants took off their shoes, socks, and heavy clothing. Bioelectrical impedance analysis (BIA) (Tanita MC-780 S/ST) was used to the body composition analysis. The body composition analysis parameters included as below (figure 3.3):

- ✓ Body Weight
- ✓ Lean Body Mass /Rate
- ✓ Segmental lean Body Mass /Rate measurement of legs, arms and trunk
- ✓ Total body Fat Mass /Rate
- ✓ Segmental body fat measurement of legs, amrs and trunk
- ✓ Total body Muscle Mass /Rate
- ✓ Segmental muscle Mass /Rate measurement of legs, arms and trunk
- ✓ Total body fluid (Litre) and percentage (%)
- ✓ Total Minerals (kg) and percentage (%)

- ✓ Basal Metabolic Rate.

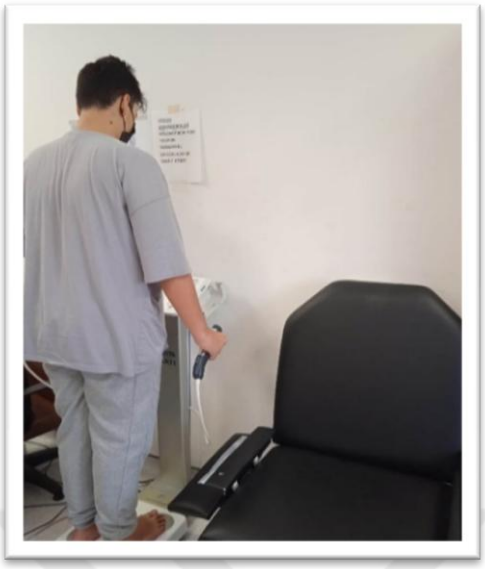

Figure 3.3. Body composition analysis

3.6. The 6 MWT

Children and teenagers carried out the 6MWT in a 23-meter hallway. Without running or jogging, participants were instructed to walk as many lengths as they could in six minutes. To clarify the instructions, they were also told to walk as rapidly as they could. The participants were informed of details during the test by being told how many minutes had passed or remained. Additionally, using brightly colored tape, the starting and finishing lines that defined the beginning and end points were traced on the floor. Blood pressure, HR, dyspnea and fatigue detection were recorded before and after the test. Blood pressure was measured using an Arm Digital sphygmand omanometer (ar+Imed), heart rate and SpO_2 were measured with a portable pulse oximeter (F04W). Children were asked to rate their level of dyspnea and fatigue the perception with Borg scale. At the end of the test, the walking distance performed in 6 minutes as recorded in meters (Figure 3.7.1 and 3.7.2). 6MWD reference equation is based on the multivariable model, age, height, BMI, waist circumference (WC), and hip circumference (HC) measures which were distincly predictive of the 6MWD in children with obesity of both genders [221]. It was developed by Makni Emna, et al. [221] and used in our study :

“Equation for the total sample 6MWD, $(24.99 \times \text{age}) + (264.85 \times \text{height}) - (2.52 \times \text{BMI}) - (3.31 \times \text{HC}) + 338.52$”.

“Equation for Girls 6MWD: (23.81 × age) + (241.86 × height) − (4.62 × HC) + 351.38”.

“Equation for Boys 6MWD: (23.94 × age) + (245.29 × height) − (3.25 × BMI) − (3.64 × WC) + 306.29 [221]”.

Figure 3.4 .Performing 6 minute walk test and measuring cardiorespiratory responses

3.7. The 1-min STST

Firstly, children seated with no contact against the back of the chair. The chair was adjusted to the children's particular heights such that the angle of their knee joints was roughly 90° when sitting. In addition, a defined height chair, i.e. 45 cm was measured from the sitting plane to the floor. To prevent utilizing their arms to assist the movement, participants should keep the feet parallel and the hands on their waists. When seated, they were instructed to fully stand up, straighten their knees, and contact the chair with their buttocks. The participants were instructed to complete as many STS repetitions as possible within 1 minute without arm rests. During the test, they were not motivated by the physiotherapist and the number of sit to stand completed after 1-min was recorded for the interpretation. For the evaluation of reliability, children and adolescents performed the 1-minute STST twice, with a break of 1 hour between trials [24] (Figure 3.6 and 3.7).


Figure 3.5. The 1-min STST

3.8. Statistical Analysis

Statistical analysis of the data SPSS version 25.0 (SPSS Inc., Chicago, IL, USA) program was used. Descriptive statistics were given as mean±standard deviation and frequency/percentage. Shapiro Wilk test was used to determine the distribution of data and the data was not normally distributed. Nonparametric tests were used in the analysis since the data did not conform to the normal distribution. For the validity analysis of the test, the correlation between the results of 1-min STS and 6MWT was examined. Depending on the distribution of the data, it was confirmed by Spearman's correlation coefficient. In order to determine the validity of 1min-STS and 6MWT, Spearman correlation analysis was used to determine the relationship between the Change in the variable (∆) of cardiorespiratory responses of the two tests. Correlation analysis was used to evaluate the concurrent validity of the HR response, SpO_2, RR, SBP, and DBP with the same responses during the 6MWT. Correlation coefficients were assessed using the following criteria: There is no or a very weak relationship (0- 0.25),a weak- medium relationship (0.25- 0.50), a good relationship (0.50- 0.75), and a very good relationship (0.75- 1.00)[222]. For the reliability analysis of the tests, "Cronbach alpha coefficient" was used. The results were evaluated at 95% confidence intervals and significance at $P< 0.05$ level. Cronbach alpha coefficient was evaluated using the following criteria: 0–0.25, no correlation or very weak correlation; 0.25–0.50, weak to moderate correlation; 0.50–0.75, strong correlation; and 0.75–1.00, very strong correlation [222].

4. RESULTS

The study was conducted at Istanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Department of Child Health and Endocrinology Diseases. Overweight and obese children and adolescents aged 8-18 years, who were followed up, were included. The overall number of participants was 41, however two patients were eliminated because they failed to complete the 6MWT. As a result, there were 39 participants, 17 of them were boys and 22 girls; 21 were children (8-12 years), and 18 were adolescents (13-17 years). The patients have completed the tests. For the girls, participants the mean age was 11,95±2,08 years, the mean height was 154,90±10,73 cm, and the mean weight was 71,54±16,72 kg. For the boys, the mean age was 12,82±2,58 years, the mean height was 164,33±16,64 cm, and the mean weight was 87,70±33,44 kg. Descriptive characteristics of the population and the characteristics are shown in table 4.1. and 4.2.

Table 4.1. Demographic and Anthropometric parameters of Overweight and Obese Children and Adolescents

Variables	**Mean±SD/n (%)**
Demographic characteristics	
Age (years)	12,33±2,32
Gender Male Female	 17(43,6%) 22(56,4%)
Weight (kg)	78,58±26,29
Height (cm)	159,01±14,24
BMI (kg/m^2)	30,34±6,38
BMI Z-score	2,95±1,24
Percentile (%)	97,47±4,06
Anthropometric parameters and Body composition	
Waist circumference (cm)	96,92 ±16,32
Hip circumference (cm)	108,56±13,89
WHtR	0,60±0,08
TBLM(kg)	46,74±13,63
TBLR(%)	60,90±9,42
TBFM(kg)	30,80±16,05
TBFR(%)	38,02±7,98
TMM (kg)	45,32±12,95
RLMM (kg)	8,44±2,88
LLMM (kg)	8,22±2,85
RAMM (kg)	2,16±0,88
LAMM (kg)	2,23±0,83
TRMM (kg)	24,23±6,28

RLFM (kg)	6,17±3,27
RLFR(%)	40,04±8,43
LLFM(kg)	6,24±3,44
LLF R(%)	40,83±8,90
RAFM(kg)	1,87±1,00
RAFR(%)	43,89±8,88
LAFM(kg)	2,31±1,32
LAFR(%)	47,73±10,19
TFM(kg)	15,06±9,03
TFR(%)	34,46±8,66
RLLM(kg)	8,93±3,06
LLLM(kg)	8,69±3,02
RALM(kg)	2,28±0,94
LALM(kg)	2,36±0,89
TLM(kg)	25,46±6,50
TBM(kg)	2,48±0,70
TBMR(%)	3,23±0,42
TBF(L)	34,92±10,08
TBFR (%)	45,27±5,64
(BMR)(kcal)	1,77±0,38

Abbreviations cm:centimeter; kg:kilogram; WHtR: waist circumference-to-height ratio; TBFM:total body fat mass; TBFR:total body fat rate; TBLM:total body lean mass; TBLMR:total body lean rate; TMM:total muscle mass; RLMM: right leg muscle mass; LLMM :left leg muscle mass; RAMM :right arm muscle mass; LAMM: left arm muscle mass; TRMM: trunk muscle mass; RLFM:right leg fat mass; ; RLFR:right leg fat rate; LLFM:left leg fat mass; LLFR:left leg fat rate; RAFM:right arm fat mass; RAFR:right arm fat rate; LAFM: left arm fat mass; LAFR: left arm fat rate; TFM/R: trunk fat mass; TFR: trunk fat rate; RLLM:right leg lean mass; LLLM: left leg lean mass; RALM: right arm lean mass; LALM: left arm lean mass; TLM:trunk lean mass; TBM: total body mineral; TBMR: total body mineral rate; TBF: total body fluid, TBFR:total body fluid rate; BMR: basal metabolic rate.

4.1. Demographic informations, Antropometric measures and Body composition parameters

Age, height, body weight, BMI, anthropometric parameters, and body composition were compared between girls and boys. In terms of gender, there were statistical differences in height, waist circumference, TFBR, RLMM, LLMM, RAMM, LAMM, RLFR, LLFR, RAFR, LAFR, RLLM, LLLM, RALM, LALM, TBMR(%), BMR, TBFR(%) (for all $p< 0.05$). Between age groups, there were statistically differences in age, weight, height, BMI, waist circumference, hip circumference, TBLM, TBFM, TMM, RLMM, LLMM, RAMM, LAMM, TRMM, TFM, RLLM, LLLM, RALM, LALM, TLM, TBM, BMR, TBF (for all $p<0,05$), (Table 4.2).

Table 4.2. The difference between Demographic informations, Anthropometric measures and Body composition parameters according to gender and age group

	Gender Mean±SD			**Age group Mean±SD**		
	Girls (n=22)	Boys (n=17)	p	8-12 years (n=21)	13-17 years (n=18)	p
Age (years)	11,95±2,08	12,82±2,58	0,21	10,62±1,46	14,33±1,28	**<0,001***
Weight (kg)	71,54±16,72	87,70±33,44	0,08	66,35±19,46	92,85±26,45	**0,001***
Height (cm)	154,90±10,73	164,33±16,64	**0,04***	151,10±11,21	168,25±11,74	**<0,001***
BMI (kg/m^2)	29,37±4,44	31,58±8,24	0,67	28,59±6,27	32,37±6,06	**0,03***
BMI Z-score	3,11±1,59	2,75±0,48	0,97	2,73±0,84	3,21±1,57	0,24
Percentile	98,58±2,14	96,02±5,40	0,26	97,09±4,19	97,91±3,97	0,70
waist circumference(cm)	94,14±10,62	104,41±19,48	**0,02***	92,10±14,15	102,56±17,26	**0,04***
Hip circumference(cm)	106,32±11,76	111,47±16,16	0,24	101,57±11,99	116,72±11,46	**<0,001***
WHtR	0,58±0,05	0,63±0,09	0,14	0,60±0,08	0,60±0,08	0,95
TBLM (kg)	42,95±9,20	51,64±16,88	0,19	40,07±9,32	54,52±13,93	**0,002***
TBLR (%)	60,51±3,84	61,42±13,82	0,15	61,76±8,20	59,90±10,83	0,93
TBFM (kg)	28,51±8,20	33,77±22,53	0,73	26,29±12,49	36,07±18,39	**0,02***
TBFR(%)	39,48±3,83	36,12±11,19	**0,04***	38,23±8,20	37,77±7,94	0,69
TMM (kg)	40,77±8,75	51,20±15,25	0,06	38,01±8,87	53,84±11,81	**<0,001***
RLMM (kg)	7,16±1,74	10,11±3,25	**0,006***	7,10±2,28	10,02±2,76	**0,002***
LLMM (kg)	6,94±1,68	9,89±3,23	**0,006***	6,86±2,21	9,82±2,73	**0,001***
RAMM (kg)	1,81±0,44	2,62±1,09	**0,02***	1,71±0,49	2,70±0,94	**<0,001***
LAMM(kg)	1,91±0,47	2,64±1,02	**0,03***	1,80±0,52	2,73±0,87	**<0,001***
TRMM (kg)	22,94±4,49	25,91±7,87	0,35	20,52±4,54	28,56±5,21	**<0,001***
RLFM(kg)	5,82±1,68	6,63±4,61	0,74	5,73±3,07	6,69±3,50	0,21
RLFR(%)	43,23±3,75	35,92±10,87	**0,01***	42,04±7,43	37,71±9,11	0,15
LLFM(kg)	5,85±1,78	6,74±4,84	0,70	5,78±3,18	6,77±3,74	0,19
LLFR(%)	44,06±4,44	36,64±11,36	**0,01***	42,92±7,78	38,38±9,70	0,14
RAFM(kg)	1,73±0,51	2,04±1,40	0,76	1,66±0,93	2,11±1,05	0,09
RAFR(%)	47,39±4,02	39,37±11,30	**0,005***	46,27±8,14	41,12±9,13	0,13
LAFM(kg)	2,19±0,69	2,48±1,87	0,48	2,13±1,30	2,53±1,35	0,16
LAFR(%)	51,79±4,48	42,48±12,97	**0,01***	50,37±9,30	44,66±10,56	0,17
TFM(kg)	13,45±4,79	17,14±12,46	0,56	11,52±5,49	19,18±10,64	**0,004***
TFR(%)	34,38±4,12	34,58±12,48	0,82	32,86±8,64	36,33±8,54	0,10
RLLM(kg)	7,58±1,86	10,67±3,46	**0,007***	7,50±2,42	10,60±2,92	**0,001***
LLLM(kg)	7,35±1,79	10,43±3,43	**0,007***	7,24±2,34	10,38±2,88	**0,001***
RALM(kg)	1,89±0,47	2,78±1,15	**0,02***	1,80±0,53	2,85±1,01	**<0,001***
LALM(kg)	2,00±0,50	2,82±1,09	**0,02***	1,90±0,55	2,90±0,93	**<0,001***
TLM(kg)	24,11±4,65	27,20±8,14	0,32	21,62±4,72	29,93±5,38	**<0,001***
TBM(kg)	2,23±0,47	2,80±0,83	0,06	2,08±0,48	2,94±0,64	**<0,001***
TBMR (%)	3,14±0,20	3,35±0,59	**0,03***	3,21±0,42	3,26±0,43	0,62
BMR (kcal)	1,59±0,23	2,00±0,42	**0,005***	1,57±0,26	2,00±0,39	**0,001***
TBF (L)	31,25±6,58	39,67±11,93	0,05	29,33±6,83	41,45±9,42	**<0,001***
TBFR (%)	44,05±2,93	46,85±7,71	**0,03***	45,20±6,00	45,35±5,35	0,88

Abbreviations cm:centimeter; kg:kilogram; WHtR: waist circumference-to-height ratio; TBFM:total body fat mass; TBFR:total body fat rate; TBLM:total body lean mass; TBLMR:total body lean rate; TMM:total muscle mass; RLMM: right leg muscle mass; LLMM :left leg muscle mass; RAMM :right arm muscle mass; LAMM: left arm muscle mass; TRMM: trunk muscle mass; RLFM:right leg fat mass; ; RLFR:right leg fat rate; LLFM:left leg fat mass; LLFR:left leg fat rate; RAFM:right arm fat mass; RAFR:right arm fat rate; LAFM: left arm fat mass; LAFR: left arm fat rate; TFM/R: trunk fat mass; TFR: trunk fat rate; RLLM:right leg lean mass; LLLM: left leg lean mass; RALM: right arm lean mass; LALM: left arm lean mass; TLM:trunk lean mass; TBM: total body mineral; TBMR: total body mineral rate; TBF: total body fluid, TBFR:total body fluid rate; BMR: basal metabolic rate.

4.2. Determination of the Validity of the 1-min STST

The correlation between the 6MWD, the primary outcome measure of the 6MWT, which is known to be valid and reliable in the evaluation of functional exercise capacity in obese children and adolescents, and the completed 1min-STS repeated number were examined in the examination of the validity of the 1-min STST. There was no statistically significant correlation found between the two tests (r=-0,06, p=0,71). The validity of 1-min STST in measuring cardiorespiratory responses was examined between 1-min STST and 6MWT using Spearman Correlation Analysis. There was no statistically significant correlation found between the two tests except in RR (r=0,43 p=0,006). (Table 4.3). During the 1-min STST and the 6MWT, the Change in the variable (Δ) of the cardiorespiratory responses were also compared. There were no significant differences in the change of variables (p<0,05). (Table 4.4).

Table 4.3. Validity of cardiorespiratory responses measured during the 1min-STST and the 6MWT

	6 MWT	**1-min STST1**	**R**	**p**
ΔHR	31,98±17,83	39,77±22,45	0,22	0,162
ΔSpO2	0,11±1,27	0,09±1,86	0,07	0,642
ΔRR	24,62±17,31	27,50±17,34	0,43	**0,006***
ΔSBP (mm Hg)	0,52±8,51	1,27±7,08	0,18	0,245
ΔDBP(mm Hg)	2,86±15,18	4,78±11,88	0,16	0,315
ΔDyspnea	1,71±1,18	1,79±1,02	-0,07	0,64
ΔLeg fatigue	1,50±1,33	1,85±1,01	0,13	0,42
ΔTotal fatigue	0,72±1,41	0,74±1,14	0,07	0,67

Abbreviations Bpm: beats per minute; Cpm: cycles per minute; Δ:change in the variable during testing, HR:heart rate;Bpm: beats per minute; RR: respiratory rate ; Cpm:cycles per minute; SBP:systolic blood pressure; DBP:diastolic blood pressure;mmHg:millimeters of mercury; 1-min STST1: 1 minute sit-to-stand test; 6MWT: 6-minute walk test.

Table 4.4. Comparison of pre- and post-test changes in cardiorespiratory responses between the 1-min STST and the 6MWT

	6 MWT	**1-min STST**	**p**
Δ HR (beats/min)	27,03±13,57	32,69±17,37	0,06
Δ SpO2 (%)	0,10±1,25	0,08±1,81	0,94
Δ RR (Cpm)	4,41±3,15	4,87±3,03	0,31
Δ SBP(mm Hg)	0,28±10,41	1,54±8,74	0,54
Δ DBP(mm Hg)	1,28 ±10,55	3,33±8,37	0,42
Δ Dyspnea (Modified Borg Scale)	1,71±1,18	1,79±1,02	0,59
Δ Leg fatigue	1,50±1,33	1,85±1,01	0,15
Δ Total fatigue	0,71±1,41	0,74±1,14	0,96

Abbreviations 1-min STST:1 min sit-to-stand test; 6MWT;6-min walk test; Δ:change in the variable during testing, HR:heart rate;Bpm: beats per minute; RR: respiratory rate ; Cpm:cycles per minute; SBP:systolic blood pressure; DBP:diastolic blood pressure; mmHg:millimeters of mercury.

4.3. The Reliability of the 1-min STST

The mean repetitions number of the first 1-min STST was 27,21±5,61, and the mean repetitions number of the second test was 28,51±5,62. There was a significant difference between the repetitions number of the two tests (p=0,01). The median number of 1-min STS repetitions (first test) ranged from 25,72 ± 6,64 in 13–17-years old to 28,48± 4,32 in 8–12-years old . The mean number of 1-min STS repetitions was higher in girls than boys: first test (girls: 28,05 ±4,34, boys: 26,12 ±6,90), second test (girls:29,82 ±4,12, boys:26,82 ±6,88) without any significant difference (p>0,05). Test- retest reliability and internal consistency showed a high reliability for the Cronbach alpha value (α= 0,94). Intraclass Correlation Coefficient was 0,90 compared with the 95% confidence interval (0,90-0,97) (Table 4.5). The reliability of the 1-min STST for the measurement of cardio-respiratory responses was moderate to strong, with a Cronbach alpha value of 0,55-0,69 and an ICC of 0,38–0,38, except in ΔSpO2, ΔSBP, ΔDBP where there was no correlation between the two tests (p>0,05). (Table 4.6).

Table 4.5. The Reliability of 1-min STST

		Test	Mean ±SD	A	ICC	95% CI	p
1-minSTST (number of repetitions)	All	FT	27,21±5,61	0,94	0,90	0,90-0,97	**<0,001***
		ST	28,51±5,62				
	Boys	FT	26,12±6,90	0,96	0,92	0,89-0,98	**<0,001***
		ST	26,82±6,88				
	Girls	FT	28,05±4,34	0,91	0,84	0,80-0,96	**<0,001***
		ST	29,82±4,12				

Abbreviations: SD: standart deviation; FT: first test, ST: second test α: Cronbach α ; ICC: Intraclass correlation coefficient; CI: confidence interval.

Table 4.6.The reliability of cardio-respiratory responses measured during the 1-min STST

	1min-STST1 (Mean ±SD)	1min-STST2 (Mean ±SD)	α	ICC	95% CI	p
ΔHR	32,69±17,37	32,77±16,67	0,55	0,38	0,15-0,76	**0,007***
ΔSpO_2	0,08±1,81	-0,10±1,55	0,31	0,18	-0,30-0,64	0,123
ΔRR	4,87±3,03	5,41±3,37	0,69	0,53	0,41-0,84	**<0,001***
ΔSBP	1,54±8,74	5,38±12,53	0,19	0,10	-0,53-0,57	0,255
ΔDBP	3,33±8,37	2,56±9,09	0,37	0,22	-0,19-0,67	0,077
ΔDyspnea (ModifiedBorg Scale)	1,79±1,02	1,80±1,08	0,57	0,40	0,18-0,77	**0,005***
Δ Leg Fatigue	1,85±1,01	1,85±1,13	0,66	0,50	0,36-0,82	**<0,001***
Δ Total Fatigue	0,74±1,14	0,92±1,40	0,66	0,50	0,36-0,82	**<0,001***

Abbreviations 1-min STST ; SD:standart deviation; ; Δ:change in the variable during testing, HR:heart rate;Bpm: beats per minute; RR: respiratory rate ; Cpm:cycles per minute; SBP:systolic blood pressure; DBP:diastolic blood pressure;mm Hg:millimeters of mercury; α: Cronbach α; ICC: Intraclass correlation coefficient; CI: confidence interval.

4.4. The results of the 1-min STST and the 6 MWT according to gender and age group

The mean number of the 1-min STST repetitions in girls was 28,05±4,34 and in boys was 26,12 ±6,90; with no statistically significant differences between gender or age group identified (p > 0,05). The mean 6MWD in girls was 448,62±62 meter and in boys was 501,10±74,99 meter, there was statistically significant difference in the 6MWT found between girls and boys (p = 0,03); the mean 6MWD in the 8-12 age group was 454,32±78,15 and for the 13-17 age group, it was 491,67±60,44; but no significant differences between age groups were found (p>0,05), (Δ) Borg dyspnea between age groups was also significantly different (1,26±0,88 vs. 2,22±1,29, p= 0,01), (Table 4.7).

Table 4.7.The results of the 1-min STST and the 6MWT according to gender and age group

Test		Gender			Age group		
		Girls (Mean±SD) N=22	**Boys (Mean±SD) N=17**	**P**	**8-12 (Mean±SD) N=21**	**13-17 (Mean±SD) N=18**	**p**
6MWT	6MWD (m)	448,72±62,29	501,10±74,99	**0,03***	454,32±78,15	491,67±60,44	0,07
	6MWD (%)	66,97±8,74	76,47±15,51	**0,04***	73,47±16,08	68,35±7,25	0,41
	ΔHR (beats/min)	29,27±12,27	24,12±14,95	0,15	23,38±11,07	31,28±15,22	0,05
	Δ SpO2 (%)	0,23±1,15	-0,06±1,39	0,73	0,00±1,37	0,22±1,11	0,79
	ΔRR(Cpm)	4,18±3,31	4,71±2,99	0,55	3,62±2,65	5,33±3,49	0,15
	Δ (SBP) (mm Hg)	0,05±11,59	0,59±8,99	0,97	0,05±9,54	0,56±11,61	0,83
	Δ (DBP) (mm Hg)	1,36±12,45	1,18±7,81	0,72	0,95±9,43	1;67±12,00	0,54
	ΔBorg dyspnea	1,16±0,99	1,74±1,60	0,80	1,26±0,88	2,22±1,29	**0,01***
	Δ Leg fatigue	1,15±0,99	1,94±1,60	0,13	1,71±1,26	1,25±1,41	0,17
	ΔTotal Fatigue	0,64±1,52	0,82±1,28	0,59	0,81±1,20	0,61±1,65	0,33
1-min STST	The number of repetitions	28,05±4,34	26,12 ±6,90	0,37	28,48±4,32	25,72±6,64	0,18
	ΔHR (beats/min)	32,68±18,33	32,71±16,60	0,94	31,90±18,06	33,61±17,00	0,70
	Δ SpO2 (%)	0,09±1,99	0,06±1,60	0,81	-0,10±1,92	0,28±1,70	0,50
	Δ RR(Cpm)	4,82±3,00	4,94±3,17	0,91	4,95±3,38	4,78±2,66	0,87
	Δ (SBP) (mm Hg)	0,45±7,22	2,94±10,46	0,13	-0,48±8,64	3,89±8,49	0,19
	Δ (DBP) (mm Hg)	1,82±7,32	5,29±9,43	0,08	1,90±8,13	5,00±8,57	0,20
	Δ Borg dyspnea	1,77±1,14	1,82±0,88	0,97	1,76±0,99	1,83±1,08	0,74
	ΔLeg fatigue	1,77±0,86	1,94±1,19	0,56	2,05±0,97	1,61±1,03	0,24
	ΔTotal Fatigue	0,95±1,29	0,47±0,87	0,13	0,71±1,27	0,78±1,00	0,86

Abbreviations beats per minute; Cpm:cycles per minute; HR:heart rate; SpO2:pulsed oxygen saturation; ΔHR: the change of the heart rate variable during the test; ΔRR: the change of the respiratory rate variable during the test; SBP:systolic blood pressure; DBP:diastolic blood pressure; ΔSBP: the change **o**f the systolic blood pressure variable during the test ; ΔDBP: the change of the diastolic blood pressure variable during the test ; 1-min STST: 1 minute sit-to-stand test; 6MWT: 6-minute walk test.

4.5. The correlation between 1-min STST and 6 MWT with body composition parameters

The number of the 1-min STS repetitions had only a moderate negative correlation with height (r= -0,41, p<0,001), weight (r= -0,44, p<0,001), BMI (r= -0,33, p= 0,03), waist circumference (r=-0,44,p<0,001), hip circumference (r=-0,39, p=0,01), total body fat mass

(r=- 0,46, p= 0,03), leg muscle mass (right, r=- 0,34, p= 0,03; left, r=- 0,36, p= 0,03), arm muscle mass (right, r= -0,36, p=0,02; left, r=- 0,35, p =0,02), leg fat mass (right, r=-0,47, p=0,02; left, r =-0,48, p= 0,02), arm fat mass (right, r=- 0,47, p= 0,02; left, r=- 0,47, p=0,02), leg fat rate (right, r=-0,33, p=0,04; left, r =-0,31, p=0,04), trunk fat rate (r=- 0,42, p<0,001), leg lean mass (right, r =-0,35, p=0,02; left, r=-0,33, p= 0,03), arm lean mass (right, r=-0,37, p=0,02; left, r=-0,34, p=0,02), and a positive moderate correlation with total fluid rate (r=0,40, p=0,01) and total minerals rate (r=0,34, p=0,03). The 6MWD had only a moderate negative correlation with arm fat rate (right, r=-0,33, p=0,03; left, r=-0,32, p=0,04). No correlation was found with the other parameters (p>0,05) (Table 4.8)

Table 4.8. The correlation between 1-min STST and 6 MWT with body composition parameters

		1min-STST (repeatition number)	6MWT (6MWD) (m)
Height (cm)	R	-0,41	0,09
	P	**<0,001***	0,56
Weight (kg)	R	-0,44	-0,05
	P	**<0,001***	0,72
BMI (kg/ $m^{2)}$	R	-0,33	-0,18
	P	**0,03***	0,24
BMI Z-score	R	0,04	-0,01
	P	0,78	0,93
Waist circumference(cm)	R	-0,44	0,01
	P	**<0,001***	0,95
Hip circumference(cm)	R	-0,39	-0,10
	P	**0,01***	0,53
WHtr	R	-0,27	-0,01
	P	0,09	0,99
TLBM(kg)	R	-0,27	-0,04
	P	0,08	0,77
TBLR (%)	R	0,41	0,19
	P	0,09	0,24
TBFM(kg)	R	-0,46	-0,20
	P	**0,03***	0,21
TBFR(%)	R	-0,39	-0,28
	P	**0,01***	0,08
TMM(kg)	R	-0,31	0,03
	P	0,05	0,85
RLMM (kg)	R	-0,34	0,09
	P	**0,03***	0,57
LLMM (kg)	R	-0,33	0,07
	P	**0,03***	0,64
RAMM(kg)	R	-0,36	0,04
	P	**0,02***	0,76
LAMM (kg)	R	-0,35	0,04
	P	**0,02***	0,76
TRMM (kg)	R	-0,22	0,07
	P	0,17	0,96
RLFM(kg)	R	-0,47	-0,22
	P	**0,02**	0,16
LLFM(kg)	R	-0,48	-0,22
	P	**0,02***	0,16
RAFM (kg)	R	-0,47	-0,23
	P	**0,02***	0,14
LAFM(kg)	R	-0,47	-0,25
	P	**0,02***	0,12
TFM(kg)	R	-0,43	-0,17
	P	0,06	0,28
RLFR(%)	R	-0,33	-0,28
	P	**0,04***	0,08
LLFR(%)	R	-0,31	-0,30
	P	**0,04***	0,06

RAFR(%)	R	-0,22	-0,33
	P	0,17	**0,03***
LAFR(%)	R	-0,29	-0,32
	P	0,07	**0,04***
TFR(%)	R	-0,42	-0,16
	P	**<0,001***	0,31
RLLM(kg)	R	-0,35	0,09
	P	**0,02***	0,58
LLLM(kg)	R	-0,33	0,07
	P	**0,03***	0,67
RALM(kg)	R	-0,37	0,05
	P	**0,02***	0,72
LALM(kg)	R	-0,34	0,05
	P	**0,02***	0,72
TLM(kg)	R	-0,22	0,01
	P	0,17	0,92
TBF (L)	R	-0,30	0,03
	P	0,05	0,84
TBFR (%)	R	0,40	0,27
	P	**0,01***	0,09
TBM(KG)	R	-0,30	0,03
	P	0,05	0,84
TBMR (%)	R	0,34	0,27
	P	**0,03***	0,09
BMR(kcal)	R	-0,30	0,03
	P	0,05	0,84

Abbreviations cm:centimeter; kg:kilogram; WHtR: waist circumference-to-height ratio; TBFM:total body fat mass; TBFR: total body fat rate; TBLM:total body lean mass; TBLR: total body lean rate; TMM:total muscle mass; RLMM: right leg muscle mass; LLMM :left leg muscle mass; RAMM :right arm muscle mass; LAMM: left arm muscle mass; TRMM: trunk muscle mass; RLFM:right leg fat mass; RLFR: right leg fat rate; LLFM:left leg fat mass; LLFR: left leg fat rate; RAFM:right arm fat mass; RAFR: right arm fat rate; LAFM: left arm fat mass; LAFR: left arm fat rate; TFM/R: trunk fat mass; TFR: trunk fat rate; RLLM:right leg lean mass; LLLM: left leg lean mass; RALM: right arm lean mass; LALM: left arm lean mass; TLM:trunk lean mass; TBM: total body mineral; TBMR: total body mineral rate; TBF: total body fluid, TBFR:total body fluid rate; BMR: basal metabolic rate.

5. DISCUSSION

As far as we know, in this study, the validity, reliability and cardiorespiratory responses of the 1-min STST are examined for the first time in overweight and obese children. Based on our findings, the 1-min STST was found to be reliable. To determine the validity of the test, the 6 MWT was selected as a reference test. The repetition number of the 1-min STST and the 6MWD were not correlated. One min-STST was found to be invalid also in measuring cardiorespiratory responses when compared with the 6 MWT. However, it showed a weak to strong short-term test-retest reliability in (HR, RR, dyspnea, fatigue) and had similar cardiorespiratory responses as the 6MWT.

The reliability of the 1-min STST was verified at a 1-hour interval. In the validity and reliability study by Reychler et al.[28], in healthy children, the patients did the second test at a 1-week interval. We shortened the interval to 1 hour, similar to children and adolescents with CF's study [24] to prevent a change in the participants' physical health, in addition to the change in body composition and physical fitness, since the overweight and obese children and adolescents participated in different treatment strategies targeting physical activity and diet . The 1-min STST showed excellent test–retest reliability (α:0,94, ICC: 0,90). The test and re-test 1-min STST were conducted according to the same protocols and under the same conditions, and we followed the prescribed methods and standard guidelines. In addition, the time interval was sufficient to rest between the two tests. Some studies showed that the test-retest reliability of the 1-min STST was high in individuals with chronic conditions (0,90-0,98) [26, 211, 215, 216, 218, 219]. Similarly, some other studies found that the 1-min STST exhibited a moderate to very good reliability for the measurement of cardiorespiratory responses in children and adolescents with CF (ICC>0,50) [29], and great reliability with short-term test-retest in healthy children (ICC= 0,90) [28]. For instance, an excellent test-retest reliability was observed in patients with coronary artery disease (ICC = 0,96) [215], in individuals with COPD (ICC = 0,90) [218], in adults with cystic fibrosis (ICC = 0,98) [211], in patients with ILD (ICC=0,93) [26], and in patients with CHF (ICC=0,93) [216]. The excellent reliability of the 1-min STST across a variety of population and health conditions may be explained by its ability to be performed in accordance with the same procedures in the same setting and by conforming to the established standard instructions.

In the present study, the reliability of the 1-min STST in measuring cardiorespiratory responses was weak to strong, in such a way that the Cronbach alpha value was between 0,55 and 0,69, and the ICC value was between 0,38 and 0,53. However, our study did not found any correlation between the 1-min STS tests in the ΔSpO2, ΔSBP, ΔDBP parameters. Similarly to our findings, Combret et al.[29] found the reliability of the 1-min STST for measuring cardiorespiratory responses during exercise moderate to very strong (ICC>0,50) in children and adolescents with CF.

The 6MWT is the valid reference field test in terms of measuring functional exercise capacity in children [192]. Additional field tests are being developed to address the practical disadvantages of the 6MWT such as a long corridor etc..[21, 223]. The 1-min STST is an alternative to other functional exercise tests in terms of features as it is more practical, easy to use, fast to apply, reliable, valid, and applicable even in small areas [22, 23]. It has been also validated to measure HR response in healthy children [28] and cardiorespiratory responses in children and adolescents with cystic fibrosis [24, 29]. The 1min-STST showed a strong correlation (r=0,59-0,82) with 6MWT in different populations with chronic diseases [26, 216-218, 224, 225]. We did not find any correlation between 1-min STS repetitions and 6MWD (p>0,05). Similarly, no correlation was reported between the 1-min STST and the 6MWT in adults with cystic fibrosis [27] and in healthy children [28]. In contrast, in children and adolescents with CF, the number of repetitions of the 1-min STST was moderately related to 6MWD (r =0,48) [24, 29]. The 1-minute STST cannot be applied as an equivalent to the 6MWT in our sample size. Both adults and children frequently change from sitting to standing during the day as it is essential for everyday tasks. The 1-min STST's inability to predict the length of a 6-minute walk can be attributed to functional differences between the tests as well as variances in the amount of energy used during a 6-minute walk as opposed to a 1-min STST [24]. As well as, Spence et al.[226] noted that 6MWT and 1-min STST functional exercise ability are two separate significant daily life functions, walking and sit-to-stand. As a result, studies emphasized that these two tests are not completely comparable in patients with COPD [226]. In our study, we found that the 1-min STST and the 6MWT in terms of cardiorespiratory responses were similar, which also demonstrated the comparability of cardiorespiratory demands. Kronberger et al.[217] found that the cardiorespiratory responses (SpO_2, blood pressure, and dyspnea) between the 6MWT and the 1-min STST were similar in patients with PH. This suggests that the demands of the physical stress levels associated with the two exercise tests are equivalent [217]. Tanriverdi et al.[216] that the

physiological responses such as heart rate, blood pressure and the change in dyspnea during the 1-min STST were comparable to those during the 6MWT in patients with CHF. However, contrary to our findings, some studies found that the cardiovascular demand was higher during the 6MWT than during the 1-min STST [200, 227]. Nevertheless, the sample size in those studies was different, and they were evaluated by a completely different research group. As a result, according to our findings, the 1-min STST could be a great alternate test for the 6MWT for assessing cardiorespiratory responses.

In our study, the mean repetitions number of the 1-min STST was 27,21±5,61. A previous study reported that the mean number repetitions number was (50,3± 13,3) in healthy children (6-12 years) [228]. Another study revealed that the mean number of repetitions of the 1-min STST was 40±10 in children and adolescents with CF [24]. When comparing children with bronchiectasis to healthy children, the mean number of repetition of 30s-STST was (21,65 ±5,28 vs. 26,55 ±3,56) [229]. The average percentage of the 1-min STST of the 8-12 years age group in our study was poor compared to reference values (respectively 37,31±5,75% vs. 77,67 ±2,03%). The average percentage of 13-17-years group was 35,34±8,35%, while the mean reference of sit-to-stand repetitions was 75,06±3,22% in healthy adolescents [23]. In the present study, the sit-to-stand number of repetitions was negatively related to body height, weight, and BMI. On the other hand, Gurses et al.[230] found that body height, weight, and BMI are not related to 10s, 30s, or 1-min STST performance in healthy young people. This discrepancy might be accounted for by the fact that the increase in BMI negatively effects trunk and lower extremity strength, body power, and the capacity to control postural stability in obese people [231]. Individuals' functional abilities on STS activity may be significantly impaired as a result of these functional problems. The 1-min STS performance may be effected by other factors such as the time of day, the footwear chosen, motivation, and attitudes toward physical exercise. Reduced physical strength and the associated functional limitations in youth have been related to obesity [232]. This could help to explain why overweight and obese children and adolescents, who were undertaken in our study, performed fewer 1-min STS tests on average than children and adolescents who were healthy or even those with chronic conditions.

In our study, the mean number of 1-min STST repetitions in girls and boys was similar (girls 28,05±4,34, boys 26,12 ±6,90), but adolescents performed less well on average during 1-min STST (28,48 ±4,32 vs. 25,72 ±6,64) compared with children, however, this result did not

reach statistical difference. It was thought that higher body height or greater leg length could be related to weaker performance in adolescents [164]. Haile et al.[23] found that the median number of repetitions in healthy children (5-16 years) ranged from 55 (boys) and 53 (girls) in 14-16-year-olds to 61 (boys) and 64 (girls) in 8-10-years-old. There were no significant variations in the distribution of the number of repeats between the two genders. However, the median number of repeats was lowest in the 14-16 year age group (females 53, males 55). Reychler et al.[228] observed a gender effect related to number of repetitions in healthy children (6–12 -year-olds). In addition, a significant difference between gender was observed before and after puberty [228]. This discrepancy may be due to the different physical activity level, living country and social environment etc.

Our sample size walked less distance (471,56 ±72,14m) than was expected in this study. Morinder et al. [181] showed that obese children and adolescents walked (571 m) shorter than children of normal weight (663 m). The passion and attitude on physical exercise might also be the cause of the lower distance of our overweight obese group. We interpret this as the overweight and obese children not working out as hard during the test as the lean children, as well as the probably higher metabolic cost of walking in obese children and overweight and adolescents compared to children and adolescents with normal body weight. In addition, a difference in the 6MWD was found between girls and boys in our study. This conclusion was not surprising given that the 6MWT was impacted by gender in children [233].

Contrary to the 1 min-STST, BMI was not related to the 6MWT. Similarly, previous studies didn't find any correlation between BMI and 6MWD neither in healthy children (aged 7 to 11 years) [234], nor in healthy and overweight children (aged 5 to 9 years) [235]. However, it was showed that children who are overweight had a lower 6MWD than their normal weight peers [181]. The higher body mass of overweight individuals necessitates more energy, which might restrict the distance reached [236, 237].

In our study, the number of 1min-STST repetitions had a moderately negative correlation with leg muscle mass, leg fat mass, leg fat rate and leg lean mass. We interpreted this as upper and lower limb muscle strength may potentially affect the 1-min STST performance. This implies that other factors, such as postural balance and quadriceps endurance, which may be impaired in overweight and obese children and adolescents, are probably responsible for STST performance. Further studies are also necessary to identify the factors explaining the STST performance in this population.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, the validity, reliability and the cardiorespiratory responses of the 1-min STST are examined for the first time in overweight and obese children. One min-STST was found to be invalid in measuring functional capacity and cardiorespiratory responses (except in ΔRR, r=0,43; p=0,006) when compared with 6MWT. However, 1-min STST has a high short-term test-retest reliability in measuring functional capacity (α:0,94, ICC: 0,90) and weak to strong reliability in measuring cardiorespiratory responses (in HR, RR, dyspnea, and fatigue) (α:0,55-0,69, ICC:0.38-0,53). Also, it has similar cardiorespiratory responses as the 6MWT in obese and overweight children and adolescents.

- Instead of the 6MWT, we cannot use the 1-min STST in measuring functional capacity in overweight and obese pediatric population.
- The 1-min STST is reliable and has similar cardiorespiratory outcomes as the 6MWT. Therefore, it seems to be a good alternative test for measuring the cardiorespiratory responses in overweight and obese pediatric population.
- The 1-min STST may be a useful functional exercise test for features such as it is more practical, easy to use, reliable, and applicable even in small areas.
- The average percentage of the 1-min STST of the children and adolescents in our study was poor compared to reference values.
- The repetition number of the 1-min STST was negatively related to body height, weight, and BMI in overweight and obese pediatric population.
- In contrast to the 6MWD, repetition number of the 1-min STST was related to BMI. For this reason, the 1-min STST might be more reflective than the 6MWT and may reveal the effects of BMI in measuring functional capacity in obese pediatric population.

- Overweight and obese youth walked less distance than was expected.
- No significant difference was found between girls and boys and children and adolescents in 1-min STST performance, but adolescents showed relatively poorer performance than children.

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APPENDICES

APPENDIX-1: CONSENT FORM

BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU

Ebeveyn Formu

Değerli anne/babalar,

Çocuğunuzu İstanbul Üniversitesi-Cerrahpaşa Cerrahpaşa Tıp Fakültesi Çocuk Sağlığı ve Hastalıkları Anabilim Dalı Endokrinolojisi Bilim Dalı'nda yürütülen "Obez ve Fazla Kilolu Çocuk ve Adölesanlarda Bir Dakika Otur Kalk Testinin Geçerliliğinin belirlenmesi" başlıklı araştırmaya davet ediyoruz. Bu araştırmaya katılıp katılmama kararını vermeden önce, araştırmanın neden ve nasıl yapılacağını bilmeniz gerekmektedir. Bu nedenle bu formun okunup anlaşılması büyük önem taşımaktadır. Eğer anlayamadığınız ve sizin için açık olmayan şeyler varsa, ya da daha fazla bilgi isterseniz bize sorunuz.

"Obez ve Fazla Kilolu Çocuk ve Adölesanlarda Bir Dakika Otur Kalk Testinin Geçerliliğinin belirlenmesi" başlıklı araştırma İstanbul Üniversitesi- Cerrahpaşa, Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Bölümü öğretim üyesi Doç. Dr. Gökşen Kuran Aslan'ın danışmanlığında, Uzm. Fzt. Çiğdem Emirza'nın yardımcı araştırmacılığında Fzt. Nesrine Benkhalifa tarafından yürütülmektedir.

Bu araştırmanın amacı, obez ve fazla kilolu çocuk ve adölesanlarda fonksiyonel kapasitenin değerlendirilmesinde kullanılan bir dakika otur kalk testinin geçerliliğinin belirlenmesidir.

Kapsamda obez ve fazla kilolu çocuk ve adölesanlarda 1dkOKT ile altı dakika yürüme testi sonuçları ilişkisine bakılacak, solunum frekansı, kalp hızı, dispne, yorgunluk cevapları değerlendirilecektir.

Bu çalışma 12 ay süresince devam edecektir. Testler, fizyoterapist tarafından yapılacaktır.

Test-retest güvenirliğin değerlendirilmesi için çocuk 1 hafta sonra 1DK-OKT ikinci testi uygulanacaktır.

Söz konusu araştırmaya, hiçbir baskı ve zorlama olmaksızın kendi rızamla çocuğumun katılmasını kabul ediyorum.

Çocuğunuza bu araştırma hakkında anlayacağı şekilde bilgilendirme yapılacak ve araştırmaya katılımı için rızası alınacaktır.

İmzalı bu form kâğıdının bir kopyası bana verilecektir.

Veli veya Vasisinin;

Adı-Soyadı:

Telefonu:

İmzası:

Tarih:

Araştırmacının;

Adı-Soyadı: Tarih: İmzası:

Fzt. Nesrine Benkhalifa

Uzm. Fzt. Çiğdem Emirza

Adı-Soyadı: Nesrine Benkhalifa

Çiğdem Emirza

İmzası:

Tarih:

APPENDIX-2: ASSESSMENT FORM

DEĞERLENDİRME FORMU

Tarih:		
Ad Soyad:		
Doğum Tarihi:		
Yaş:		
Cinsiyet:		
Boy(cm):	**Ağırlık(kg):**	**VKİ (kg/m²):**
Öğrenim Durumu:		
Özgeçmiş:		
Soygeçmiş:		
Antropometrik Ölçümler		
Bel çevresi:		
Kalça çevresi:		
Bel/kalça oranı:		
Vücut yağ yüzdesi:		
Vücut kas yüzdesi:		
Vücut su yüzdesi:		
Vücut yağ ağırlığı:		
Vücut kas ağırlığı:		

1 dakika Otur Kalk Testi				
Tarih:	**Ölçüm**	**İstirahat**	**Test Sonrası**	**Oturup kalkma sayısı**
1DK-OKT 1.test	**SpO_2**			
	Kalp Hızı			
	Solunum Frekansı			
	Kan Basıncı			
	Dispne			
	Yorgunluk			
Tarih:	**Ölçüm**	**İstirahat**	**Test Sonrası**	**Oturup kalkma sayısı**
1DK-OKT 2.test	**SpO_2**			
	Kalp Hızı			
	Solunum Frekansı			
	Kan Basıncı			
	Dispne			
	Yorgunluk			

Altı Dakika Yürüme Testi			**Tarih:**	
Ölçüm	**İstirahat**	**Test Sonrası**	**Tur Sayısı**	**Mesafe**
SpO_2				
Kalp Hızı				
Solunum Frekansı				
Kan Basıncı				
Dispne				
Yorgunluk				

Dispne		
Modifiye Borg Skalası	İstirahat	Aktivite
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Determination of The Validity of Sit-to-Stand Test in Overweight and Obese Children and Adolescents

ORİJİNALLİK RAPORU

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BENZERLİK ENDEKSİ	İNTERNET KAYNAKLARI	YAYINLAR	ÖĞRENCİ ÖDEVLERİ

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