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ASSESMENT OF PHYSICAL PERFORMANCE AND REPRODUCIBILITY ON SHUTTLE RUN TEST BETWEEN OBESE AND NON-OBESE ADOLESCENTS AGED 13 - 18 YEARS: A COMPARATIVE STUDY

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Abstract :

Introduction: The prevalence of obesity has been increasing among youth worldwide. Reduced level of habitual physical activity is hypothesized to be a factor in increased prevalence of obesity. Shuttle run test has been used as a primary outcome measure for the assesment of physical performance. Thus, this study aimed to compare the performance on shuttle run test between obese and non- obese adolescents and the reproducibility of two SRT carried out after 24 hours. **Method**: A comparative study in which 36 adolescents, aged 13-18 were recruited from a school and the sports academy. This study consists of two visits in school and the sports club. On our first visit the first SRT carried out and on second day i.e., after 24 hours the second SRT were carried out.
Result: There was a significant difference in the distance traveled by non-obese in comparison with obese over weight adolescents. The Non-obese group has covered max distance 750m in SRT1 more the than distance the distance covered by obese group 586 in SRT1. There is no significant difference in the distance covered in SRT1 and SRT2 in both obese as well as non-obese group. The distance traveled in the best SRT had correlation with weight No correlation was observed in the non-obese adolescents
Conclusion: Overweight children have presented lower performance in shuttle run test there was significant difference in performance of SRT between obese and non-obese adolescents. Even though it was reproducible, the best performance was recorded during the first shuttle run, which leads us to suggest applying only one test is enough for the assesment of cardiorespiratory fitness.

KEYWORDS : cardiorespiratory fitness, Adolescents, Physical fitness, Obesity, Reproducibility, Shuttle run test, BMI.

INTRODUCTION

Adolescence is the phase of life between childhood and adulthood, from age 11 to 19. It is a unique stage of human development and an important time for laying the foundations of good health.[1,2] Adolescents experience rapid physical, cognitive and psychosocial growth. This affects how they feel, think, make decisions, and interact with the world around them.[1,2] Physical Activity is an individual characteristic that is at best moderately stable across childhood into adolescence and adolescence into young adulthood.[3] Physical performance influence by changes in body size, physique and body composition associated with growth and maturation.[4,5] Increasing academic demands and accessibility of computers and the internet is also contribute to more Sedentary lifestyle among youths. Obesity and overweight among children and adolescents have become important and alarming public health problem globally.[6] Physical activity and fitness play important role in preventing overweight and obesity among adolescents.[7,8]
The decline in adolescent physical fitness in recent decades had raised concern about current populations possible future challenges with health and physical function.[9] Physical fitness has been found to have well established association with health markers during adolescence and health outcome later in life.[10] Physical fitness can be classified into Cardiorespiratory, musculoskeletal, and neuromuscular fitness.[11] Nowadays, Cardiorespiratory fitness is considered one of the most powerful marker of health even above other traditional marker such as weight status, blood pressure or cholesterol level.[12] Additionally, during childhood higher cardiorespiratory fitness level have been associated with a healthier cardiovascular profile in adulthood. Therefore, cardiorespiratory fitness testing may help to identify a target population for primary prevention both in adolescents and adults as well as for health promotion policies.[13,14] Cardiorespiratory fitness can

be objectively assisted by test conducted in laboratory, but the need of expensive equipment limits it's use in school or college environment.[13,14] In this context, field test might be alternative for assessing cardiorespiratory fitness in school and college adolescents due to its low cost and its easy applicability, with the advantage that a big no of student or children can be assisted simultaneously.[14] 20-meter shuttle run test is probably the most widely used field test for estimating cardiorespiratory fitness. The prevalence of obesity has been increasing among youth worldwide. Reduced level of habitual physical activity is hypothesized to be a factor in increased prevalence of obesity.[15] Young adolescent spend an average of 6.1 hours each day watching television, using computer or other smart technology.[16]

Obesity, physical inactivity and poor physical fitness are independent risk factor for chronic disease. Adolescents with obesity may also present with enhance degenerative changes in the skeletal and articular system, with premature loss of osteoblast function and growth of cancellous bone, preterm demineralization and a resultant increase in fracture risk.[17,18] The process of cardiovascular disease begins childhood and associated risk factors, including inactivity and obesity, tract through adolescence, (11-25years) into adulthood, imparting heightened risk of premature mortality.[16] The study found an increase in risk of premature death of people who were underweight as well as for people classed as overweight. The risk increases steadily and steeply as BMI increases.[11] Amongst children and adolescents, obesity-related complications may result in a decline in life expectancy and deteriorated quality of life.[6] A physically active lifestyle has been shown to significantly reduce the risk of developing cardiovascular disease.[14] Physical therapists are equipped with the ideal skills and potential to evaluate, measure, prevention and intervention for cardiorespiratory endurance, agility and to reduce obesity in adolescents. From a therapist's point of view, it important to find out relationship between the obesity and cardiovascular fitness may be important for the identification increased risk chronic cardiovascular diseases, other health problems in adolescents. Physiotherapists have great potential for physical activity promotion.[19]

20-meter shuttle run (20MSR) test, also called the ''Course Navette'', "PACER", or "Multistage fitness test", is probably the most widely used field test for estimating cardiorespiratory.[5] The 20MSR test is simple, easy to administer and not too time-consuming, it requires minimal equipment, and a large number of individuals can be tested simultaneously.[21] The test is progressive in intensity it is easy at the beginning and gets more difficult at the end.

NEED OF THE STUDY

Fatness and fitness both influence cardiovascular profile. Level of physical fitness in adolescence is positively associated with present and future health-related outcomes such as risk for obesity, cardiovascular disease, skeletal health and mental health. The prevalence of obesity is nowadays increasing among the youth because of physical inactivity, sedentary lifestyle and also due to change in lifestyle because of covid- 19 in last two years. Test reproducibility is important for the possibility to meet physiological variability, although there are multiple previous studies on Shuttle run test in children and adolescents available, reports on reproducibility are rare.

Thus, need arises to asses physical performance on shuttle run test between obese and non-obese adolescents so that proper interventions can be enhanced to maintain the cardiorespiratory fitness during adolescence and adulthood which is one of the most important health related threats affecting cardiovascular and cardiometabolic risk in adulthood and will commonly cause diminished cardiorespiratory fitness in adulthood and late adulthood.

AIM

To assess physical performance and reproducibility on shuttle run test between obese and non- obese adolescent aged 13-18 year.

OBJECTIVE

PRIMARY OBJECTIVE

a. To evaluate physical performance & reproducibility on shuttle run test in obese adolescent aged between 13-18 years

b. To evaluate physical performance & reproducibility on shuttle run test in non-obese adolescent aged between 13-18 years

c. To compare the physical performance and reproducibility on shuttle run test between obese and non-obese adolescents aged 13-18 years.

HYPOTHESIS

Null hypothesis : There will be no significant difference between the physical performance and reproducibility on shuttle run test between obese and non-obese adolescent aged 13-18

Alternate hypothesis (H1): There will be significant difference between the physical performance and reproducibility on shuttle run test between obese and non-obese adolescent aged 13-18

Data and Sources of Data

For this study the data were collected from the school and the sports club 24 and 12 respectively, both male and female. The according the Asian scale of BMI were used for group allocation , both obese and non-obese group were purposively allocated according to the BMI in respective groups.

RESEARCH METHODOLOGY

Population and Sample

Adolescent aged 13-18 years were included, the study type is observational study, comparative study design and the method of sampling was purposive sampling. The study setting were the school and the sports academy and the minimum sample size for the study was, 21 therefore the sample size in this study was taken 36, which was divided into group of 18 each. Study duration was six months. Inclusion criteria; Both boys and girls willing to participate Healthy adolescents. Participants with no history of cardiorespiratory diseases or musculoskeletal disorders. Apparently healthy participants who did not present any injury, physical and/or mental disabilities According to WHO Asian BMI criteria for obesity, overweight adolescents: with BMI $\geq$ 23, obese: BMI 25 - $\geq$ 30, non-obese: 18.5 -

22.9. Exclusion Criteria; Participants with special conditions (e.g., disabilities or chronic diseases) Participants having with lower-extremity or spinal dysfunction. Participants with history of seizure disorder Any recent history of ankle sprain, fracture of lower limb. Participants having hearing aid, or previously diagnosed hearing difficulty. Material used was 20meter long runway (non-slippery surface) Measuring tape, Chalk powder, Audio player and cassette, Digital weighing machine, Pulse oximeter , FitnessGram SRT app, Consent form, Pencil/pen, Score sheet (FitnessGram sheet), Modified Borg scale. Outcome measure was the 20-Shuttle run test.

PROCEDURE

Ethical clearance was obtained from the Institutional Ethical Committee. The written permission to conduct study and recruit students as subjects for this research was taken from the Principal of the school. Subjects were screened according to inclusion and exclusion criteria on day -1. The purpose & procedure of the study was explained to participant. A written consent was obtained from selected subjects. The selected subjects were evaluated by below mentioned method. A case record form was given to the participants. A case record form with points like demographic indicators, family status, duration spent on physical activity, leisure time activities, study hours, watching television, computer use, age, school, and class were administered to the subjects, from this case record form the information regarding to their routine was obtained for the present study on day -1.

SHUTTLE RUN TEST:

The FitnessGram protocol was used to conduct 20-meter Shuttle Run Test. The Test was conducted on the playground in which two lines 20-meter apart were drawn. Subjects were divided into two groups of obese and non-obese Resting heart rate was measured using pulse oximeter before the test. Before starting the actual test there was a warm-up session for the subjects, in which shoulder/ arm circles, jumping jacks, standing side bends, knee bends, and ankle circles, Stretching hamstrings and calf was performed. After completing warm up, participants were instructed for the test.

The Instructions given to participants were: They must continuously run from one cone to other cone (one end to other end) in time with the 'beeps'. If they reached a cone early, they must wait there until they hear a beep. They were considered'out'when they fail to reach the cone three times in a row.

Anthropometric measurements:

For body weight measurement, the subjects were wearing pants and t-shirt, without shoes. Using a digital scale for weight, with maximum capacity of 150 kg

Height measurements was carried out with a measuring tape fixed on the wall, the subjects were barefoot and positioned with parallel feet, ankles close to each other, in upright position and arms along the body, with the head positioned so that the bottom of the eye socket was on the same plane as the ear external orifice

Body mass index (BMI) was calculated by dividing body weight, expressed in kilogram, by the square of child's height in meters. Then body mass index was calculated and subjects were classified according to Asian classification

Classification	BMI (kg/m^2)	Risk of co-morbidities
Underweight	< 18.5	Low (but increased risk of other clinical problems)
Normal range	18.5 – 22.9	Average
Overweight	≥ 23	
At risk	23 – 24.9	Increased
Obese I	25 – 29.9	Moderate
Obese II	≥ 30	Severe

FIG:1 PARTICIPANTS COMPLETED THE LAP WITH THE BEEP.

FIG:2 PARTICIPANTS RETURN BACK FOR SECOND LAP ON BEEP.

Sr. No.	Variable	Groups	Obese		Non-obese	
			n	%	n	%
1	Gender	Male	7	38.89	10	55.56
		Female	11	61.11	8	44.44
2	Age	13-14	6	33.33	7	38.89
		15-16	6	33.33	6	33.33
		17-18	6	33.33	5	27.78
3	BMI(kg/m^2)	overweight	17	100.00	0	0.00
		non-obese	0	0.00	18	100.00
4	Study Setting	school	12	66.67	12	66.67
		sport club	6	33.33	6	33.33

STASTICAL ANALYSIS

Data was entered into MS Excel before it was statistically Analyzed in "Minitab" of MS Windows. All the results are shown in tabular as well as graphical format to visualize the statistically significant difference more clearly. Descriptive statistics including mean, standard deviation and percentages were used to summarize descriptive data. The analyses were performed for all participants classified according to age, BMI, sedentary hours, transport type used, sports & physical activity.

The statistical significance of difference of SRT1 and SRT2, quantitative characteristics in study group (intra group comparison i.e., obese/non-obese) using paired t-test, and for inter group comparison specifically the comparison of variables for SRT between obese and non-obese was done by unpaired t-test. The better performance on SRT (test with larger distance) between non-obese and obese adolescents was expressed in mean difference and level of agreement.

RESULTS AND DISCUSSION

***Table 1*: Shows demographic data and anthropometric characteristics of obese and non-obese**

Out of total 36 participants 18 were obese and the 18 were non- obese in obese group 39% participants were male whereas 56% were male participants in non-obese group. In the obese group 33% were in each age group 13-14, 15-16,17-18 respectively; whereas 39% were in the age of 13-14, 33%in 15-16, 17-18 year and rest 28% were in 17-18 year. Majority of participants 67% were recruited from the school and 33.33% were from the sports club.

***Table 3:* Comparison of SRT1 and SRT2 in obese adolescents. (Data are presented as means ± SD)**

Obese Group					
HR rest (bpm)	Size	Mean	S.D.	t	p
SRT1	18	84.88	3.84	0.61	0.55
SRT2	18	84.16	3.38		
Shuttle Attained	Size	Mean	S.D.	t	p
SRT1	18	29.28	6.07	4.34	0.00
SRT2	18	27.78	6.03		
distance(m)	Size	Mean	S.D.	t	p
SRT1	18	586.70	122.10	4.34	0.00

SRT2	18	556.70	122.00		
HRmax (bpm)	Size	Mean	S.D.	t	p
SRT1	18	139.72	7.90	0.53	0.60
SRT2	18	139.00	7.62		
Borg	Size	Mean	S.D.	t	p
SRT1	18	2.88	0.32	* Can't conduct test	
SRT2	18	2.88	0.32		

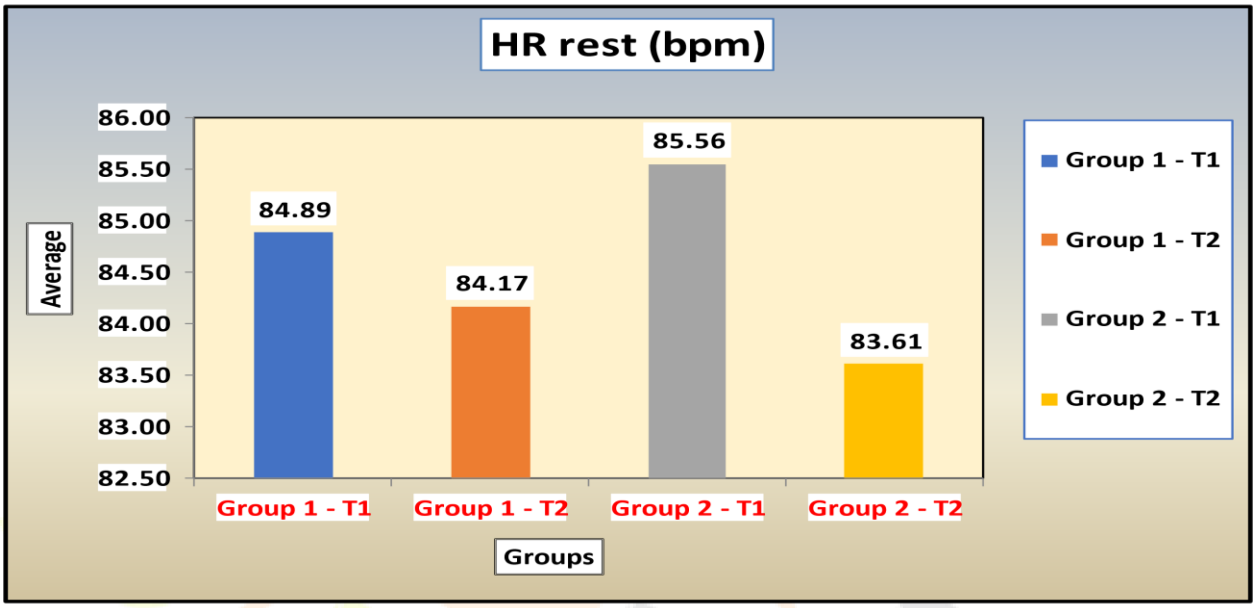
Non-obese Group					
HR rest (bpm)	Size	Mean	S.D.	t	p
SRT1	18	85.56	3.26	1.28	0.21
SRT2	18	83.61	5.74		
Shuttle Attained	Size	Mean	S.D.	t	p
SRT1	18	38.28	9.39	1.51	0.15
SRT2	18	36.94	8.65		
distance(m)	Size	Mean	S.D.	t	p
SRT1	18	750.00	171.00	1.49	0.15
SRT2	18	738.90	173.10		
HRmax (bpm)	Size	Mean	S.D.	t	p
SRT1	18	140.50	5.77	0.75	0.46
SRT2	18	139.61	6.61		
Borg	Size	Mean	S.D.	t	p
SRT1	18	3.00	0.00	1.00	0.33
SRT2	18	2.94	0.23		

As expected by groups allocation, obese group presented with significantly higher BMI than non-obese group (Table1). In SRT1 five participants had covered longer distance, and out of 18 participants two participants covered longer distance in SRT2, single participant covered the same distance in both the SRT. Obese group showed reduced the total shuttle attained and distance values in SRT2, There was no significant difference in HR at rest and maximum HR for SRT1 and SRT2. No difference was observed for Borg scores in any condition, BMI may affect performance in STR, as seen in Table3 that shows the comparison of both SRT1 and SRT2 in obese.

***Table 4:* Comparison of SRT1 and SRT2 in non- obese adolescents. (Data are presented as means ± SD)**

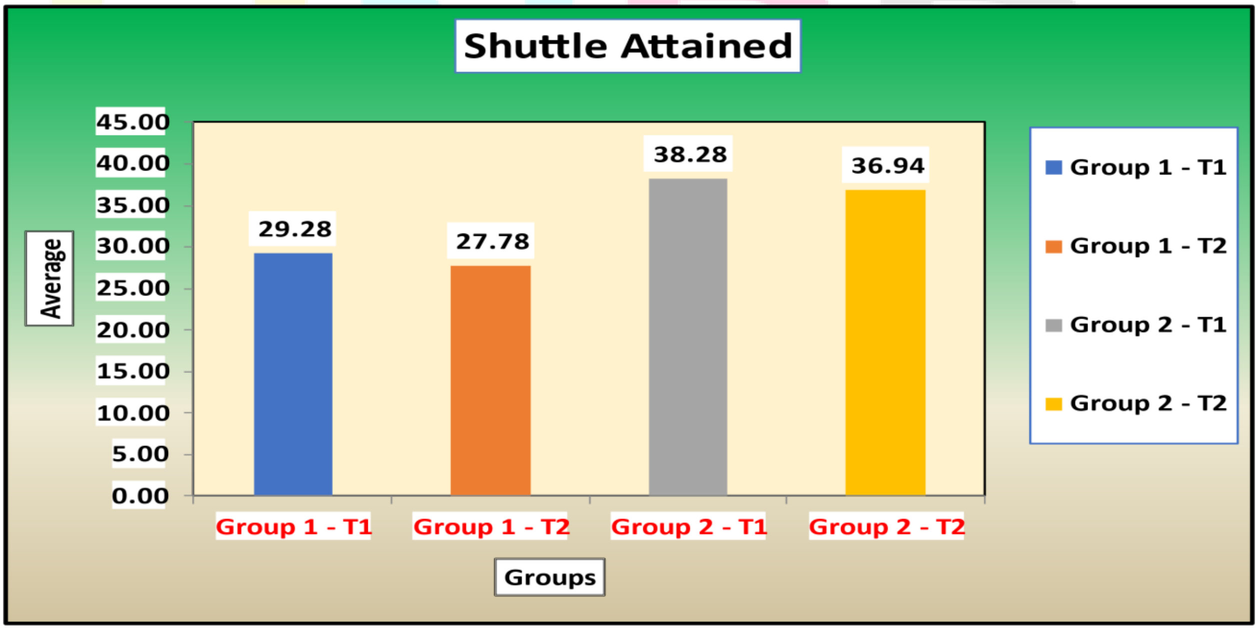
Non-obese group has normal BMI and as the table 2 suggest, Participants of this group showing more physical and sports activity than obese group. Out of eighteen six participants had covered longer distance in the SRT1, and nine participants in the SRT2, and only two participants showed the same distance in both tests. There was no significant difference in HR at rest and maximum HR for SRT1 and SRT2, Although participants presented with reduction in the shuttle attained in time and in the distance in the SRT 2, this reduction was not significant. No difference was observed for Borg scores in any condition.

***Graph 1**: Graph showing the HR rest(bpm).*



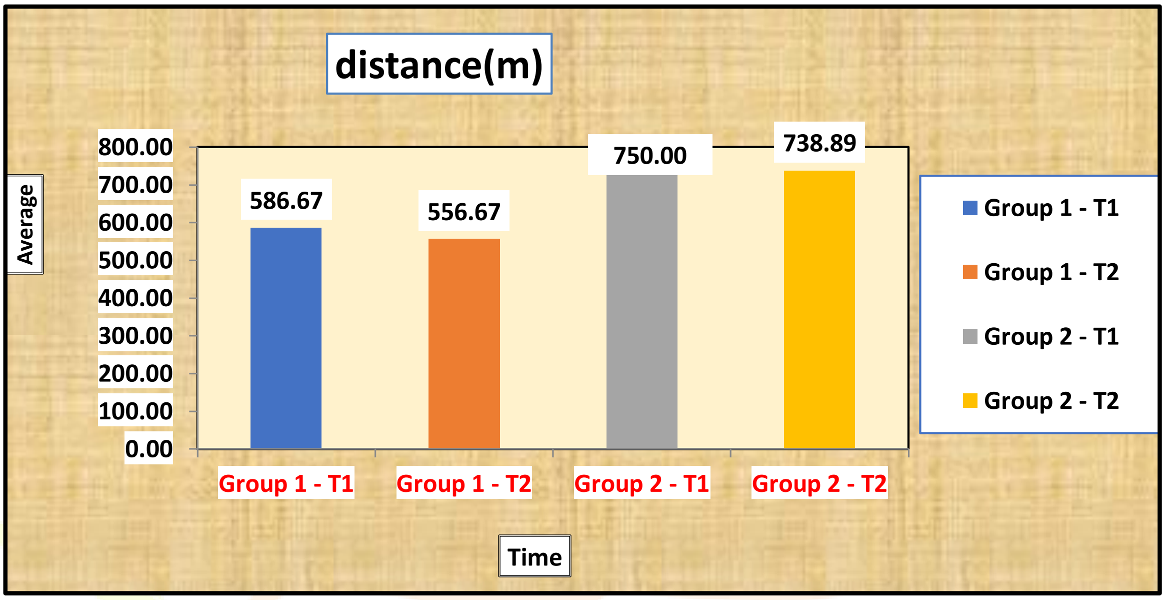
The heart rate taken at rest has no abnormal findings. The HR at rest for SRT1 and SRT2 there was no significant difference for both obese and non-obese adolescents.
*NOTE * (Group 1 and Group2 is of obese and non-obese participants respectively and T1 and T2 here considered the SRT1 and SRT2 respectively.)*

***Graph 2:** Graph of shuttle attained in the both SRT1and SRT2, by obese and non-obese adolescents.*



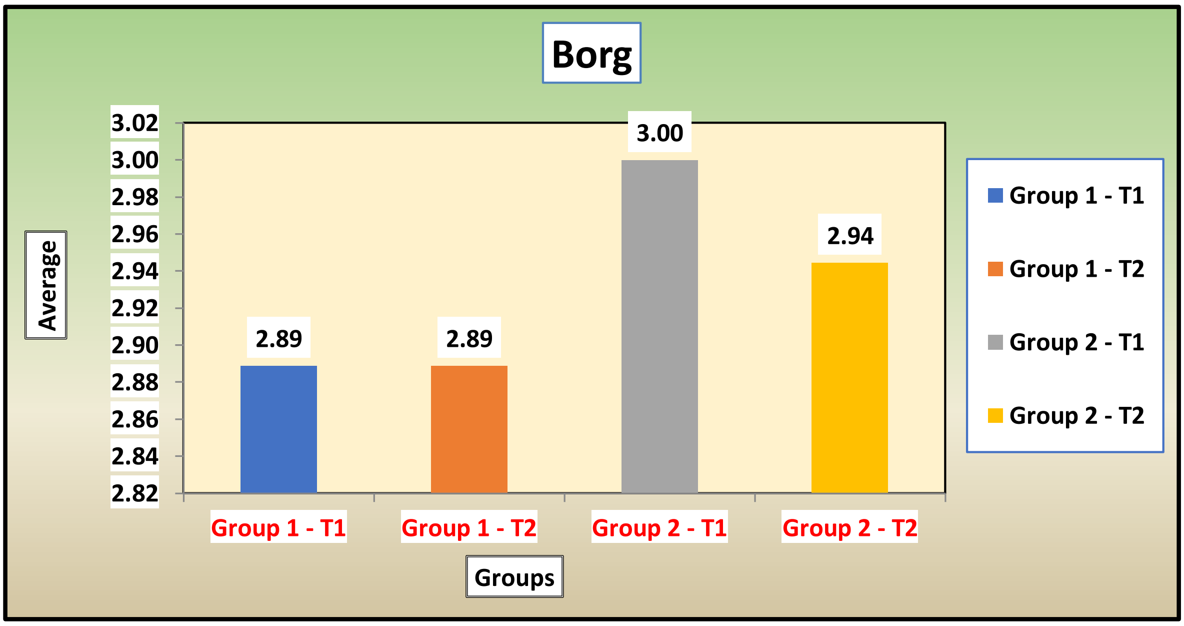
The graph shows the significant difference in shuttle attained by both groups. Obese and non-obese adolescent attained maximum 29 shuttles and 38 shuttles respectively. The obese participants attained lesser shuttles than the non- obese group in SRT1. There is no significant difference in the shuttle attained in SRT1 and SRT2 in both obese as well as non-obese group.
Refer NOTE(Graph1)*

Graph 3: ***Graph of distance travel by participants of both obese and non-obese group in SRT1 and SRT2***



The graph shows the significant difference in distance covered by both groups. Non-obese group has covered max distance 750m in SRT1 more the than distance the distance covered by obese group 586 in SRT1. There is no significant difference in the distance covered in SRT1 and SRT2 in both obese as well as non-obese group. *Refer NOTE*(Graph1)*

Graph 4: ***Graph showing Borg score after the test in both obese and non-obese.***



No significant difference was observed for Borg scores in any conditions.
Refer NOTE(Graph1)*

DISCCUSSION

The objective of this study was to assess the performance of shuttle run test between obese and non-obese adolescents, the study includes both male and female aged 13-18 years. The results suggest association between the BMI and the physical activity, that affects the performance in shuttle run test. overweight and obese adolescents presented the worst performance in shuttle run test compared to non-obese adolescents. While considering the reproducibility of shuttle run test taken on different days the best performance was made at the first shuttle run test.

In a study Janusz Kwiecinski set al., (2018) which was to evaluate the relationship between specific physical fitness items and BMI among the youth specific physical fitness item were included sprint, standing, long jump, and shuttle run test. The best performance of adolescents on SRT was seen on thin spectrum of population and performance get progressively poorer as BMI increases across the normal to the overweight and obese. Ostojic et al. pointed out a high prevalence of adiposity among Serbian schoolchildren aged 6–14 years old, with a strong negative relationship between aerobic fitness and adiposity[27] by correlating fitness and fatness in 6–14year old Serbian school children. Also, it supports the present study that the BMI specifically overweight/obesity and the physical fitness of a person has strong impact on the performance of the shuttle run test. Rauner et al. (2000) explored relationship between physical activity, physical fitness and overweight in adolescents and reported that overweight and obesity were inversely related to physical activity. However, the results were remained unclear about the correlation, whether excessive body weight was the cause or the effect of low levels of exercise and ftness[37]. The strength of the association between sports/physical activity and BMI may vary among countries.Higher level of self-reported physical activity and sports participation lead to lower body weight or a more favorable distribution of body fat[27]. The same results were found by Ortega et al. (2013) which confirmed that high levels of physical activity during childhood and adolescence, particularly involvement in sports activities, decreased total and central adiposity later in life, and suggested that increasing the rates of physical fitness in overweight children and adolescents may have many positive effects on health[35].

In our study, the obese group of adolescents showed the lower performance which was similar to the observation in previous studies, Characteristics related to low performance in physical test with overweight children may be explained by a disproportional relationship between their body weight and their muscular composition[22], because the fat mass found in children with ages from 6 to 10 years old is 16.2% for the nourished ones and 32.7% on the obese ones[23].

Test reproducibility is important for the possibility to meet physiological variability, although there are multiple previous studies on Shuttle run test in children and adolescents available [11-16], reports on reproducibility are rare. Results that we found in this study confirm that there is no such need to repeat shuttle run test in healthy adolescent because the better performance occurred in the test was taken first. However, we cannot rule out that the performance of test taken on day second i.e., SRT2 was reduced that may have occurred due to muscle fatigue, not only for peripheral muscle fatigue but also for central fatigue. A previous study has shown that obese girls (13.9 ± 0.9 years) presented early fatigue in comparison with their lean peers[27].

Although we have not observed difference between the performance from SRT1 to SRT2 intragroup, on average, obese group traveled shorter distance than non-obese group. This finding could be related to higher amount of type II fibers which are more prone to fatigue and the excessive work to move the body mass[27]. The latter can be supported in the present study by the negative and significant correlation between the traveled distance and weight and BMI only in the obese children, i.e., the higher the weight and BMI; lower is the distance travelled on the shuttle run test.

CONCLUSION

Overweight children have presented lower performance in shuttle run test there was significant difference in performance of SRT between obese and non-obese adolescents. Even though it was reproducible, the best performance was recorded during the first shuttle run, which leads us to suggest applying only one test is enough for the assesment of cardiorespiratory fitness.

LIMITATIONS

1. Information about the sexual maturation status and the hereditary type of obesity was not considered.
2. This study did not include the participants from different socioeconomic status, it could have aided to compare performance on SRT with different socioeconomic levels.
3. Sample size is small; hence results cannot be generalized. Thus, future studies should consider larger and wider spectrum of adolscents.
4. Also, other components of fitness along with diet- nutrition and sociocultural factors were not studied. Exploration of which would have given better picture regarding pattern of physical activity and overall health in adolscents.
5. Only BMI, and not any other anthropometric measures were assessed hence, it can also be included for better assesment of obesity.

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