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Original Research Article

Cardio Respiratory Fitness among Normal, Overweight and Obese Adolescent Girls of Hyderabad

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ABSTRACT

Background: Cardio respiratory fitness in childhood is an important predictor of morbidity and mortality in adulthood. Overweight and Obesity are the major health concerns that the adolescents are facing globally. Obesity is the root cause for various cardiovascular, metabolic and musculoskeletal disorders that are life threatening ailments. There are no studies that have documented the cardio respiratory fitness in adolescent girls of Hyderabad. The objective of this study is to know the Cardio respiratory endurance (VO2max) among normal, overweight and obese adolescent girls of Hyderabad. To find the changes in VO2max with increase in body fat mass.
Materials & Methodology: This is a cross sectional study involving 60 girls with an age group of 14 -16 years and were categorized into 3 groups (n=20) based on their BMI and WHR. All three groups were assessed for Cardio respiratory fitness using 20m shuttle run test. Results: The data was analyzed using ANOVA and ($P< 0.05$) in all the 3 groups. This suggests the significant difference of VO2max in all the 3 groups.
Conclusion: VO2 max was higher in normal group which suggests a good cardio vascular profile. VO2 max in overweight was better than obese group and less than in control group. VO2 max was poor in obese group indicating that increase in fat mass has a negative relationship with cardio respiratory fitness and the low VO2max is associated with many cardiovascular risk factors in later life.

Keywords: Adolescents, Cardio respiratory fitness, Body mass index, Waist to Hip ratio, Obesity, Overweight.

INTRODUCTION

Adolescence is a healthy phase of life .It is also the period where the physical, reproductive and psychological growth takes place. The most alarming problem among adolescent girls in India is being either overweight or underweight. The global prevalence of obesity is escalating day by day and about 200 million school children are either overweight or obese. Leading a sedentary life style, lack of physical activity in school and at home, consumption of high caloric foods, spending most of the time with gadgets had made the childhood and adolescent obesity on the rise worldwide. [1]

As per the statistics taken from the Indian Journal of Endocrinology and Metabolism, approximately 5.74% and 8.82% of Indian school children are obese. In urban south India 21.4% boys and 18.5% girls aged 13-18yrs are either overweight or obese. [2]

Obesity and Overweight is an increase in adiposity that leads to various metabolic disorders, cardiovascular complications, musculoskeletal problems, cancer, multiple organ failure all due to excessive secretion of adipokines the pro inflammatory cells that are atherogenic in nature. [3] There is an increase in free fatty acid synthesis due to increase in number and size of fat cells in obesity resulting in increased insulin resistance. There is an increase in Prothrombin activator inhibitor-1 secretion from fat cells which is a procoagulant and along with endothelial dysfunction in obesity leads to cardiovascular risk factors such as coronary artery disease, dyslipidemia etc. [4] The reason why Obesity is an important factor for CVD.

According to Centre for disease control and prevention (CDC), Fitness is the ability of the person to do activities without fatigue. Fitness consists of health and skill related components. Cardio Respiratory fitness (CRF) is one of the health related fitness component and is an important marker of health since childhood. [2] It is the ability of the cardiovascular and respiratory systems to supply adequate amount of oxygenated blood during exhaustive exercise involving large muscle groups for a prolonged period of time without fatigue. [2]

Cardio respiratory fitness can be measured in terms of VO2max (ml/kg/min). It measures the capacity of the body to utilize oxygen. Assessing VO2 max in children and adolescents is very important to determine the cardiovascular, metabolic and musculoskeletal risk factors in adult life. Clinical trials have shown that atherosclerosis which is a major cardiovascular complication begins in childhood and leads to adulthood mortality. High VO2 max shows that the child is free of cardio metabolic complications in later life and a low VO2max in childhood suggests that the child is prone for high cardiovascular risk profile. [5]

During the pubertal age i.e., during the adolescent age, the VO2max decreases by 3-12ml/kg/min in the age group of 8 to 18 years (Malina et al, 2004) in females. During puberty there is increase in body fat, lean body mass, and bone mineral density leading to overall increase in BMI. There is also an increase in adipose tissue causing an inclination towards deposition of body fat due to the hormone estrogen. [6] In obese adolescents with high body fat there may be further reduction in VO2max especially girls.

There are studies showing that excess adiposity does not affect the cardio respiratory fitness in overweight and normal children and adolescents. [7, 8] There are studies reflecting that the cardio respiratory fitness decreases with increase in body fat. [9-11]

Hyderabad is known for the top food destinations and surveys have shown that this city stands first place regarding childhood obesity among other cities of India announced by SMTV a famous news channel on Jan 28th 2017. Many studies were done on assessing the cardio respiratory fitness in adolescents in developed countries. The data in India is limited and there are no studies conducted on assessing cardio respiratory fitness among high school children of Hyderabad and Probably this is the first study. Hence I intended to assess the cardio respiratory fitness in terms of VO2max among normal, overweight and obese adolescent girls.

MATERIALS AND METHODS

The study consists of 60 girl students taken from Sri Ramachandra High School Children of Hyderabad.

1. **Inclusion criteria:**

a. Females with age group of 14 to 16 years
b. Haemodynamically stable

c. Otherwise healthy
d. BMI <85th percentile as Normal
e. BMI between 85th to 95thpercentile as Overweight
f. BMI>95thpercentile as Obese (According to International Obesity Task Force IOTF classification)
g. Waist to Hip (WHR) ratio 0.75 to 0.80 as normal adolescent
h. Waist to Hip (WHR) ratio 0.80 to 0.85 as overweight adolescent
i. Waist to Hip (WHR) ratio 0.85 to 0.90 as obese adolescent

2. Exclusion criteria:

a. Male subjects
b. History of cardiac disease and respiratory disorders
c. Not on regular medications affecting cardiovascular and respiratory system
d. Not undergoing any physical conditioning program.
e. Syndromic Obesity & Dysmorphic syndromes
f. Hypothalamic obesity
g. Chronic illness
h. Endocrine or Genetic disorders
i. Abnormal growth past 1 year
j. Dysmenorrhoea

The high school students who met the inclusion criteria were divided into 3 groups based on their BMI and Waist to Hip ratio (WHR) into Normal, Overweight and Obese group. Each group consists of 20 participants. Parental and Head of the school permission was obtained. All the participants were asked to fill the PAR-Q questionnaire and were clinically examined by the physician whether they are fit to participate in the study. The students were explained about the test and a demo was held. They were refrained to eat anything 3 hours before the test. Informed consent was obtained both from the student and parent.

20 meter shuttle Run Test:

This test is also called the Beep test or Progressive Aerobic Cardiovascular endurance (PACER) test, is a field test and is a valid tool to measure aerobic capacity (VO2max) in children and adolescents. [12] This multistage fitness test was first described by Luc Leger [11] with 1 minute protocol which starts at a speed of 8.5 km/hr and increases by 0.5 km/hr each minute. There are 21 levels in this test. Each level lasts for a minute. The test involves shuttling between two lines called a lap which are placed 20 meters apart. The subject has to run and touch the line before beep sound is heard. There is an increase in speed and the beeps come closer as the test proceeds. The test is terminated if the subject cannot run further or touch the line before the beep is heard.

Scoring depends on the number of laps taken by the subject before termination of the test and computed in the formula given by Leger et al 1988

$31.025+3.238 \times S-3.248 \times A + 0.1536 \times S \times A$

Where S= final speed (km/hr) & A= age

The shuttle run test was done in all the 3 groups and the VO2max values were compared statistically.

STATISTICAL ANALYSIS:

The results obtained were expressed as mean ± standard deviation (SD). A p value of <0.05 was considered statistically significant. Statistical Analysis was done by using ANOVA test.

RESULTS

60 Healthy adolescent high school girls studying in 9th and 10th class with an age group of 14-16 years (14.80±16.40) were categorized into 3 groups(n=20) based on their BMI percentiles (20.05±31.40) and WHR (0.7810±0.8522). There is no significant difference of age among the 3 groups as P value is greater than 0.05.There is a statistically significant difference among the 3 groups in terms of BMI and WHR as the P value is less than 0.05. All the participants were assessed for cardio respiratory endurance in terms of VO2max expressed in ml/kg/min using 20m shuttle run test. The results have shown that there is a negative relationship between BMI & VO2max.

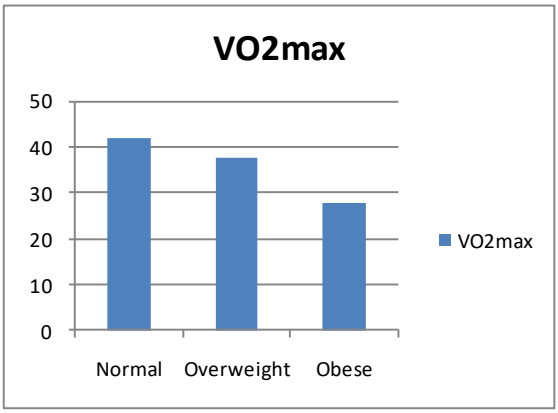
SHUTTLE RUN SCORE

Table 1:

	N	Mean	Standard deviation	F	Sig.
Normal	20	42.05	2.625	128.543	.000
Overweight	20	37.40	3.347		
Obese	20	27.60	6.713		

Table-1 shows Mean, Standard deviation (S.D), F test, Significance (p) value of Shuttle run test in normal, overweight, and obese groups.

Normal group shows mean is 42.05 is 2.625. Overweight group mean is 37.40 and S.D is 3.347 Obese group females mean is 31.80 and S.D is 6.713.ANOVA test was done. From ANOVA test calculated value (F-Value) is 128.543, P value is 0.000.Table value at 5% level of significance at 2,57 degrees of freedom is 3.15.F value is greater than table value. (128.543 > 3.15.Here P value 0.000 is less than 0.05.So there is a Significance difference among the 3 groups. The VO2 max is more in normal group than Overweight group. The overweight group had better VO2max than obese group. Obese group results show very less low cardio respiratory fitness.



ANOVA:

Table 2:

	Sum of squares	df	Mean square	F	Sig
Between groups	2176.433	2	1088.217	125.543	.000
Within groups	482.550	57	8.466		
Total	2658.983	59			

Post Hoc tests

Multiple comparisons

Dependent variable: Shuttle run score

Table 3:

(1)Group			Mean difference (I-J)	Std. Error	Sig
	NORMAL	overweight	4.650	.920	.000
		obesity	14.450	.920	.000
	OVERWEIGHT	normal	-4.650	.920	.000
		obesity	9.800	.920	.000
	OBESE	normal	-14.450	.920	.000
		overweight	-9.800	.920	.000

Table 2 and 3 shows the P value is 0.000 which is less than 0.05 in between the groups and within the groups. The results suggest that the shuttle run test was performed better by Normal group than overweight and obese group. The overweight group performed the test better than obese group but not as good as Normal group. The Obese group could not perform well in comparison to Normal and Overweight. This suggests that VO2 max is good in Normal followed by Overweight and very poor in Obese group.

DISCUSSION

The main aim of my study is to examine the cardio respiratory or aerobic capacity in terms of VO2max in relation to BMI. To the best of my knowledge this is the first study to assess VO2max levels in Hyderabad high school children.

Cardiorespiratory endurance or General endurance is the ability of the cardiovascular and respiratory systems to supply oxygenated blood to the active muscles during prolonged physical activity. VO2max is defined as the maximum capacity of the body to utilize oxygen during maximum effort. VO2 max depends upon the oxygen transport, the oxygen

binding capacity of the blood, and the body's ability to extract oxygen and the muscles oxidative capacity. VO2max is internationally accepted parameter to measure cardio respiratory endurance and is used in my study. [13]

The present study showed statistically significant higher level of VO2 max in normal weight girls when compared to overweight girls and Overweight girls showed a better VO2max than obese girls. The decrease in VO2max in overweight and obese girls might be due to the following reasons:

The mitochondrial oxidative enzyme activity is very less in obese people as the number of mitochondria and their function is limited in the skeletal muscles of overweight and obese individuals. Whereas the Glycolytic enzymes that is the phosphofructokinase and a-glycerol phosphate activity is more in obesity and type 2 diabetes. [14]

The Type 1 muscle fibers also called the slow twitch oxidative fibers are more in number than type II fibers in obese individuals. As the name implies the type 1 fibers are rich in mitochondria and glutamines enhancing the oxidative capacity of the skeletal muscles and also enhancing the glucose metabolism regulated by insulin. Some other studies have also implied the same. [14]

Increasing adiposity is associated with lower skeletal muscle oxidative capacity and capillarization. Skeletal muscle capillaries are a fundamental component in the diffusion of various substances including oxygen, glucose, insulin, and fatty acids from the circulation to skeletal muscle. [15]

The increase in body fat in obese individuals should have an increase in capillarization in order to provide adequate oxygen and nutrient diffusion but the results have shown that there is low adipose tissue capillary density, decrease in vascular endothelial growth factor (VEGF) suggesting that obese Adipose tissue is deprived of oxygen. [16]

My study has shown the results which are in consistent with other studies

Buskirk et al has concluded that there is decrease in VO2 max in obese and overweight individuals when compared to normal. They supported that the overweight and obese individuals could not sustain prolonged activity due to their excessive body weight due to increase in fat mass accumulation and also due to decrease in supply of oxygenated blood to working muscles Living in obesogenic environment that is consuming high caloric diet and lack of regular physical activity is the main reason for increase in total body fat mass leading to poor VO2 max. [17]

The study done by Laxmi C.C, et al., in titled "Effect of BMI on Cardio respiratory Fitness in Young Healthy Males", showed that the BMI and VO2max are negatively correlated ($r = -0.48$, $p<0.01$). They concluded that the decrease of VO2 max is probably due to the excessive fat accumulation that caused the inability of the active muscles to extract oxygen from blood creating an extra burden on the heart to meet the metabolic demand. Low cardio respiratory fitness in young adults with increased body fat could be a factor for developing cardio vascular co morbidities later in middle age. [10]

In the study "Body Mass Index and VO2 max Relationship of FKUI Fitness Challenge 2012 Participants in Gelora Bung Karno Jakarta" shows that Participants are 23 women and 36 men age 15-48 years old with mean age 32.86 ± 12.85 years old. Mean VO2 max is 27.94 ± 6.91 and mean BMI is 23.36 ± 3.41. There is a significant negative correlation between VO2max and BMI which is -0.408 ($p=0.01$). [11]

The main limitation of my study is a small sample size and the study is done on students of a single school. Further studies can be done on different age groups and in different gender, taking large sample size, direct measurement of VO2max can be taken, other health and skill fitness parameters can be tested, intervention can

be done to check in decreasing body fat and its effect on VO2max.

CONCLUSION

Estimated VO2max ($ml.kg^{-1}.min^{-1}$) is higher in normal when compared to overweight and obese adolescent girls. Low Cardio respiratory fitness in children is an important predictor of morbidity and mortality in adult life. This CRF provides necessary information regarding cardiovascular status of the child and helps in preventing future hazardous health complications. The problem of increase in body fat can be overcome by making it compulsory to implement physical education programs in schools and eating healthy diet and leading an active life style.

Conflict of interest: None

REFERENCES

1. Malhotra A. Obesity among Indian adolescents : Some emerging trends. J Obes Metab Res 2014;1:46-8
2. Michael A J R, R Srinivasan, Arockiam T. Childhood Obesity: The Indian scenario compared with worldwide. Curre Res Diabetes & Obes J .2018 ;5(5):555672.
3. Redinger RN . The pathophysiology of obesity and its clinical manifestations. Gastroenterol Hepatol (NY).2007 Nov ;3(11):856-6.
4. Prabha Setty, BV Padmanabha, BR Doddamani. Correlation between obesity and cardio respiratory fitness. International journal of medicine science and public health. 2013. vol2, Issue 2.
5. Bhammar DM, Stickford JL, Bernhardt V , Babb TG. Verification of maximal oxygen uptake on obese and non obese children. Medicine & science in sports and exercise 2017 Apr; 49(4):702-710.
6. Maina et.al Growth, Maturation , and physical activity. Medicine & science in sports and exercise J24(7), July 1992.
7. K.Padmapriya , and B Sujaya. Physical Fitness in South India Adolescents by Vo2Max. RRJMHS. Volume 2, Issue 3. July - September, 2013.
8. Luc F. Van Gaal. Mechanisms linking obesity with cardiovascular disease Nature: Volume 444, pages 875 – 880 (14 December 2006)
9. Hasmukh shah, Tejas Parajapathi et al. Association of body mass index with Vo2 Max in Indian adults. International journal of basic applied physiology, 5(1), 2016.
10. Laxmi CC, Udaya IB and Vinutha Shankar S in titled, Effect of BMI on cardio respiratory Fittness in young healthy males , International journal of scientific and research publications , 4(2) , Issue no 2250-3153, (2014).
11. Santu Dhara and KAllol Chatterjee. A study of VO2 max in relation with body mass index (BMI) of physical education students. Research Journal of physical education sciences, ISSN 2320-9011 Vol. 3(6), 9-12 June (2015).
12. Daniel mayorga – Vega, Pablo Aguilar-Soto, and Jesus Viciana. Criterion –Related validity of the 20-M shuttle run test for estimation cardiorespiratory Fittness : A Meta –Analysis. J Sports sci Med 2015 Sep; 14(3): 536-547.
13. Leger,L; .Lambert J,; goulet A,; Rowan,C.: Dinelle,Y.(June 1984). "[Aerobic capacity of 6 – 17 – years old Quebecois –20 Meter shuttle run test with 1 minute stages]". Canadian journal of applied sports science. Journal canadien Des science appliqués Au sport .9(2) : 64-69 . ISSN 0700-+3978.PMID 6733834.
14. Jing He, 1 Simon Watkins,2 and David E.Kelly.Skeletal muscle lipid content and oxidative enzyme activity in relation to muscle fiber Type in Type 2 Diabetes and obesity .Diabetes 2001 Apr ; 50(4) :817-823.
15. Gavin TP, StallingsHW3rd, Zwetsloot KA , Westerkamp LM, Ryan NA ,Moore RA , Pofahl WE, Hickner RC .Lower capillary density but no difference in VEGF expression in obese vs. Lean young skeletal muscle in humans. J Applied physiology (1985).2005 Jan; 98(1) : 315-21.
16. Pasarica M, Sereda OR, Redman LM, ALbarado DC, Hymel DT , Roan LE , Rood JC , Burk DH, Smith SR . Reduced adipose tissue oxygenation in human obesity: evidence for rarefaction, macrophages chemo taxis, and inflammation without an angiogenic response. Diabetes .2009 Mar;58(3):718-25 DOI :10.2337/db08-1098.
17. Buskirk E, Taylor HL. Maximal oxygen intake &its relation to body composition with special reference to chronic physical activity & obesity. Journal of applied Physiology 1957;11: 72-78.

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