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Adiposity and its relationship with cardiorespiratory fitness among overweight individuals: A correlational study

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Abstract
Background and objectives: Overweight leads to serious health consequences. It is an abnormal or excessive fat accumulation that may impair health. The risks associated with overweight are primarily related to the deposition of adipose tissue, which leads to excess adiposity. Adiposity is defined as the degree of body fat accumulation. Waist to height ratio (WHtR) is considered as a gold standard alternate way to estimate adiposity. It is a simple, accurate and non age dependent index with high applicability to screening overweight in children and adults. It is a slightly better predictor than other various anthropometric measurement that measure adiposity of the body.It is well established that abdominal adiposity is a strong predictor of morbidity and mortality. It is also reported that high levels of cardio respiratory fitness (CRF) are associated with lower risk of all cause mortality. Reduced cardiopulmonary fitness is associated with increased cardiovascular disease. Maximal oxygen consumption (VO2max) is considered the gold standard of cardio-pulmonary and muscle cell fitness. The current study is to evaluate the relationship between adiposity and cardio-respiratory fitness among over weight individuals. A Correlation study conducted in RV College of physiotherapy Bangalore. 100 overweight individuals of either gender in the aged between 18 to 30 years were recruited from recognized institute. Individually all the subject were evaluated for adiposity and cardio respiratory fitness using Waist to Height Ratio and VO2max (3 minutes step test) respectively. The test result were correlated and statistically analyzed. The results showed there is a small strength of negative correlation between vo2 max and waist height ratio with Pearson's coefficient (r = -0.2).
Conclusion: There is a inverse relationship between adiposity and cardio respiratory fitness.

Keywords: Waist height ratio, vo2max, overweight individuals

Introduction
Overweight is the most increase rates in recent decades as a major public health concern in many countries including India. According to a latest Indian government health survey which found that 1 in 5 women are now in overweight. The National Family Health Survey (NFHS-4) whose survey period was between 2015-16, in that 26.3% men were found to be overweight in urban areas, 14.3% men in rural areas and 20.7% women in the country were found to be overweight in India. Overweight is described as excess amount of body weight, including both fat and fat free mass, in relationship to a standard weight for height [1]. It may also defined as an abnormal or excessive fat accumulation that may impair health [2]. The WHO defines overweight as a BMI equal to or more than 25kg/m2. The National Heart, Lungs, and Blood Institute identifies overweight as a BMI of 25-29.9 kg/m2. The fundamental cause of overweight is an energy imbalance between calories consumed on one hand and calories expended on the other hand [1]. Overweight leads to serious health consequences. The risks associated with overweight are primarily related to the deposition of adipose tissue, which leads to excess adiposity or body fatness [3]. Adiposity is defined as the degree of body fat accumulation. The Latin term adiposity means severe or morbid overweight. An increasing overweight is associated with a growing risk for diseases, associated with obesity [4]. Physical inactivity and sedentary behavior leads to accumulation of excess adipose tissue. It is one of a risk factor for the cardiovascular disease and is a serious and widespread problem globally [5]. Risk increases progressively as BMI increases and leads to chronic diseases such as

cardiovascular diseases mainly coronary heart diseases, stroke and it also reduces the cardio respiratory fitness of an individual [3]. For this reasons we must emphasize the importance of assessing adiposity in clinical practices.

There are several tools that determine the adiposity of the body like BMI, Waist to Hip Ratio (WHR), Waist Circumference (WC) and Waist to Height Ratio (WhtR) etc. Among these all Waist to height ratio is considered as a gold standard alternate way to estimate adiposity because it has accountability for height too [6]. The use of waist to height ratio (WHtR) for detecting abdominal obesity was first proposed in the mid-1990 [7]. It is a simple, accurate and non age dependent index with high applicability to screening overweight in children and adults [8]. A new study shows calculating a person's waist to height ratio is the most accurate and efficient way of identifying whether or not they are at risk of obesity [9]. It is also a screening tool for detecting cardio vascular diseases risk factors [7]. It is a slightly better predictor than other various anthropometric measurement that measure adiposity of the body [10]. This is probably because there is a positive association between waist and height in global populations of mixed ethnicity that include a wide range of heights [10]. An advantage of using WHtR over waist circumference is that boundary values can be set that are the same for men and women [10]. The suggested boundary value of 0.5 proposes that individuals should 'keep waist circumference to less than half your height [10]. It is well established that abdominal adiposity is a strong predictor of morbidity and mortality [3]. It is also reported that high levels of cardio respiratory fitness (CRF) are associated with lower risk of all cause mortality [11]. CRF also referred as aerobic capacity is one of the most important components of physical fitness. Measurement of vo2 max is considered as an important part in the evaluation of cardio respiratory health and aerobic fitness. VO2 max (maximal oxygen consumption, maximal oxygen uptake, or maximal aerobic capacity) is the maximum capacity of an individual's body to transport and use oxygen during incremental exercise, which reflects the physical fitness of the individual. It is widely used as an indicator of health. In 2016 American Heart Association published a scientific statement recommending that CRF, quantifiable as VO2max, be regularly assessed and utilizes as a clinical vital sign. It is the primary indicator of aerobic fitness, cardiovascular health, and endurance performance.

Need of the study

Rise in CVD in India can be attributed to overweight. There is limited literature and evidences regarding waist height ratio to measure adiposity of the body. Hence, the current study was designed to evaluate association between adiposity and cardio respiratory fitness in overweight individuals and also attempts to create an awareness related to this issue.

Objectives

A study to examine the relationship between adiposity and cardio respiratory fitness among overweight individuals.

Materials and Methods

Source of data: RV College of Physiotherapy, Bangalore.

Method of data collection: The examiner personally contacted the concerned authorities at the centers and obtained requisite permission to carry out the study. Subsequently, the examiner screened the samples for meeting the inclusion and exclusion criteria and the samples were recruited for the study on obtaining informed consent to the participation.

Research design: The research design selected for this study is Correlational study.

Sample size: Total 100 subjects.

Sampling technique: Convenient sampling

Materials required:

1. Inch tape to measure waist circumference and height (inch).
2. 16.25inch step to perform 3 minutes step test.
3. Metronome beat that produce sound to step at regular intervals.
4. Weighing machine to measure individual's weight.
5. Sphygmomanometer and stethoscope. (lifeline)

Outcome measures

1. WHtR-Waist height ratio
2. Vo2 peak-peak oxygen uptake

Inclusion criteria

1. Subjects with BMI between 25-29kg/m2.
2. Both genders will be included.
3. Age between 18-30 years.
4. Individual with functional vision and hearing.

Exclusion criteria

1. Symptomatic cardiovascular diseases.
2. Significant orthopedic condition or chronic pain condition.

Methodology

All the subjects with the BMI more than 25 kg/m^2 and meet the study criteria were considered for inclusion in the study. Subjects were explained about the study procedure and an informed consent was obtained. Materials and equipments required for the procedure was arranged prior to the study. Individually all the subject were evaluated for adiposity and cardio respiratory fitness using Waist to Height Ratio and VO2max respectively.

Measurement of Waist to height ratio

Waist height ratio was measured for every subject by subject's waist circumference, divided by subject's height. Anatomical landmark for the waist circumference was anterior superior iliac spine. Both the parameters was measured in same unit (cm).

WHtR= waist circumference/ height

After taking these values, the VO2max was evaluated to check the cardio respiratory fitness.

Measurement of VO2max

Vo2max was assessed by Queens college step test. This test is a useful measure of CR capacity and has been found to be a validated and reliable field test. All the subject performed a sub maximal 3 minute step test with the metronome 96BPM for male and 88BPM for female. The subjects were using a 4 step cadence, 'up-up-down- down' for 3 minutes on the 16.25inch box. The subjects were asked to avoid coffee, alcohol and smoking before 24 hrs of the test and asked to inform any giddiness, breathlessness, muscle cramp during the test. Immediately after the completion of the 3minute step test, radial pulse is measured at end of the test, hence vo2max will be obtained using following formula.

Men: VO2max (ml/kg/min)=111.33-0.42×heart rate (bpm)
Women: VO2max (ml/kg/min)=65.81-0.1847× heart rate (bpm)

Fig 1: Assessment of vo2 max using Queen's college 3 minutes step test.

Data analysis

Data was analyzed using SPSS for windows, version 16.

1. Pearson product moment correlation was performed to investigate the relationship between WHR and VO2 peak.
2. Scatter plots between WHR and VO2peak.
3. Level of significance set as $p \leq 00.05$

Result

We have assessed 120 subjects for the eligibility of 3 minutes steps test. Out of these we have excluded 20 who didn't met the inclusion criteria, they are 13 unwilling to do, 5 orthopedics condition, 2 are asthma. Finally 100 subjects have been selected. We performed baseline evaluation of WHtR, Waist circumference, height, weight, vo2 max. At last we analyzed 100 subjects.

Table 1: Demographic characteristics of Participants.

Variable	Mean±SD
Age	21.73± 3.64
Height	182.50±7.5
Weight	95.00±8.8
Gender	Male=30 female=70

The demographic characteristic of participants in which there were 30 male and 70 females whose mean± SD of age was 21.73±3.64, mean ±SD height was 182.50±7.5, and mean ±SD weight was 95.00±8.8.

Table 2: Baseline characteristics of outcome measures.

	Mean SD
Waist height ratio	0.58±0.079
Vo2max	37.49±4.74

The characteristics of outcomes measures waist height ratio and vo2max whose mean ±SD waist height ratio was 0.59± 0.079, mean ± SD vo2 max was 37.49±4.74.

Table 3: Correlation between WHtR and vo2 max.

	Pearson's correlation	P value	n
WHtR	-0.2	<0.05	100
Vo2max			

The correlation of WHtR and VO2 peak done using Pearson's correlation. r value was -0.2. p value was <0.05.

Scatter diagram showing correlation between WHtR and vo2 max.

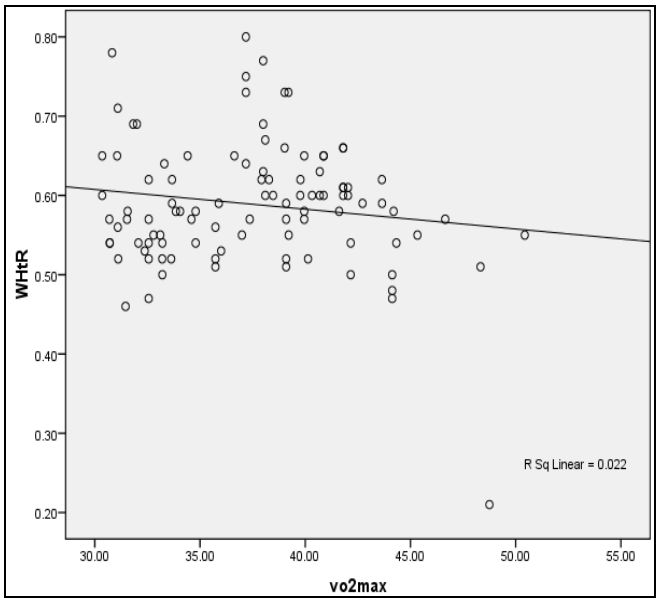

Fig 2: The scatter diagram showing correlation between WHtR and Vo2 max.

Discussion

People have generally two types of muscle fibers: slow twitch (type I) and fast twitch (type II). Type I muscle fibers have a high level of aerobic endurance whereas type II have poor aerobic endurance. In obese individuals there is increase in type II muscle fibers and decrease in type I muscle fibers which may have important effect on reduced oxygen uptake [12].

Pei-gang Wang *et al* 2011 reported that excess body fat impairs CRF. Result of this study suggested that there is significance of improving CRF for preventing overweight and lowering the risk of CVD. Several studies have suggested that high levels of CRF attenuate the deleterious consequences ascribed to high fatness. Similarly, overweight individuals have increased sympathetic nerve firing rate than normal subjects. Blood pressure is increased in overweight individuals. Obesity results in a state of chronic volume overload. Increased pre-load and stroke volume is associated with hypertension and thus greater likelihood of cardiac failure. A study done by William L. *et al* 2009 described Cardio respiratory fitness has been inversely associated with mortality in overweight, and obese individuals. Results from prospective studies showed that improvement in cardio respiratory fitness were associated with attenuated age related weight gain which supports the current study as the results are negatively or inversely correlated between CRF and adiposity. Vo2max is widely regarded as the best single measurement of CRF. The absolute value of VO2max is one of the indices of an individual's cardio respiratory fitness to transport oxygen to working muscles. The fitness level of an obese individual is generally low and hence the V02 max also comes out to be

low, which is represented by the results of the current study.

The height that WHtR takes into account would suggest that the taller individual would have less of a risk of cardio metabolic disease than the shorter individual with the same waist circumference which has been proven by previous studies.[13] The results of this study supports the evidence that WHtR may be a more useful indicator of cardio respiratory fitness yielding stronger correlations with the cardio respiratory fitness test scores than WC in both girls and boys.

If the WHtR of an individual is high, the body surface area is proportionately larger and hence more V02max is needed to be delivered and hence the efficiency is lower.

In the current study it was found that there was a small strength of negative correlation between overweight and VO2max (ml/kg/min) ($r = -0.2$) $p<0.05$). This indicates that if a person's waist height ratio (adiposity) increases his or her CRF will decrease and vice versa.

However our findings differ with the study findings conducted by Trapthi Kamath *et al* 2016 which reported positive correlation (moderate Strength) between adiposity with cardio respiratory fitness in normal sedentary young individuals.

Limitation

1. Small sample size.
2. Other age groups can be taken for further study.
3. Practice and motivation levels can influence the score attained, and the scoring can be subjective.

Conclusion

1. There is a small strength of negative association between WHtR and VO2 peak.
2. WHR ratio can be used in clinical settings to estimate adiposity as it is a rapid and inexpensive method.
3. Queen's college step test can be applied to produce a good estimation of maximum oxygen uptake in field where large numbers of participants are to be evaluated without a well equipped laboratory.

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