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Research Article

COMPARISON OF CARDIORESPIRATORY FITNESS BETWEEN PHYSICALLY ACTIVE AND INACTIVE CHILDREN IN THE AGE GROUP OF 10-15 YEARS USING YMCA-3 MINUTE STEP TEST

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ABSTRACT

Aim: To assess the cardio respiratory fitness of physically active and inactive children in the age group of 10-15 years using YMCA-TMST.
Objective: To assess and compare the cardio respiratory fitness of physically active and inactive children in the age group of 10-15 years using YMCA-TMST.
Methodology: Children were recruited into active and inactive categories according to WHO guidelines. From amongst the 500 subjects who matched the inclusion criteria and gave consent/assent for the study, a stratified random sampling of 207 subjects was done as per their age, gender and activity status. Post a demonstration of the step test was shown to the study subjects wherein according to the step test protocol the participants stepped on and off a 30 step 24 times/minute for 3 minutes with the help of metronome set at 96 beats/minute. Pulse rate, recovery time and Rate of Perceived Exertion (RPE) were noted using Modified Borgs scale, were recorded pre and post the test.
Statistics & Results: Data was collected on a data sheet & encoded for computerized analysis using SPSS version 22 for Windows. The post pulse rate (that is the pulse taken at first minute after the completion of the test) (P=<0.0001), RPE (P=<0.0001)and the recovery time for children in the age group of 10-15 years were compared and the results were found to be statistically significant(P=<0.0001)..
Conclusions: The cardio respiratory fitness as measured through Pulse rate, Pulse recovery time and Rate of Perceived Exertion using YMCA-TMST was better in physically active children as compared to physically inactive children.
Implication: This study fulfils the need for a quick, easy and feasible field test for cardiorespiratory fitness amongst the physically active and inactive children in the age group of 10-15 years using YMCA-TMST.

INTRODUCTION

Ancient philosophers and physicians such as Plato and Hippocrates believed in the relationship between physical activity and health, and the lack of physical activity and disease. However, by the mid-20th century it was believed that physical activity might be harmful to health. In concordance with this belief, the recommended treatment for the time after myocardial infarction was complete bed rest. It was not until the landmark epidemiological studies in the 1950s that physical inactivity was associated with increased risk of coronary heart disease (CHD).[(1)]Physical activity has been identified as an important determinant of cardio respiratory fitness of an individual.[(1)]On the other hand, inactivity is recognized as an important risk factor for metabolic syndrome in children. Moreover, physical activity is shown to be effective as prevention against cancer, Type II diabetes, and cardiovascular diseases, even if patients do not reduce weight.[(2)(3)]

Physical activity is also important for bone density and growth in children and adolescents and has a positive influence on memory, mental capacity, and social behaviour in children, regardless of their body mass index. The level of physical activity in childhood seems to continue into adulthood.[(2)(3)]Cardio respiratory fitness is considered an important marker of health in young people[(5)],and clear links have been established between the levels of fitness and coronary heart disease risk factors in adolescents and young

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children[6][7].Time spent sedentary presents an additional potential risk factor to the development of disease.[8]

The physiological responses to exercises have become well established. The benefits of exercise or physical activity has a dose- response relationship that is the more the physical activity the greater the health benefits.[1]At normal and sub maximum levels of exercise, cardiac output and heart rate responses increases linearly as the workload increase; at near maximum and maximum levels of exertion the heart rate response becomes less linear and increases disproportionately to the workload imposed in line with the Frank starling principle.[9]In view of the now well recognized benefits of physical activity in youth, there have been worldwide deliberation on adequate physical activity in young subjects.

According to WHO guideline (2010) it is suggested, that children aged 5–17 years must accumulate 60 min of moderate-to-vigorous physical activity (MVPA) daily, in addition to everyday physical activities.[3]We have used this definition of adequate physical activities for children recommended by WHO to classify our study subjects into physically active and physically non active categories.

Adolescents today and their level of Physical Activity

Due to a rapid growth in technology and busy lifestyle most children are unable to engage in requisite levels of physical activity. Children now a days makes use of electrical devices (television),mobilephones, play station and video games as a medium of recreation. The habit of playing outdoor games is declining in children probably because of lack of playgrounds or not enough space available to play gamesbecause of urbanization. Also they have burden of academics because of growing competition in the field of education. However there are a few children who are involved in various kinds of sports activity and engage themselves every day. Lifestyle diseases have taken prominence these days and are major cause of morbidity and mortality that lay their foundation in this age group. Research has corroborated that these diseases are no longer restricted to adults, but are seen in adolescents of today's age too.[1][7] Adolescents is an important time period for habitual activity for exercise or lifestyle choices.

Assessment of Cardiovascular Fitness in Children

Schools & educational institutions happen to be the most likely places for assessment of cardiovascular fitness in children. There are various tests available from literature that are used for the objective assessment of cardiovascular fitness, most commonly used of these clinical exercise tests are 6 minute walk test, shuttle walk test, cardiac stress test etc. These tests are time consuming, require adequate space or even specialized instruments. However in school premises, limited space or not having enough time to assess the entire batch and unavailability of specialized instruments limits the usage of these test. This becomes a more prominent limitation in cities like Mumbai, where most of the school do not have an attached independent playground.

Hence there is a need for an easy, reproducible, time efficient screening tests that can be used for determination of cardiorespiratory fitness, particularly in school going children. Young's Men Christian Association-Three Minute Step Test(YMCA-TMST)happens to meet all these criteria. The YMCA-TMST is a simple, effective, short duration test which does not require any specialized equipment and can be performed anywhere.[10]

Since, there is no substantial evidence available to assess the cardio respiratory fitness in adolescent subjects using a short duration yet effective step test, hence this study proposed to compare the cardio respiratory fitness amongst the physically active and inactive children in the age group of 10-15 years using YMCA-TMST.

MATERIALS AND METHOD

***Research Approach*:** Cross-sectional study.

***Study Tool*:** Young Men's Christian Association-Three Minute Step Test (YMCA-TMST), 12-inch (0.305-m) tall step stool, Stopwatch and metronome, Pulse oximeter, Weighing machine, Stadiometer

Inclusion Criteria

- Children in the age group of 10-15 years (active as well as inactive as per WHO criteria).[3]
- The subject should match the above criteria for atleast 6 months prior to the study.

Exclusion Criteria

- Children with any cardio respiratory, neurological, musculoskeletal problems.
- Children with any acute conditions which might interfere with the test.
- Morbidly obese.

Sample Size: 207

***Study Subjects*:** Children in the age group of 10-15 years (active as well as inactive as per WHO criteria).

Outcome Measures

- Pulse Rate immediately after the exercise
- Recovery time.
- Rate of perceived exertion (RPE) using Modified Borg's Scale.

METHODOLOGY

Procedure

Children were recruited into the study on the basis of inclusion criteria & were grouped into active and inactive categories according to WHO guidelines.[3]

From amongst the 500 subjects who matched the inclusion criteria and gave consent/assent for the study, a stratified random sampling of 207 subjects was done as per their age, gender and activity status. Anthropometry value like height was measured using Stadiometer and weight was obtained using calibrated scale, and the Body Mass Index (BMI) of the children were calculated using the height and weight values.**BMI= weight(kg)/height(m)^2**.

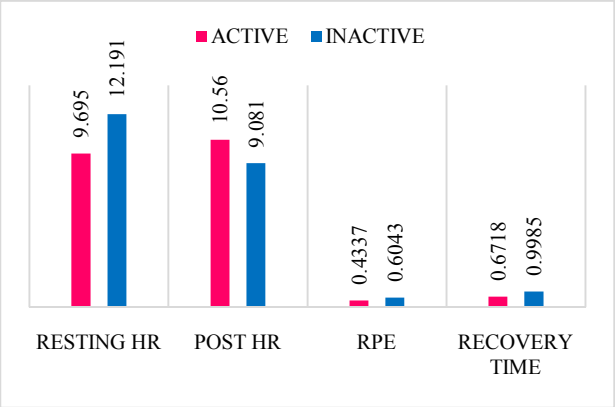
Pulse rate was recorded pre and post the test.

The recovery time that is the time taken by heart rate to come to its baseline (Pre-exercise value)was noted.

A demonstration of the step test was shown to the children. According to the step test protocol the participants stepped on and off a 30cm (12 inch)step 24 times/minute for 3 minutes with the help of metronome set at 96 beats/minute. Immediately after completion of the test the children's pulse rate was obtained with a pulse oximeter. The vitals at first minute post the test were taken into consideration. Subjects were instructed to sit still, breath normally, and not to engage in conversation during recovery period. The Rate of Perceived Exertion (RPE) was also noted using Modified Borgs scale.

Statistical Analysis and Results

Data was collected on a data sheet & encoded for computerized analysis using SPSS version 22 for Windows.The resting pulse rate for children in the age group of 10-15 were calculated and the results were not statistically significant (P=0.333) which suggests that both the group are homogeneous with respect to pulse rate.



	Resting Hr (mean SD)	Post HR (mean SD)	Rpe (mean SD)	Recovery Time (mean SD)
Active	9.695	10.56	0.4337	0.6718
Inactive	12.191	9.081	0.6043	0.9985

The post pulse rate (that is the pulse taken at first minute after the completion of the test) (P=<0.0001), RPE (P=<0.0001) and the recovery time for children in the age group of 10-15 years were compared and the results were statistically significant (P=<0.0001).

DISCUSSION

Our study aimed to compare the cardio respiratory fitness between physically active and inactive children in the age group of 10-15 years using YMCA-TMST.In view of the children not being able to engage themselves in various physical activity and having a sedentary lifestyle it was important to check the cardio respiratory fitness between the active and inactive children using an exercise test that is quick, easy, less time consuming and requiring minimum equipment. Cardio respiratory assessment was done on 207 subjects using YMCA-TMST out of which 200 subjects completed the test and 7 subjects could not complete the test due to muscular pain and inability to match their speed with the beats of the metronome. Their rate of perceived exertion was 5 on modified Borg's scale for the children who did not complete the test because of muscular pain. A study done by Russell,et.al found out that children are more active than adults, but their activity levels decline as they move towards adolescence and significant number of young people do not participate in recommended levels of physical activity and more than one third of students spend > 3 hours per day watching television. Similar trend of decline in levels of PA is being observed in India too.[30]

Demographic Analysis

The study was done on 207 subjects, (104 boys and 103 girls) out of which 7 subjects dropped out (4 boys, 3 girls).The dropout rate was 3.38%.The reported reasons for drop out were inability to perform the test, due to muscle fatigue.(RPE-5, according to modified Borg scale)

The study done by us compared the BMI between active and inactive children in the age group of 10-15 years of both the genders and the data compared resulted the date to be not significant suggestive of having homogenous data(p= 0.70).

Cardio respiratory Fitness

Evaluation of CRF requires easy, reproducible screening test that can be conducted under the condition of an epidemiological study. Most of the tests being conducted currently to measure peak oxygen uptake (VO2 max)need a special environment and special conditions.

This is probably the reason why there are no substantial studies to measure VO2 max in children. Individuals with high value of peak oxygen uptake are characterised by the ability to restore all pre exercise reactions rapidly and a low heart rate during sub maximal exercises and therefore the post exercise pulse rate and pulse recovery time obtained from the YMCA-TMST are both considered to be indicators of CRF. Also RPE is taken as one of an outcome measures because it is an indicator of pulmonary ventilation.

Heart Rate Response to Exercise

In our study it was observed that post exercise (step test) heart rate was less in physically active children as compared to physically inactive children. The "p" value was significant (p= <0.001)which suggests that cardiac output during exercise increases as there is an increase in the heart rate that is achieved during exercise. Heart rate increases proportionally as there is increase in workload of the heart till a maximum heart rate is achieved. (Evans DL-1985)[20] Cardiac output varies widely with the level of activity of the body. In physically active children as a response to exercise training cardiac adaptations takes place and therefore for any given activity the increase in heart rate is less as compared to physically inactive children. The hemodynamic consequences of an exercise program include a decrease in resting HR, decrease in the post exercise heart rate and systolic pressure and cardiac adaptations in form of increased stroke volume to the response to training are responsible for that.[9]

Recovery Time

In this study the time taken for recovery was more for inactive children as compared to active and the difference was found to be statistically significant.(p= <0.0001). Pulse rate recovery after exercise depends on many factors mainly cardio respiratory fitness, after moderate or heavy exercise, however, the recovery pattern is characterized by two distinct phases, an initial exponential drop followed by a slower decline to resting

level.[9]In response to physical activity of adequate intensity, the vagal tone increases, because of this increased cardiac vagal tone the recovery of HR to resting levels is faster in active subjects as compared to inactive.

Our results were supported by a study done by Na Du,et.al who conducted a study to examine the effects of endurance training on heart rate recovery after exercise and cardiac autonomic nervous system modulation in female marathon runners by comparing it with untrained controls. The study concluded that endurance training induces significant alterations in cardiac ANS modulation at rest and significant acceleration of HR recovery after exercise in study subjects.[16]

Rate of Perceived Exertion

The rate of perceived exertion was found to be higher in physically inactive children as compared to active and this was found to be statistically significant. (p= <0.0001).The rate of perceived exertion is determined majorly by change in the pulmonary system and the musculoskeletal system.The adaptations that takes place are as follows:

Pulmonary Adaptations

In physically active subjects,in response to physical activity like the step test,the ventilation increases in tandem with the cardiac output owing to an improvement in training induced tidal volume reserves.

In untrained subjects, when cardiac output rises but ventilation does not improve, ventilation perfusion mismatch occurs resulting in fall in arterial oxygen pressure and saturation. Thus with exertion there is a decrease in oxygen saturation and oxygen content of the blood.[9]

During exercise several changes take place in the skeletal muscle, such as changes in the temperature, acidity and ion concentrations. The changes in this parameters affects the performance of an individual and also cause muscular fatigue. The stored glycogen in muscle can be split into glucose and then glucose can be used for energy. Glycolysis is the first part of this process which takes place anaerobically. During glycolysis each glucose molecule is split into two pyruvic acid molecules and energy is released in the form of 2 ATP molecules. This pyruvic acid molecules can be used by the mitochondria of the muscle cells and combines with oxygen to form ATP molecules. During high intensity exercises the demand for oxygen is increased and supply of the oxygen doesn't meet the required demand. In absence of sufficient supply of oxygen, this pyruvic acid is converted into lactic acid and gets accumulated in the muscle causing muscle fatigue. Also, the increase in respiratory rate to counter the ventilation perfusion mismatch leads to breathlessness in non-active subjects thus accounting for their higher rate of perceived exertion post step test.[28]

Limitations: Our study calculated cardio respiratory fitness in terms of pulse rate, recovery time and rate of perceived exertion. Assessment of maximum oxygen uptake (VO2max) has not been calculated in our study in absence of exhaled air analysis or a valid predictive formula to calculate the same.

CONCLUSIONS

The cardio respiratory fitness as measured through Pulse rate, Pulse recovery time and Rate of Perceived Exertion using YMCA-TMST was better in physically active children as compared to physically inactive children.

Conflict of Interest. To the best of my knowledge, there were no known conflict of interest encountered in the present research

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