

CORRELATION OF ACSM'S WALKING EQUATION AND DIRECTLY MEASURED $VO_{2\max}$ IN INDIAN POPULATION: A PILOT STUDY

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ABSTRACT

Purpose of study: American College of Sports and Medicine equation is applied in many cardiovascular centers and sports medicine laboratory. It is used in majority of the commercial software available for exercise testing ACSM has published several metabolic equations for the indirect estimation of $VO_{2\max}$. So the purpose of the study was to find the applicability of ACSM walking equation in Indian population. **Aim and Objective:** To find out the correlation between actual $VO_{2\max}$ and predicted $VO_{2\max}$ 18-25 years female in Nagpur. **Methodology:** All the participants were selected according to sample of convenience and given a thorough explanation of the procedure in the language they understand. Each participant signed written informed consent before participating in the study in the language they could comprehend. Subjects were screened on the basis of selection criteria and PAR-q & you questionnaire. Total 20 participants were selected and demographic and anthropometric data was recorded. In this $VO_{2\max}$ was calculated directly by gas analyzer using AD instrument and indirectly by ACSM's walking equation and data was analyzed. **Result:** The mean and standard deviation of directly measured $VO_{2\max}$ (ml/kg/min) is 8.6354 and ± 4.5557 this shows the range of $VO_{2\max}$ for the studied population and $VO_{2\max}$ predicted by ACSM walking equation is 38.1891 and ± 5.4691 . The person's correlation for direct and indirect measurement of $VO_{2\max}$ suggested that there is no correlations with the 'r' value ($r=0.11$, $p=0.05$). **Conclusion:** The present study concluded that there is no correlation between actual and predicted $VO_{2\max}$ in the studied population and need to develop new regression equation for studied population i.e; ACSM equation is not applicable to the studied population.

KEY WORDS: American College of Sports and Medicine walking equation, $VO_{2\max}$, Indian population.

INTRODUCTION

Cardio respiratory fitness or maximal aerobic power is the overall capacity of the cardiovascular and respiratory system and the ability to carry out prolonged strenuous exercise. In current scenario, the cardio respiratory fitness is regarded the most important health fitness parameter because the low levels of cardio respiratory fitness have been associated with a markedly increase in risk of premature death from all causes and specifically from cardiovascular disease [1]. The maximal oxygen consumption [$VO_{2\max}$] attained during a graded maximal exercise till voluntary exhaustion has been considered the single best indicator of the cardio respiratory fitness [2]. Maximal oxygen consumption [$VO_{2\max}$] is the maximum amount of oxygen a person can take in and the value does not change despite an increase in

workload overtime until voluntarily exhaustion [3]. $VO_{2\max}$ reflects the amount of oxygen utilized by the working muscles [4]. It is expressed as liters/min as an absolute value or in milliliters/kg/min as a relative $VO_{2\max}$. $VO_{2\max}$ can be estimated using maximal or sub-maximal test and by direct or indirect methods. An indirect method of calculating $VO_{2\max}$ is exercise based and non-exercise based. Exercise based $VO_{2\max}$ is calculated by equations such as cooper 12 min test, 1 mile rock port test etc. Non exercise based $VO_{2\max}$ is estimated by age, body surface area, body mass index, fat % e.g. Wassermann equation. Direct method also known as maximal graded exercise test can be estimated by using Open Circuit Spirometry which is generally used in clinical or research settings e.g. treadmill test, cycle ergometry [1,2,3].

$VO_{2\max}$ is often estimated using predictive equations rather than direct measurements as it is cost effective and relatively easier, and is not only used in sport medicine but also of late in life style intervention program [5,6,7]. ACSM equation is applied in many cardiovascular centers and sports medicine laboratory [3]. It is used in majority of the commercial software available for exercise testing ACSM has published several metabolic equations for the indirect estimation of $VO_{2\max}$ while walking, running, and stepping as well



DOI: 10.5455/ijcbr.2017.33.09

eISSN: 2395-0471
pISSN: 2521-0394

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for arm and leg ergometers[8].

As there is dearth of literature on applicability of ACSM walking equation in Indian population, so the pilot study was undertaken.

MATERIALS AND METHODS

Study design: Observational study

Ethics approval: Institutional ethical committee approved and each participant signed written informed consent before participating in the study in the language they could comprehend.

Study place: V.S.P.M's college of physiotherapy.

Sample size and sampling method: 20 female subjects and convenience sampling method was used.

Inclusion criteria: Normal females, age-18-25, body mass index -18-24.9, Normal Waist circumference Females:> 88 cms

Exclusion criteria: History of Cardio respiratory illness & neurological condition, Recent History of musculo-skeletal trauma & infectious disease, uncontrolled metabolic disorder, especially abled population, Subjects who could not understand the procedure

Methodology:

All the participants were selected according to sample of convenience and given a thorough explanation of the procedure in the language they understand. Subjects were screened on the basis of selection criteria and PAR-questionnaire [1, 9]. Total 20 participants were selected and demographic and anthropometric data was recorded. A prerequisite for the participant before the direct measurement VO_{2max} was explained. Participants were asked to drink plenty of fluids, not to engage in any physical activity and to refrain from ingesting food, alcohol, caffeine prior to the test.

DIRECT MEASUREMENT OF VO_{2MAX} [1,2]: The mask along with mouth piece was connected through the head cap and fixed with the help of straps. They are informed about the inclinations after every 3 minutes and increase in the speed during procedure. Subjects were instructed to walk or run according to the speed set in Modified Bruce Protocol [10]. The subjects were encouraged to perform the procedure to their maximum tolerance level. Pulse, BP and SpO2 were measured before, during and after the procedure. After the test, the patient was allowed to sit for some time and gas analysis (AD instrument) was done.

Test termination criteria [1, 2, 10]:

Drop in systolic BP of >10mm Hg from baseline BP despite an increase in workload.

Shortness of breath, wheezing, leg cramps or claudicating.

Signs of poor perfusion, light headedness, nausea.

Subjects request to stop the test.

Physical or verbal manifestations of severe fatigue.

Indirect measurement of VO_{2MAX} : [1, 8] ACSM walking equation: $VO_{2max} = (0.1 \times \text{speed}) + (1.8 \times \text{speed} \times \text{grade}) + 3.5$

Data analysis: The descriptive data was analyzed by

statistical package for social sciences (SPSS) version 16. Pearson's correlation was calculated using regression. Level of significance was set at 0.05 .

RESULTS

Table 1. Age, BMI and waist circumference of participants

	Mean± SD
AGE (YEARS)	22.30±0.98
BMI(kg/m ²)	21.21±2.23
Waist circumference (cms)	54.75±4.46

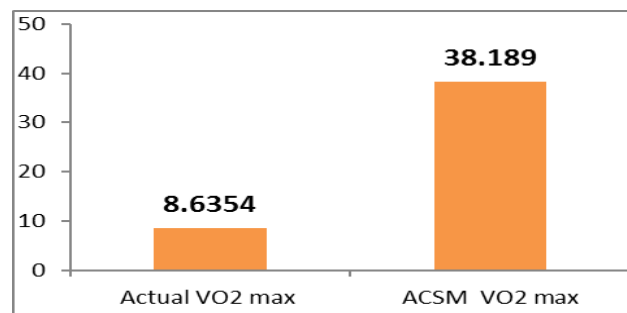


Figure 1. VO_{2max} calculated by treadmill test

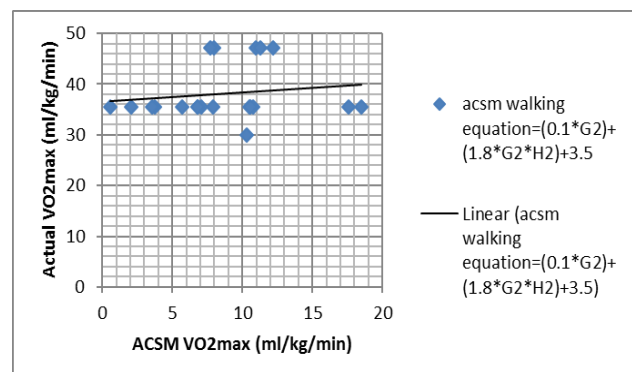


Figure 2. VO_{2max} calculated by treadmill test

The Figure 1 shows the mean of VO_{2max} (ml/kg/min) calculated by treadmill test using Modified Bruce Protocol and ACSM Walking equation.

Shows that there is a no co-relation of VO_{2max} calculated by treadmill test using Modified Bruce Protocol and ACSM Walking equation.

DISCUSSION

The actual VO_{2max} was calculated using gas analyzer with Modified Bruce Protocol in the exercise physiology laboratory. Predicted VO_{2max} was calculated by using ACSM's walking equation as the subject in the study walked with the maximum speed of 4.2 miles per hour which was less than 5 miles per hour [1, 2].

In the present study mean and standard deviation of directly measured VO_{2max} (ml/kg/min) is 8.6 ± 4.56 and

$\text{VO}_{2\text{max}}$ predicted by ACSM walking equation is 38.19 ± 5.47 for the studied population. The actual $\text{VO}_{2\text{max}}$ is lower than the predicted $\text{VO}_{2\text{max}}$ from the ACSM walking equation which suggest that the predictive equation is not found to be applicable to the studied population. As the ACSM's equation designed and developed using highly fit male subjects or based on estimates on Caucasian populations which differ from the Indians [8, 9]. Also the equation consists of only the grade and speed, not the time [1,2] taken to reach the stage which may be the confounding factor which may lead to error in prediction. The population in the study was not undergoing any fitness program so that may be the reason for low actual values of $\text{VO}_{2\text{max}}$ in the present study [7, 11, 12]. Nitin YM et al in their study found that physical activity level is strong predictor of time to $\text{VO}_{2\text{max}}$ and time taken to achieve $\text{VO}_{2\text{max}}$ is an important factor in determining $\text{VO}_{2\text{max}}$. It was also found that an overestimation in the $\text{VO}_{2\text{max}}$ values from predicted equations which supports the present study [4].

The present study, found that there is no co-relation between actual and predicted $\text{VO}_{2\text{max}}$ with the 'r' value ($r=0.11$, $p=0.05$). As $\text{VO}_{2\text{max}}$ is influenced by many factors such as age, gender, body surface area, BMI, time, level of physical activity, genotype and phenotype which differs according to individuals [13]. And these parameters are not considered in the equation which can affect the strength to calculate $\text{VO}_{2\text{max}}$.

When the study compared predicted and actual $\text{VO}_{2\text{max}}$ it was found that $\text{VO}_{2\text{max}}$ calculated by ACSM equation was overestimated which can be supported by study done by Koutlianos N et al [3] and Pinaki Chatterjee [6], in their study it was found that there was no correlation between direct and indirect equations in the studied population. Koutlianos N et al [3] supports the result of present study which found that predicted $\text{VO}_{2\text{max}}$ by ACSM's running equation were also overestimated for the studied athletes. The result of present study is also supported by Christina G [7] using lower limb cycle ergometer with ramp protocol and $\text{VO}_{2\text{max}}$ estimated using modified ACSM equation and they concluded that error of estimation of $\text{VO}_{2\text{max}}$ [7]. Peterson et al also found that ACSM's equation overestimated $\text{VO}_{2\text{max}}$ in older fit men and women and concluded that equation is not appropriate to use when treadmill testing [14]. The study done by Bruce et al, suggest that there is a physiological difference in various population and each has a unique relationship of workload with VO_2 [15, 16].

CONCLUSION

The present study concluded that there is no correlation between actual and predicted $\text{VO}_{2\text{max}}$ in the studied population.

Future scope of study: To study on a larger sample size and develop a regression equation for both males and females.

Financial Support : None

Conflicts of Interest: There are no conflicts of interest.

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How to Cite this article: Rashmi N. Ronghe, Neha Ashok Gotmare, Mangala G Deshpande. Correlation of ACSM's Walking Equation And Directly Measured $\text{VO}_{2\text{max}}$ In Indian Population: A Pilot Study . *Int. j. clin. biomed. res.* 2017;3(3): 31-33.