

## Correlation of Wasserman's Equation and Directly Measured $VO_2$ Max in Indian Population - A Pilot Study

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### Abstract

**Purpose of study:**  $VO_2$  max can be measured by direct and indirect method. Maximal oxygen uptake ( $VO_2$  max) during a graded maximal exercise test is the objective gold standard method to assess cardio respiratory fitness. Direct method (open circuit spirometry) requires specialized trained equipment, trained personnel and is expensive.  $VO_2$  max is measured indirectly through these tests using regression equations. These regression equations have been formulated on the basis of normative data obtained from Caucasian population.

**Aim and Objective:** To find out the correlation between observed  $VO_2$  max and predicted  $VO_2$  max in Indian population.

**Study design:** Cross sectional study

**Methodology:** 22 college students aged between 18-25 years were included after fulfilling the selection criteria demographic data was recorded and vitals were taken before, during and after the procedure. In this  $VO_2$  max was calculated directly by gas analyzer using AD instrument and indirectly by Wasserman's equation (non exercise based) and data was further analysed statically.

**Result:** The Interclass Correlation found between direct and indirect methods was 0.39 which shows that there is poor limit of agreement between the two methods.

**Conclusion:** The Wasserman's equation was inapplicable to evaluate  $VO_2$  max for the students included in the study.

**Keywords:** Wasserman's equation,  $VO_2$  max.

### 1. Introduction

The most important component of physical fitness is cardio respiratory endurance [1]. The criterion to measure cardio respiratory fitness is person's maximal oxygen uptake. It is the product of maximum cardiac output and arteriovenous oxygen difference  $\{[VO_{2max} = \text{cardiac output} \times (aO_2 - vO_2)]\}$ . Therefore it is directly related to the functional capacity of the heart. It is considered as an important criterion because low cardio respiratory fitness increases the risk of premature death from all causes and specially from cardiovascular diseases[2]. Measurement of physical fitness is a common and appropriate practice in preventive and rehabilitative exercise programs [1]. Oxygen uptake at maximum exercise ( $VO_2$  max) is considered the best available index for

assessment of exercise capacity. Maximal oxygen uptake ( $VO_2$  max) during a graded maximal exercise test is the objective gold standard method to assess cardiorespiratory fitness and is also used as a predictor of cardiovascular morbidity and mortality [1]. It is the region where oxygen uptake plateaus and shows no further increase/s only slightly with an additional workload. The  $vo_{2max}$  is measured in either mL/min or mL/kg/min, it quantifies an individual's maximal ability to utilize oxygen in aerobic production of ATP. The measurement of  $VO_{2max}$  is used for many purposes including quantifying training intensity for aerobic exercise prescription, monitoring the effect of aerobic training programs, and classifying individuals for health risk[3].

Determination of maximum oxygen uptake (VO<sub>2max</sub>) by direct method is associated with equipment, space and personnel with through study of exercise science to carry out this test. It is difficult, exhausting and often hazardous to perform with regardless to the type of ergometer used. It is costlier and restricted within the laboratory because of its exhausting and difficult experimental protocol, and also it is complicated for larger population. It is not feasible so the variety of maximal and submaximal tests can be used to estimate VO<sub>2max</sub> [2]. This method requires specialized trained equipment, trained personnel and is expensive. So as it is not feasible and desirable, a variety of sub maximal and maximal exercise tests can be used to estimate VO<sub>2max</sub>[2]. VO<sub>2max</sub> is measured indirectly through these tests using regression equations [3]. These regression equations have been formulated on the basis of normative data obtained from Caucasian population. Among various indirect methods Wasserman's equation is non-exercise based equation which is based on anthropometric measurement [4]. So the purpose of the study was to assess the applicability of Wasserman's equation to predict VO<sub>2max</sub> in Indian population.

## 2. Material and methodology

Institutional ethical committee approval was obtained. A cross-sectional study was done at the institute in the physiology lab with normal subjects within the age group of 18-25 years. Within this age group diagnosed cases of Cardiovascular / Respiratory / Neuromuscular / Musculoskeletal / Rheumatologic conditions, uncontrolled metabolic diseases(diabetes, myxedma etc.), any recent ECG changes, lower limb fractures and URTI, mentally challenged and specially abled and participant who could not comprehend the procedure were excluded. 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 [1]. Total 22 participants were selected and demographic and anthropometric data was recorded. Direct measurement VO<sub>2max</sub> was done using Open circuit spirometry (AD instrument) using Modified Bruce protocol [2] to measure VO<sub>2max</sub> in the physiology lab. A prerequisite for the participant before the direct measurement VO<sub>2max</sub> 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. Indirect using predicted non-exercise based Wasserman's equation Male: - VO<sub>2max</sub> (L/min) = wt X

[50.72-(0.372 X age)]/1000; Female:-VO<sub>2max</sub> (L/min) = (wt+42.8) X (22.78-0.17 X age)/1000[4].

Data was analyzed using SPSS version 20.0. Pearson's co-relation test was used to find out the co-relation between direct and indirect VO<sub>2max</sub>. Intra-class correlation coefficient (ICC) was used to find out limit of agreement between two methods.

## 3. Result

Data analysis revealed no co-relation between direct and predicted VO<sub>2max</sub> (r=0.24, p > 0.05) was found - statistically non significant. The ICC between two methods was 0.39 which shows poor limit of agreement. Age (r=0.49, p<0.05) and height (r=0.49, p<0.05) correlated moderately and BMI(r=0.661,p=0.001) showed good co-relation with directly measured VO<sub>2max</sub> and were statistically significant. Age and BMI had no-correlation while height is weakly correlated (r=0.112, p>0.05) with predicted VO<sub>2max</sub> which was statistically non-significant.

**Table 1: Showing weak correlation of Direct and predicted VO<sub>2max</sub>**

Parameters (VO <sub>2max</sub> )	r	p
Direct and predicted	0.24	>0.05

## 4. Discussion

The purpose of this study was to find the correlation between direct and predicted VO<sub>2max</sub> in normal population within the age group 18-25 years of Nagpur with the sample size was 22, out of which 16 subjects were female and 6 were male. Direct estimation of VO<sub>2max</sub> comprised treadmill exercise while indirect was predicted by Wasserman's equation based on anthropometric parameters. From the study, results indicated that age (r=0.49, p<0.05) and height (r=0.49, p<0.05) were moderately correlated and BMI (r= -0.661, p=0.001) had good inverse correlation with directly measured VO<sub>2max</sub>. Study done by Chatterjee *et al* has also proved that there is inverse relationship between BMI and VO<sub>2max</sub> [5]. Obese individual has lower VO<sub>2max</sub> values than normal weight individual due to the fact that adipose tissue is relatively metabolically inactive [6] and excess body fat impairs cardio-respiratory functions and reduces mechanical efficiency for a given work load [5]. While there is no correlation of age and BMI with predicted VO<sub>2max</sub> but has weak correlation with height. So it proves that VO<sub>2max</sub> is influenced by many factors which include age, sex, body size, composition and level of aerobic training [7].

The mean and standard deviation of directly measured VO<sub>2max</sub> (ml/kg/min) was 2.72 ± 2.57; and predicted by Wassermann's equation VO<sub>2max</sub> was 2.07± 0.46

for the studied population. The resulting 'r' value ( $r=0.242$ ) indicated that  $VO_{2max}$  by direct and predicted method are weakly correlated and not statistically significant. The study by Krishna Kumar *et al*, found that  $VO_{2max}$  derived from Wasserman's equation was not applicable in the studied population which supports the result of present study [3]. The study by Debeaumont *et al.*, in 2016 using Wasserman *et al* and Glaser *et al* method were valid to predict  $VO_{2peak}$  in obese women and men respectively but found the accuracy of the predictions was low for both methods [8]. Another study done in Brazilian population in 2014 suggested that there was difference in directly measured and predicted  $VO_{2peak}$  values by Wasserman's and Jones equation [9].

The present study found that Intra Class Correlation coefficient (ICC) was also assessed to measure the agreement between two methods which was 0.39. As per the guidelines ICC values above 0.75 indicate good reliability, and those below 0.75 indicate poor to moderate reliability. The ICC value of present study suggests poor limit of agreement between two methods indicating Wasserman's equation is not applicable to estimate  $VO_{2max}$  to the studied population. The study by Reza Ahmadian concluded that direct  $VO_{2max}$  and predicted by the Hansen and Wasserman reference had wide variations in predicted versus directly measured  $VO_{2max}$  which supports the present study [5].

Sample size was small and the study is not applicable to all age groups. So, further studies can be done in different age groups and larger sample size and a normogram and new regression equation should be developed.

## 5. Conclusion

The present study concludes that there is inapplicability of prediction equation based on anthropometric parameters in the population under study. Thus it is not applicable to evaluate aerobic fitness in terms of  $VO_{2max}$  for the studied Indian population of Nagpur.

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