

Content available at: <https://www.ipinnovative.com/open-access-journals>

Indian Journal of Clinical Anatomy and Physiology

Journal homepage: <https://www.ijcap.org/>

## Original Research Article

A study showing a correlation between the effect of treadmill and ergometer on  $\text{VO}_2\text{max}$  in athleteVivek V Nalgirkar<sup>1</sup>, Mrunalini R Kanvinde<sup>1,\*</sup><sup>1</sup>Dept. of Physiology, D Y Patil Medical College Hospital and Research Institute, Navi Mumbai, Maharashtra, India

## ARTICLE INFO

## Article history:

Received 06-01-2022

Accepted 13-02-2022

Available online 01-03-2022

## Keywords:

 $\text{VO}_2\text{max}$ 

Treadmill

Hand ergometer

Bruce protocol

Stress test lab

Athletes

Non-athletes

## ABSTRACT

The goal of this study was to correlate the effect of the treadmill and ergometer on  $\text{VO}_2\text{max}$  through Bruce protocol and Mosso's ergograph. Depending on the need for oxygen to tissues  $\text{VO}_2\text{max}$  increases as a subject does treadmill from moderate to maximal. As exercise intensity increases so does oxygen consumption reaches the point where exercise intensity can continue to increase without the associated rise in oxygen consumption. As endurance training results in central and peripheral adaptations that markedly improve an individual's ability to perform physical work, athletes are thus commonly assumed to be able to tolerate many kinds of physiological stressors better than non-athletes.

After getting approval from a medical ethics committee, data collection was done at the Stress test lab. at Nerul, Navi Mumbai by keeping some inclusive and exclusive criteria. After taking permission from the medical ethics committee. 40 athletes were asked to do treadmill as well as hand ergometer with a proper duration of exercise for 2 weeks and their  $\text{VO}_2\text{max}$  were assessed by using specific formulae for treadmill and hand ergometer. For the treadmill, a protocol used was Bruce protocol while for the hand ergometer, the ergograph was used as Mosso's ergograph. For comparison and proper results, 40 non-athlete were asked to do treadmill and hand ergometer. Statistical analysis was done by unpaired T-test.

In athletes, a good correlation was between the effect of treadmill and ergometer on  $\text{VO}_2\text{max}$  ( $P > 0.001$ ) an athlete as compared to non-athletes ( $P > 0.001$ ) after estimating  $\text{VO}_2\text{max}$ .  $\text{VO}_2\text{max}$  was found to be much more increased in athletes as well as non-athletes performing treadmill than athletes as well as non-athletes performing hand ergometry ( $P > 0.001$ ).

**Conclusion:** It was concluded  $\text{VO}_2\text{max}$  is found to be much more increased during treadmill than ergometer in athletes as compared to non-athletes.

This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: [reprint@ipinnovative.com](mailto:reprint@ipinnovative.com)

## 1. Introduction

To our knowledge, no paper has examined the agreement between the treadmill and the hand ergometer. Treadmill and the hand ergometer are the two most common exercises and are used interchangeably to assess exercise tolerance.

As exercise intensity increases so does oxygen consumption reaches the point where exercise intensity can continue to increase without the associated rise in oxygen

consumption. Regular physical activity during leisure time is associated with better health outcomes. Physical fitness and level of regular exercise are closely related to cardiovascular health. To maintain a healthy lifestyle, the importance of physical activity cannot be underestimated. It is the single most important endeavor that one can participate in to promote health throughout a lifetime.

Physical fitness and level of regular exercise are closely related to cardiovascular health Regular exercise leads to functional and structural adaptations that improve cardiac function.<sup>1</sup> Modifiable lifestyle factors, as cardiorespiratory

\* Corresponding author.

E-mail address: [vaishnav5bale@gmail.com](mailto:vaishnav5bale@gmail.com) (M. R. Kanvinde).

fitness (CRF) and body mass, may prevent hypertension. To maintain a healthy lifestyle, the importance of physical activity cannot be underestimated. It is the single most important endeavor that one can participate in to promote health throughout a lifetime. (38)

When challenged with any physical task, the human body responds through a series of integrated changes in function that involve most, if not all, of its physiologic systems. Movement requires activation and control of the musculoskeletal system; the cardiovascular and respiratory systems provide the ability to sustain this movement over extended periods. When the body engages in exercise training several times a week or more frequently, each of these physiologic systems undergoes specific adaptations that increase the body's efficiency and capacity.

Endurance training results in central and peripheral adaptations that markedly improve an individual's ability to perform physical work. Athletes are thus commonly assumed to be able to tolerate many kinds of physiological stressors better than non-athletes.

Movement requires activation and control of the musculoskeletal system; the cardiovascular and respiratory systems provide the ability to sustain this movement over extended periods. When the body engages in exercise training several times a week or more frequently, each of these physiologic systems undergoes specific adaptations that increase the body's efficiency and capacity. The magnitude of these changes depends largely on the intensity and duration of the training sessions, the force or load used in training, and the body's initial level of fitness. Removal of the training stimulus, however, will result in loss of the efficiency and capacity that was gained through these training-induced adaptations; this loss is a process called detraining.

$\dot{V}O_{2max}$  gives as important guidance about the oxygen requirement of the heart per beat. As for exercise intensity increase, oxygen consumption reaches the point where exercise intensity can continue to increase without the associated rise in oxygen consumption. Therefore cardiorespiratory fitness can be a limitation for  $\dot{V}O_{2max}$ , which is an important component of health-related physical fitness

## 2. Methodology

### 2.1. Data collection

After getting approval from the medical ethics committee and permission from Dr. Priya Cholera and Dr. Kane (HOD of Cardiology) the study was initiated in the Stress Test Lab at Dr. D. Y. Patil Hospital & Research center, Nerul, Navi Mumbai. For this study, 40 athletes and non-athletes were chosen (age-group above 18 - 24 years).

### 2.2. Inclusion criteria

BMI should be 18–24  $6m^2/kg$  (according to National Institute of Health Science).

### 2.3. Exclusion criteria

1. The subject should have a 2–3 hours gap between diet and exercise.
2. Subject should not have a cardiorespiratory or orthopedic disease.

In this study, safety parameters chosen were age, height, weight, blood pressure, pulse, and respiratory parameters were respiratory rates, peak expiratory flow rate while predictors chosen were  $\dot{V}O_{2max}$ .

Before the commencement of the study, the subject was asked to sign an informed consent form.

BMI of the subject was calculated by the formula-

$$BMI = \frac{Weight\ in\ Kg}{Height\ in\ m^2}$$

Height was measured by a measuring tape. Weight was measured by a standard weighing machine (stadiometer).

Blood pressure and pulse were recorded by a standardized digital blood pressure monitor.

Peak expiratory flow rate was recorded by using a peak expiratory flow meter.

After signing an informed consent form, one group of 20 athletes were asked to perform treadmill and another group of 20 athletes was asked to perform hand ergography and from safety parameters,  $\dot{V}O_{2max}$  and was calculated, to predict correlation.

For comparison 40 non-athlete were asked to do treadmill and hand ergometer and their  $\dot{V}O_{2max}$  was also calculated

### 2.4. Treadmill

20 athletes and 20 non-athletes were asked to perform exercise on Treadmill, by using Bruce protocol for the different duration 3 times a week. (Till to get 90% of maximal, age-predicted heart-rate was achieved).<sup>2</sup> Treadmill – intensity – 10mm/mv, frequency – 50 hertz, speed – 25 m/sec.

### 2.5. Hand ergography

20 athletes and 20 non-athletes were asked to perform hand ergography for 15 mins, 3 times a week. Ergograph used is Mosso's ergograph, in which there is an arrangement for fixing the hand and fingers in appropriate holders and the middle finger is put in a sling present at another end, which is to be flexed for alternate seconds. A weight of 1.5kg is attached to the cord, which acts as a tension.<sup>3</sup> After doing each exercise -Treadmill and hand ergography, blood pressure. Pulse and respiratory rate and peak expiratory flow rate was again recorded  $\dot{V}O_{2max}$  was calculated as.-

$$\dot{V}O_{2max} \text{ (ml/kg/min)} = 3.62 \times T + 3.91 \text{ (Treadmill)} \quad (12)$$

$$\dot{V}O_{2max} = 15.3 \times \text{HR rest/HR max (Ergography)}$$

## 2.6. Statistical analysis

Statistical analysis was done by unpaired T-test.

## 3. Result

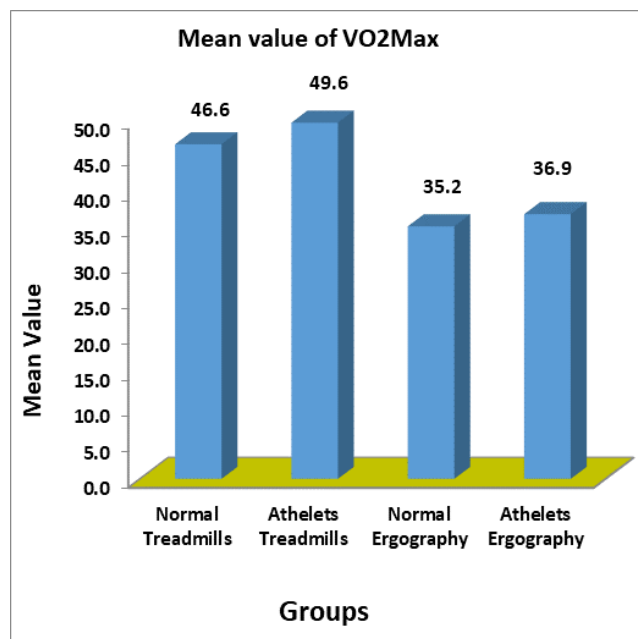


Fig. 1:

Tables 1 and 2 along with the graph show that a good correlation was between the effect of the treadmill and ergometer on  $\dot{V}O_{2max}$  ( $P > 0.001$ ) in athletes as compared to non-athletes ( $P > 0.001$ ) after estimating  $\dot{V}O_{2max}$ .  $\dot{V}O_{2max}$  was found to be much more increased in athletes as well as non-athletes performing treadmill than athletes as well as non-athletes performing hand ergometry ( $P > 0.001$ ).

Thus a much more correlation was found out between the effect of the treadmill through Bruce protocol and the ergometer through Mosso's ergograph on  $\dot{V}O_{2max}$  in athletes as compared to non-athletes.

## 4. Discussion

This study demonstrates how  $\dot{V}O_{2max}$ , calculated after doing the treadmill through Bruce protocol and hand ergometer is the best parameter in athletes and non-athletes. This study indicates that young, normal, sedentary men i.e. non-athletes are capable of developing some of the athlete's physiological characteristics. The effects of exercise (Treadmill and hand ergometer) on  $\dot{V}O_{2max}$  are dependent upon the frequency, intensity, and duration of

the exercise itself, consistent with the findings of Guoyuan Huang.<sup>1</sup>

The abilities of such functional components are reflected in such measurable terms as maximal oxygen uptake and physical working capacity.<sup>4</sup> Recreational athletes, a growing population that is commonly encountered in clinical practice, perform far less exercise volume and do so at lower training intensities than athletes at higher training intensity. But to what degree the moderate-intensity exercise training typically practiced by recreational athletes is unknown.<sup>5</sup>

However, it is agreed that ventilatory or diffusion capacities, or both, are not limiting factors in determining a normal individual's exercise capabilities.<sup>6</sup>

Physiologically  $\dot{V}O_{2max}$  is the intensity of an individual to increase metabolic processes with the requirements of increased physical efforts. This result due to the transformation of chemical energy into a mechanical one. This, in combination with your body's improved ability to deliver blood to muscles during exertion, ensures that oxygen gets distributed more effectively when you're exercising and when you're resting matching with the result obtained by Andrew J Shah.<sup>7</sup>

To the athlete who does aspire to endurance-type sports and does have favorable genetics for aerobic activities, the emphasis changes from things that cannot be changed (genetics) to abilities that can be improved like muscular endurance, neuromuscular coordination, mechanical efficiency, and cardiorespiratory fitness.  $\dot{V}O_{2max}$  will be the ultimate limiting factor in endurance activities for the chronically trained athlete.  $\dot{V}O_{2max}$  is the measure of aerobic capacity and determined as an international standard of physical capacity.

As per Smita S. Bute,  $\dot{V}O_{2max}$  in athletes is 62% higher than non-athletes, which suggested that men who regularly exercise vigorously can maintain cardiovascular function, which is a consistent finding in many training studies.<sup>8</sup>

In athletes, it is oxygen delivery, not oxygen utilization that limits  $\dot{V}O_{2max}$ . After physical training,  $\dot{V}O_{2max}$  improvement mainly originates during exercise with increasing stroke volume. The maximum rate of work that can be performed is limited by the combined capacities of the cardiovascular and respiratory systems to take in, transport, and use oxygen. Thus maximum oxygen intake measures the functional capacity of the cardiovascular system and is a useful criterion for assessment of overall capacity to perform work.

This study also indicates that non-athletes are capable of developing some of the true athlete's physiological characteristics. They possess an expanded oxygen transport system which should be reflected in increased work capabilities.

**Table 1:**

Parameters	Athletes	Unpaired T-Test	P-value	Significant at 5% level
Duration	Athletes Ergography Athletes Treadmill	0.486	0.630	No
VO <sub>2</sub> max	Athletes Ergography Athletes Treadmill	10.139**	<0.001	es

**Table 2:**

Parameters	Normal	Unpaired T-Test	P-value	Significant at 5% level
Duration	Normal Ergography Normal Treadmill	4.116**	<0.001	Yes
VO <sub>2</sub> max	Normal Ergography Normal Treadmill	11.544**	<0.001	Yes

\*Statistically significant at 5% level i.e., P<0.05 \*\*statistically highly significant at 0.01% level i.e., P<0.001

## 5. Conclusion

It was concluded  $\dot{V}O_{2max}$  is found to be much more increased during treadmill than ergometer in athletes as compared to non-athletes.

## 6. Source of Funding

None.

## 7. Conflict of Interest

The authors declare no conflict of interest.

## References

- Huang G, Gibson CA, Tran ZV, Osness WH. Controlled Endurance Exercise Training and VO<sub>2</sub>max Changes in Older Adults: A Meta-Analysis. *Prev Cardiol.* 2005;8(4):217–25.
- Dwyer GB, Davis SE. ACSM's Health-Related Physical Fitness Assessment Manual. Baltimore: Lippincott Williams & Wilkins; 2008.
- Gim MN, Choi JH. The effects of weekly exercise time on VO<sub>2</sub>max and resting metabolic rate in normal adults. *J Phys Ther Sci.* 2016;28(4):1359–63.
- Pakkala A, Veeranna N, Kulkarni SB. A comparative study of cardiopulmonary efficiency in athletes and non-athletes. *J Indian Med*

*Assoc.* 2005;103(10):522–7.

- Moreira-Da-Costa M. Maximal oxygen uptake during exercise using trained or untrained muscles. *Braz J Med Biol Res.* 1984;17(2):197–202.
- George JD, Paul SL, Hyde A, Bradshaw DI, Vehrs PR, Hager RL, et al. Prediction of Maximum Oxygen Uptake Using Both Exercise and Non-Exercise Data. *Meas Phys Educ Exerc Sci.* 2009;13(1):1–12.
- Shaw AJ, Ingham SA, Atkinson G, Folland JP. The co-relation between Running Economy and Maximal Oxygen Uptake: Cross-Sectional and Longitudinal Relationships in Highly Trained Distance Runners. *PLoS One.* 2015;10(4):e0123101.
- Bute SS. A Comparative Study of VO<sub>2</sub> Max in Young Female Athletes and Non-Athletes. *IOSR J Sport Phys Educ.* 2014;1(7):27–9.

## Author biography

**Vivek V Nalgirkar**, Professor

**Mrunalini R Kanvinde**, Assistant Professor

**Cite this article:** Nalgirkar VV, Kanvinde MR. A study showing a correlation between the effect of treadmill and ergometer on VO<sub>2</sub>max in athlete. *Indian J Clin Anat Physiol* 2022;9(1):50-53.