

## Short Communication

# Effect of Short-term Physical Exercise on Serum Total Testosterone Levels in Young Adults

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## Abstract

The effect of short term (12 weeks) physical exercise on serum total testosterone level was evaluated in 30 young male adults, aged 18-27 years (mean age  $21.67 \pm 2.26$  years). These medical students, having sedentary life style underwent heavy exercise by attaining heart rate 125-150 beats/min on bicycle ergometer for 15 min on alternate day basis amounted to 670 kilopond metre per minute work done and percentage of  $VO_{2max}$  was  $71 \pm 3$ . Pre-exercise serum total testosterone levels ( $5.49 \pm 1.31$ ) of students were compared with those obtained after 1 week and 12 weeks of initiation of exercise. The serum total testosterone was measured by DRG Testosterone ELISA kit. After 1 week of exercise, a statistically insignificant decrease ( $5.488 \pm 1.32$ ;  $P > 0.05$ ) was found while after 12 weeks of exercise, a statistically significant increase ( $6.41 \pm 2.28$   $P < 0.05$ ) was noticed between the pre-and post-exercise serum total testosterone levels. We conclude that short-term exercise produces an elevation in serum testosterone levels in young adults.

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## Introduction

Testosterone is a major male androgen, synthesized from cholesterol in Leydig cells of testes. The most potent biological effect of testosterone is its stimulation of growth of sexual tissues. However, it is also thought to increase: appetite, lean body weight, red cell production, bone density, glucose uptake by muscle, muscle glycogen storage, and protein synthesis associated with muscle strength (1).

In fact, a reduced secretion has been associated with surgical stress, electrical shock and psychological stress (2).

The magnitude of testosterone release during exercise can be varied by exercise mode, intensity, and duration. An acute bout of exercise rapidly elevates testosterone level in circulation. This response is mediated by increased sympathetic activity during exercise and lactate, a metabolite produced from exercised skeletal muscle during anaerobic glycolysis (3).

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So with this background in hand, present study was designed to evaluate the effect of short-term physical exercise on serum testosterone levels in young adults.

## Method

### Subjects

The study was executed on 30 male, medical students in the department of Physiology, G.S.V.M. Medical College, Kanpur. The subjects were briefed about the study protocol and their written consent was taken. All the subjects were having a sedentary life style with almost equal involvement in physical exercise and similar diet pattern.

The physical characteristics of the subjects were the following : age  $21.67 \pm 2.26$  yrs; height  $169.2 \pm 7.51$  cm; weight  $63.8 \pm 9.67$  kg; BMI  $22.3 \pm 3.09$  kg/m<sup>2</sup>.

Subjects were excluded having history of any chronic disease, endocrinopathy or taking any serum testosterone altering medicine. Sportsmen and athletes were excluded from the study.

### Study protocol

The baseline reading of serum total testosterone was taken before exercise, by collecting 3 ml of venous blood in plain vial and serum was separated out. The DRG Testosterone ELISA kit was used for the quantitative in vitro diagnostic measurement of testosterone. Sex Hormone Binding Globulin was not measured separately.

The exercise was performed on bicycle ergometer on the alternate day basis under supervision and serum total testosterone levels were measured after 1 week of initiation of exercise and then after 12 weeks of exercise. The target of exercise was to achieve a heart rate ranging from 125-150 beats/minute. This target was attained in 15 minutes by doing cycling, which amounted to 670 kilopond meter per minute work done (the tension was kept at 3 kg, revolutions were 130/min, circumference of wheel was 1.72 metre). Percentage of  $VO_{2max}$  was  $71 \pm 3$  (4).  $VO_{2max}$  of individual subject was calculated as per the given steps :-

(a) Heart rate of each subject was recorded during last 10 sec. on each occasion of exercise & it was multiplied by the figure of 6 to get the value in terms of per minute.

- (b) For each subject, mean of heart rates of all occasions of exercise was calculated.
- (c)  $O_2$  consumption (L/min) was calculated for each subject by joining the mean of total heart rate of all occasions for the subject and power output 670 (work done in kpm per min) on Astrand Nomogram (Fig. 1).
- (d) The mean of  $O_2$  consumption for the study group was calculated, which came to be  $2.56 \pm 3.0$ . Finally the % of  $VO_{2max}$  was calculated by taking 3.6 L/min as standard value of  $VO_{2max}$  for physically untrained normal male person (5).

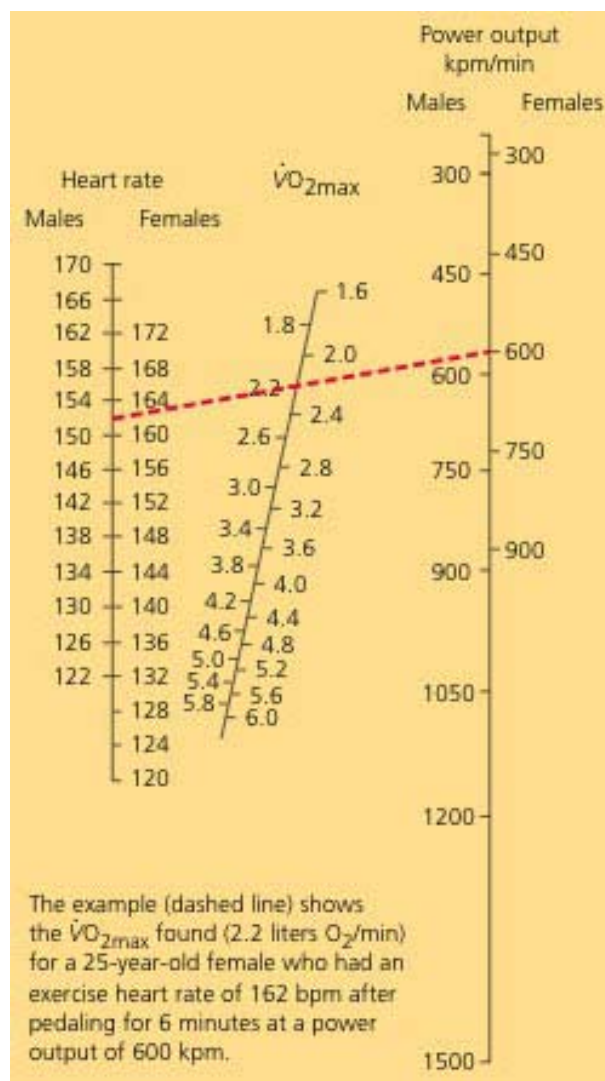


Fig. 1 : Astrand nomogram.

### Statistical analysis

Statistical analysis was performed by the help of Excel statistical software Inter-assay Coefficient of variation 29.69% and Intra-assay coefficient of variation 35.10% were calculated to assess the variability induced by the physical and methodological factors related to assay.

## Results

Serum total testosterone level of the subjects before exercise was  $5.49 \pm 1.31$  (Mean  $\pm$  S.D.).

After exercise of 1 week, serum testosterone was  $5.488 \pm 1.30$ . The change is statistically non-significant, as  $P \leq 0.05$ . A statistically significant change ( $P \leq 0.05$ ) was noticed after 12 weeks of exercise; as serum total testosterone level of the subjects before exercise was  $5.49 \pm 1.31$  and after exercise at 12 weeks, was  $6.4 \pm 2.28$  (Table I).

TABLE I: Serum total testosterone level of all the subjects.

Before exercise	Serum total testosterone (ng/dl)	
	After exercise of 1 week	After exercise of 12 weeks
$5.49 \pm 1.31$	$5.488 \pm 1.32$	$6.41 \pm 2.28$

P value 0.05; P value < 0.05.

## Discussion

Present study showed a slight decline in testosterone level in comparison to basal level in young sedentary medical students after undergoing heavy exercise for a period of 1 week but 12 week heavy exercise on the other hand brought increment in serum total testosterone level.

The reason of decline in the level of testosterone after 1 week of physical exercise may partly be associated to the fact that testosterone secretion is highly related not only to physiological but also to psychological and environmental factors. Poor physical and psychological adaptability of the sedentary young adults in the initial phase of physical

exercise programme may have resulted in suppression of testosterone secretion (6). Further there are evidences that if body is under stressful condition, psychic stimulation causes disturbance in the Hypothalamic-Hypophyseal-Axis and as a consequence, raised level of ACTH may be found and reflexly resulting in declined testosterone for the initial exercise programme. However, in due course of time with improved physical status of the body to bear the physical stress of certain level, would not impose so much stress upon the body (2).

The increment in the serum testosterone level after a span of 12 weeks exercise can be well explained on the basis of few quoted studies. Sutton et al have suggested that during exercise the rise of testosterone may either be due to its increased secretion or decreased clearance or both (7). Stimuli during exercise such as catecholamines, prostaglandins and alteration in testicular blood flow could be the attributory factors in the rise of testosterone. Further during exercise hepatic blood flow is reduced which brings about the decreased hepatic clearance of androgens, bringing elevation in the circulating level of Testosterone. Zmuda JM et al also added that during exercise sex hormone binding globulin (SHBG) levels are increased (although it was not assessed in the present study during pre exercise and post exercise period) that binds testosterone with the high affinity, approximately half the circulating testosterone in the men is bound to it and perhaps responsible for retardation of hepatic clearance of testosterone (8).

It has also been well discussed in many studies that what may be the likely significance of the elevated serum testosterone level in exercise. Firstly, androgen receptors are present in skeletal and cardiac muscle and regulate the expression of the muscle proteins actin and myosin heavy chains. Exercise may enhance the responsiveness of muscle to androgenic hormones by up regulating these receptors. Thus androgens play a well recognised role in maintenance of bone and muscle tissues and in exercise they may be important in muscle fibres repair and hypertrophy (9). Secondly, it appears that muscle glycogen is of particular importance as energy substrate and exercise increases the ability of muscle tissue to synthesize and store glycogen,

which may be dependent on adequate testosterone levels. Thus, the rise in testosterone in exercise may be important in utilization and replenishment of muscle glycogen. Thirdly, it is generally known that lactate is a metabolite of anaerobic glycolysis produced from exercised skeletal muscles and increased demand of energy utilization, is again said to be working under the effect of elevated testosterone (10). Lastly, the positive effect of exercise on improving insulin sensitivity could partially be associated with the exercise induced testosterone release. The level of muscular activity gets reduced with age concurrently causing insulin resistance and type 2 diabetes mellitus. Increasing muscle mass is a well known physiological action of testosterone and thus responsible for improved insulin sensitivity and glucose tolerance (11). As androgens also increase muscle mass and if more muscle mass undergo regular exercise, it again causes increased androgen secretion thus, a vicious cycle sets up which is very vital for physiological concept based treatment of insulin resistance or type 2 diabetes mellitus. Since Diabetes causes not only derangement of carbohydrate metabolism but equally of fat metabolism. So chances of atherosclerosis and its complications are reduced.

On the basis of above outline of discussion we can very well presume that even heavy physical exercise is important in improving the ability of fertility in young adults by raised level of testosterone.

Though, total testosterone showed a bimodal seasonal variation ( $P < 0.001$ ) with a small peak in February, the nadir in June, and a more prominent peak in October and November. However, the seasonal variation was not much significant in the present study as it was of 3 months duration (same season pertaining to Indian weather) starting from Oct to Dec and in all the subjects almost parallel changes were seen.

### Conclusion

We conclude that short-term exercise produces an elevation in serum testosterone levels in young adults and factors during exercise such as catecholamines, prostaglandins and alteration in testicular blood flow could be the attributory causes in the rise of testosterone. This response is also mediated by lactate, a metabolite produced from exercised skeletal muscle during anaerobic glycolysis.

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