

## Ergogenic Effects of Yohimbine: Standardized Cycling Clinical Study

Hayder M. Al-Kuraishy\*<sup>1</sup>, Haidar A. N. Abood<sup>2</sup>, Ali Ismail A. Al-Gareeb<sup>1</sup>

<sup>1</sup>Department of Pharmacology/College of Medicine/ Al-Mustansiriya University/ Baghdad/ Iraq

<sup>2</sup>Department of Pharmacology/College of Medicine/ Kerbala University/ Kerbala/ Iraq

### Abstract

**Background:** Ergogenic denote rising in the capacity of the body for eliminating exhaustion and enhancing physical performance, with broad variety of drugs are apparent to be ergogenic in their effects. Yohimbine is an alkaloid recognized as an antagonist to the noradrenergic  $\alpha_2$ -receptors which normalize noradrenaline release in the central nervous system and their activation decreases the discharge of noradrenaline in the synaptic terminal.

**Objectives:** This study was designed to evaluate the ergogenic effects of yohimbine in normal healthy volunteers.

**Patients and Methods:** The present study was conducted in Department of Pharmacology, College of Medicine, Al-Mustansiriya University, Baghdad-Iraq, in collaboration with Department of Pharmacology, College of Medicine, University of Kerbala, Kerbala-Iraq, during April of 2013. The subjects of this study were medical students. 20 male volunteers were conformist to join up this single blind random experimental study. The exercise program consists of cycling on an ergometer. Pulse was measured using ear pulse sensor and maximum pulse rate achieved in this study and the entire exercise parameters were recorded as baseline data, then each subject take yohimbine tablets 5 mg (orally) and after 2 hours, each subject run on cycling ergometer to fatigue state, then, the display functions of bicycle were scanned. Besides, maximal oxygen uptake ( $VO_2$  max) was measured to estimate oxygen consumptions.

**Results & discussion:** Yohimbine significantly improved all ergogenic parameters (efforts, calories, distance, speed and exercise time) from baseline after single oral dose of 5mg, where  $p$  values were  $< 0.05$ . Moreover; yohimbine significantly accelerate the oxygen consumption in both oxygen consumptions and velocity at maximal oxygen uptake regarding maximum heart rate and resting heart rate with  $p$  values  $< 0.05$ .

**Conclusions:** Yohimbine accelerates and improves cycling performances via positive ergogenic effects .So, yohimbine can be used as ergogenic agent for ameliorating the physical fatigue.

**Key words:** Ergogenic Effect, Yohimbine, Cycling Ergometer

### Introduction

Ergogenic denote rising in the capacity of the body for eliminating exhaustion and enhancing physical performance, with broad variety of drugs are apparent to be ergogenic in their effects <sup>(1, 2)</sup>. Stimulant drugs, such as caffeine, ephedrine and amphetamine are frequently augmented

physical power and endurance <sup>(3)</sup>. Amphetamine demonstrated increases in joint extension force and body endurance via noradrenaline activation that rising the calcium entry and consequently better body force creation via naturally released adrenaline and noradrenaline throughout periods of strain <sup>(4)</sup>. Also, central stimulants amplify endurance and

\*For Correspondence: E-mail hayderm36@yahoo.com

prejudiced performance via escalating levels of dopamine and noradrenaline<sup>(3)</sup>.

Moreover; methamphetamine create unreliable euphoric feelings, through boosting the synaptic dopamine levels in the limbic system. Also, its exciting effects augment metabolism and motor action during endurance workouts<sup>(5,6)</sup>. Even though  $\beta_2$ -adrenoceptor agonists are agents that increase muscle mass via stimulating the protein anabolism and amplifying the metabolism of lipids and carbohydrates, but producing unpredictable ergogenic effects<sup>(7)</sup>.

Yohimbine is an alkaloid recognized as an antagonist to the noradrenergic  $\alpha_2$ -receptors which normalize noradrenaline release in the central nervous system and their activation decreases the discharge of noradrenaline in the synaptic terminal. Furthermore; yohimbine rapidly reduces motor restrictions caused by injury, in experimental animals and so voluntary movements are re-established in hemiplegic patients, in both rat and human<sup>(8-10)</sup>. In addition it is a 5-HT antagonist at low dose but in higher doses it acts as a 5-HT1A agonist so slowdown the sympathetic activity. Yohimbine also acts ultimately in other receptors, such as GABAergics, cholinergics and dopaminergics<sup>(11-15)</sup>.

Disparity of yohimbine affinity and its isomers for the  $\alpha_2$ -adrenergic subtypes possibly will also clarify inconsistency in tissue-specific actions<sup>(16)</sup>. Additionally yohimbine administration in a dose (0.2 mg/kg) increases plasma levels of fatty acid and glycerol in obese and non-obese regardless of gender effect so yohimbine improved weight loss via sympathetic activation but quiescent energy expenditure remained constant<sup>(17,18)</sup>. Therefore, yohimbine produced diverse ergogenic effects at different receptor levels but share the same general mechanism of stimulant agents.

### Objectives:

Because many drugs that augment the adrenergic transmission improve physical

and exercise fitness, this study was designed to evaluate the ergogenic effects of yohimbine in normal healthy volunteers.

## Subjects and Methods

This work was approved in Department of Pharmacology, College of Medicine, Al-Mustansiriya University, Baghdad-Iraq in collaboration with Department of Pharmacology, College of Medicine, University of Kerbala, Kerbala-Iraq, during April of 2013. It is permitted by via the scientific board of judges of Department of Pharmacology, Al-Mustansiriya University and qualified by the parquet of Medical College. The subjects of present study were medical students. 20 male volunteers were conformist to join up and absolute this single blind random experimental study. The exercise program consists of cycling on an ergometer (TUNTURI 5835011 Oy, Ltd. Germany). This type of ergometer assembles EN accuracy and security standard (class A, EN-959-1+5). It allows the user to calculate time, pulse, speed, energy consumption, and effort, it display the selected function. The energy consumption shows only an estimate of the read consumption. Pulse was measured by using ear pulse sensor. The maximum pulse rate achieved in this study and the entire exercise parameters were recorded as baseline data, then each subject take 5 mg yohimbine (orally) and after 2 hours, each subject ran on cycling ergometer to fatigue state, then, the display functions of bicycle were scanned. Also, maximal oxygen uptake ( $VO_2$  max) was measured to estimate oxygen consumptions.

$$VO_2 \text{ max} = 15 \frac{HR_{max}}{HR_{rest}}$$

$HR_{max}$  = Maximum heart rate  
(beats/minute)

$HR_{rest}$  = Resting heart rate (beats/minute)  
 $vVO_2$ max (velocity at maximal oxygen uptake) is a powerful successively pace

which be able to be sustain for six minutes.  
 $vVO_2\max = VO_2\max / 3.5$  (19-21).

#### Statistical Analysis:

Results are expressed as numeral, and mean  $\pm$  SD. The data were analyzed via SPSS version 20 using Student's "t" test (paired two tailed) taking  $p < 0.05$  as limit of significance.

Table 1. Ergogenic effects of yohimbine regarding cycling ergometer.

parameters	Effort (watt)	Calories (Kcal)	Distance (m)	Speed (m/minute)	Time (minute)
Before	71.71 $\pm$ 16.213	25.61 $\pm$ 16.011	161.027 $\pm$ 50.811	26.251 $\pm$ 4.127	7.314 $\pm$ 1.787
After	76.88 $\pm$ 19.310	29.71 $\pm$ 19.112	175.122 $\pm$ 51.201	29.911 $\pm$ 1.222	9.414 $\pm$ 2.131
P value	0.011493*	0.000155*	0.0000251*	0.000371*	0.00113*

\* P value < 0.05

Moreover; yohimbine significantly accelerate the oxygen consumption in both oxygen consumptions and velocity at

## Results

Yohimbine significantly improved all ergogenic parameters from baseline after single oral dose of 5mg, where  $p$  values were < 0.05 (table 1).

maximal oxygen uptake regarding maximum heart rate and resting heart rate with  $p$  values < 0.05 (table 2).

Table 2. Effects of yohimbine on maximal oxygen consumption.

parameters	Heart rate beat/m	VO <sub>2</sub> max ml/min/kg	vVO <sub>2</sub> max ml/min/kg
Before	82.32 $\pm$ 14.44	37.33 $\pm$ 2.55	10.67 $\pm$ 0.728
After	93.12 $\pm$ 12.67	43.32 $\pm$ 64.43	12.377 $\pm$ 18.408
P value	0.0000429*	0.0000214*	0.000148*

\* P value < 0.05

Therefore; results of the present study showed that yohimbine significantly accelerate and improve the ergogenic performances in normal healthy volunteers.

## Discussion

The present study showed that yohimbine improved exercise and ergogenic performances so central and peripheral stimulant effects of yohimbine are synergized in ergogenic activation. In humans,  $\alpha_2$ -adrenergic receptor modulating drugs can adapt numerous forms of focusing functions. In continued cognitive tasks, clonidine weaken performance while,  $\alpha_2$ -antagonist atipamezole advance alert attention and blight behavioral and physiological measures of awareness; however, clonidine blight focused attention and this be able to be upturned by idazoxan.<sup>(22-24)</sup> Those studies indicated that central effects of  $\alpha_2$ -antagonist improve the physical performances via neuronal

attentional activations. Through rising levels of noradrenaline, yohimbine augment patience and individual force, despite higher performance (25-28). These studies support our finding because yohimbine in this study increase effort, speed, distance and calorie expenditure.

The sympathomimetic drugs amplifies blood pressure, heart rate, peripheral resistance, and a rearrangement of blood from splanchnic vasculatures to the skeletal vasculatures. This might consequence in augmentation of core warmth. These effects are more distinct during maximal effort exercise also ephedrine act indirectly from side to side the action of endogenous adrenaline and noradrenaline<sup>(29)</sup>. Nevertheless, studies examine the efficiency of pseudoephedrine in progressing performance account no ergogenic outcome of a beneficial dose of pseudoephedrine which display central nervous system stimulation in doses of 60 mg/day and create amphetamine excitement that may possibly repress the

central constituent of fatigue<sup>(30)</sup>. Supplementary ergogenic possessions might be owing to skeletal activation, changed lung function through bronchodilation, or altered fuel consumption. Exceedingly tiny research has scrutinized its property on petite time exercise subsequent a 120 mg dose of pseudoephedrine. It appear that no ergogenic consequence be present in aerobic exercise next intake of a beneficial dose but if competitors were to use pseudoephedrine for performance augmentation it is probable so as to an elevated dose would be used<sup>(31-33)</sup>.

Yohimbine exert a direct influence on skeletal muscle, generating hyper-excitability this might perhaps lead to superior enrollment of motor units consented to muscle clusters to agreement more powerfully<sup>(15)</sup>. This identical outcome might also exist with pseudoephedrine and amphetamine<sup>(25)</sup>. The mechanisms accountable for the exacting performance alters are indistinct. Elevated motivation is necessary as a supramaximal effort is requisite as of the subject to achieve as a great deal effort as possible so increase psychological force is solitary mechanism through which performance possibly will be enhanced; or local muscular factors<sup>(34)</sup>. Thus; from these finding and previous studies all ergogenic effects of drugs are linked to the releasing of noradrenaline through which the sympathetic drive and motor activity are accelerated so yohimbine because it's a powerful releaser of noradrenaline, it accelerate and ameliorate the ergogenic performances.

Protracted exhaustive exercise persuade central fatigue due to inadequate productivity from the motor brain area this called supraspinal limitation but the reason is uncertain so; propose that noradrenaline, nor dopamine reuptake inhibitor, donate to the advancement of central fatigue following an extended cycling work out, but in the present study this fatigue not revealed may be due to short cycling time

< 20minute or yohimbine mask this effects because it increase both dopamine and noradrenaline<sup>(35)</sup>, also fundamental fatigue appear in higher dose of yohimbine but ;in this experimental study yohimbine dose was small (5 mg).

The standard male VO<sub>2</sub> max just about 35-40 ml/kg/min. while female VO<sub>2</sub> max was 27-31 ml/kg/min these levels be able to get better with exercise and diminish with age, although the scale of trainability as well diverges extensively<sup>(36)</sup>. The things disturbing VO<sub>2</sub> are frequently separated into provide and require factors, provide is the convey of oxygen to the mitochondria (counting pulmonary circulation, stroke cardiac volume, blood amount, and capillary compactness of the skeletal muscle) whilst require is the tempo of mitochondrial oxidative phosphorylation can for oxygen reduction in the course of the provide factor is frequently deliberate to be the limiting one<sup>(37)</sup>. And because of yohimbine increase heart rate and blood pressure via increasing in noradrenaline secretion so it increase stroke volume and skeletal muscle diffusion therefore it indirectly accelerate oxygen consumption and augment VO<sub>2</sub> max<sup>(38)</sup>.

The higher cardiac/pulmonary stamina, the extra oxygen has been delivered toward exercising muscles, so advanced the level of exercise performances therefore; the superior aerobic capability, the advanced the level of aerobic suitability<sup>(39-41)</sup>.

Gender dissimilarity in VO<sub>2</sub> max is might be due to the physical and training programs. Females classically achieve VO<sub>2</sub> max scores 15-30 % below of male. Even amongst skilled endurance athletes, gender discrepancy range between 15-20%<sup>(42)</sup>. Thus in the present study gender difference are excluded via selection of male only to avoid bias and to shows better enhancement effect of yohimbine on ergogenic performances .so yohimbine accelerate VO<sub>2</sub> max significantly which perse indicate a positive ergogenic effects.

## Conclusions

Yohimbine accelerates and improves cycling performances via positive ergogenic effects. So, yohimbine can be used as ergogenic agent for ameliorating the physical fatigue.

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