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## The Effect of Glutamine and Glucose Supplementation on Maximal Aerobic Power and Hemoglobin Concentration in Athlete Young Girls

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### ABSTRACT

**Background.** Maximal Aerobic Power is related to many quantities and qualities such as supplements.

**Objectives.** The purpose of the present study was to describe the effect of short-term supplementation of glutamine and glucose on hemoglobin and maximum aerobic power in female athletes.

**Methods.** In this quasi-experimental study, 40 female athletes (age  $21.9 \pm 2.6$  years, height  $161.8 \pm 5.1$  cm, weight  $57.8 \pm 6.3$  kg, BMI  $21.9 \pm 1.5$  kg/m<sup>2</sup>) volunteered to participate in the present study. Before intervention, the participants were divided randomly into four equal groups (each group=10); placebo, glutamine supplement (0.3 g/kg body weight), glucose supplement (1.0 g/kg body weight) and glutamine-glucose combination supplement. VO<sub>2</sub>max measured using Bruce protocol and also, hemoglobin concentrations were measured via blood sampling at 12h fasting state. The experimental groups did two-week supplementation accompanied with moderate intensity aerobic exercise, three sessions per week and (45-60) minutes per session. At the end of period of supplementation VO<sub>2</sub>max and hemoglobin values were measured again.

**Results.** Short-term supplementation of glutamine (P=0.0001), glucose (P=0.0001) and glutamine-glucose (P=0.0001) improved significantly VO<sub>2</sub>max values. Also, hemoglobin levels increased significantly in glutamine (P=0.012) and glutamine-glucose (P=0.0001) groups.

**Conclusion.** It seems that short-term supplementation of glutamine, glucose and glutamine-glucose may lead to improvement in aerobic performance in young female athletes.

**KEY WORDS:** *Supplementation, Glutamine, Glucose, Aerobic Power, Athlete Girls.*

### INTRODUCTION

Improvement in athletic performance is the subject of many studies and in this regard, physical fitness is a main factor in relation to performance of athletes in different sports (1). Among different factors of physical fitness, aerobic fitness is considered as an important and effective factor related to health and performance (2). Aerobic performance is affected by factors such as maximal aerobic power, anaerobic power and work economy (3).

During exercise, the most important index of aerobic fitness is maximum oxygen consumption (VO<sub>2</sub>max) (4). In fact, VO<sub>2</sub>max is a point that body reaches the maximum amount of oxygen consumption and athletes who have better fitness consume more oxygen and they can be trained with high intensity.

In recent years, researchers have studied other factors other than VO<sub>2</sub>max to estimate aerobic fitness of athletes. Time of exhaustion of

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athletes is one of these factors and its increase after training not only indicates increase of general endurance, but it is also related to anaerobic capacity of athletes (5). Therefore, blood indices that have duty of carrying and delivering oxygen to tissues and make continuity of activity of a person possible should not be ignored. Henderson et al. (2004) have indicated that intensive interval training leads to increase of hemoglobin and hematocrit concentration and may influence aerobic capacity of athletes (6). On the other hand, the ability of red cells for carrying oxygen through increase of their amounts, increase of blood fluidity and ability of receiving more oxygen by these cells are considered as factors that are effective in increase of maximal aerobic power (7, 8).

Coaches and athletes have been looking for creating more abilities in receiving, carrying and consuming oxygen for increase of  $VO_{2max}$  through different exercises. However, in addition to physical activities, other methods have been used. One of these methods is use of sport supplements such as glutamine and carbohydrate supplements. Glutamine is one of several amino acids available in human body and in spite of the fact that it is not necessary amino acid, it can be essential in some digestive diseases and/or better athletic performance. Moreover, it has been reported that glutamine has effective role in transportation of nitrogen from a limb to another and it is directly effective in anabolic and catabolic processes (9). Other findings have confirmed that this amino acid has influenced maintenance of basic acidosis of body, gluconeogenesis and production of nucleotides (10, 11). Other studies have reported that excess consuming of glutamine by immune cells may be another reason for glutamine reduction after prolonged activities (12). Moreover, long-term activities can lead to increase of cortisol and catabolism, releasing glutamine from muscle and then gluconeogenesis increase in liver and kidneys (13).

Various findings have shown that aerobic exercises face to free radicals production and oxidative stress during prolonged aerobic exercises. Baghaei et al. (2010) have reported that athletes face to increase of indices of oxidative stress during aerobic exercise and injuries (14). Increase of free radicals is

accompanied with various injuries such as hemoglobin oxidation that does not affect ability in oxygen transport (15). Considering role of glutamine in increase of immune cells activity, it can be expected that glutamine becomes effective in reduction of hemoglobin oxidation. Some studies have shown that protein reduction leads to decrease in hemoglobin concentrations (16). Although there are no studies related converting glutamines to globin, a probable mechanism is expected. Different findings have shown that increase of hemoglobin depends on changes and increase of IGF-I and IGF-II (17). On the other hand, some studies have referred to the role of glutamine in increase of GH and then increase of IGF-I and IGF-II (18). Hence, it seems that glutamine may be effective in changes of hemoglobin concentration through increase of GH. However, glutamine role in amount and concentration of hemoglobin is not clear and the mentioned mechanisms are probable and it is not well-known that how effective glutamine consumption can be in hemoglobin changes and increase of  $VO_{2max}$  in athletes. On the other hand, use of glucose has been studied in different researches and different studies have reported positive effects of using carbohydrate and glucose on athletic performance and  $VO_{2max}$  through increase of blood glucose, intramuscular reserves and insulin sensitivity (19). However, it seems that combination of protein and glucose has different results. Therefore, have Ivy et al. (2003) showed that combination of protein and carbohydrate can lead to improvement in performance (20). McCleave et al., (2011) have also reported increase of aerobic power due to use of combination of proteins and carbohydrates and have expressed that one of its reasons is increase of albumin and intramuscular oxidative enzymes (21). In conclusion the present study tries to survey the effect of short-term consumption of glutamine and glucose supplement on hemoglobin values and maximal aerobic power of female athletes.

## **MATERIALS AND METHODS**

**Participants.** In a quasi-experimental study with pretest-posttest design, 40 volunteered athlete female of Tehran city in 2015 (age  $21.9 \pm 2.6$  years, height  $161.8 \pm 5.1$  cm, weight

57.8±6.3 kg and BMI 21.9±1.5 kg/m<sup>2</sup>) were selected and divided randomly into four equal groups of placebo, glutamine supplementation, glucose supplementation and combination of glutamine and glucose supplementation. Prior to participation, all subjects read and signed informed, voluntary consent forms. Prerequisites to participate in the present study were having no history of chronic disease, nutritional allergy, and specific medicine consumption, to be period and have regular exercise (at least three sessions per week for recent two years). At the first session, some information about diet and how supplements consumption were given to all participants.

**Supplementation.** Glutamine and glucose dosage was 0.3 and 1 g/body weight accompanied with 250 ml water, respectively.

**Exercise Protocol.** All participants had done aerobic exercises, three sessions per week and lasting 60 minutes each session. Training intensity was set at (60-75) % MHR. Supplementation period was 14 days.

Hemoglobin concentrations and aerobic power assessment were evaluated 24h before and after intervention at fasting state. Bruce protocol was used to assess VO<sub>2</sub>max.

**Statistical Analysis.** Data were analyzed using one-way analyze of variance (ANOVA) and Tukey post-hoc test. The level of significant was set at P<0.05. Statistical analysis was performed by SPSS software.

**RESULTS**

Demographic characteristics of participants presented in table1. Table 2 lists the descriptive values of VO<sub>2</sub>max of participants before and after intervention. One way ANOVA result of VO<sub>2</sub>max reveals a significant difference while compared among the four groups at post-test. Post-hoc multiple comparison of VO<sub>2</sub>max is found significant between Glucose and Glutamine Glucose (P<0.05). Also, one way ANOVA result of Hemoglobin reveals no significant difference (P>0.05).

**Table1.** Demographic characteristics of participants (Mean±SD).

Variable	Group	Placebo	Glutamine supplementation	Glucose supplementation	Glutamine+Glucose supplementation
Age (years)		21.2±2.5	22.8±2.6	20.1±2.5	23.7±1.2
Height (cm)		162.7±4.2	159.6±5.6	160.8±4.6	164.1±5.1
Weight (kg)		57.2±5.4	53.1±4.8	58±5.9	62±6.1
BMI (kg/m <sup>2</sup> )		21.6±1.5	20.9±1.5	22.3±1.3	22.9±1.1
VO <sub>2</sub> max (ml/kg <sup>-1</sup> /min <sup>-1</sup> )		43.2±4.9	40.3±3.7	38.3±4.6	42.2±5.8
Hemoglobin (g/dl)		13.03±0.65	12.86±0.88	13.12±0.74	12.91±1

**Table2.** VO<sub>2</sub>max and Hemoglobin status in studied groups (Mean±SD)

group	VO <sub>2</sub> max (ml/kg <sup>-1</sup> /min <sup>-1</sup> )		Hemoglobin (g/dl)	
	Pre-test	Post-test	Pre-test	Post-test
Placebo	43.2±4.9	44.16±3.32	13.03±0.65	12.97±0.77
Glutamine	40.3±3.7	43.09±2.51	12.86±0.88	13.54±0.68
Glucose	38.3±4.6	40.14±4.31	13.12±0.74	13.33±0.81
Glutamine Glucose	42.2±5.8	46.30±3.85	12.91±1	13.83±0.59

**DISCUSSION AND CONCLUSION**

The results of the present study show that after short-term supplementation of glutamine,

glucose and a combination of glutamine and glucose, Vo<sub>2</sub> max improved. The findings of the present study are in agreement with the findings

of the research of Akbarnejad et al. (2006) (22), Ghanbarzade et al. (2011) (23), Ferguson et al. (2011) (24). In contrast, they are disagree with the findings of the research of Marvud et al. (2008) (25), Mansur et al. (2015) (26) and Church et al. (2010) (27). Aerobic depends on a lot of physiological qualities and quantities whose most important ones include lung, volume of hemoglobin, density of hemoglobin, blood volume, heart volume, maximum heart rate and amount of muscle mass (2, 28). Hence, paying attention to this point will be important because increase of aerobic ability can be surveyed from the two aspects, increase of capacity of consumption of slow-twitch muscle tissue and increase of number and volume of muscle mitochondrial. In other words, the ability of the consumption of oxygen by tissue is a factor that has been confirmed in the increase of aerobic ability (29). Therefore, female athletes in comparing to male athletes have less  $VO_2\text{max}$  due to muscle mass (30). Therefore, most of researchers emphasize on increase the mass of slow-twitch muscles and the establishment of physiological and biological changes such as improvement of efficiency of effective enzymes in oxygen consumption in improvement aerobic ability. From the second aspect, increase of diffusion capacity of lungs and increase of ability of carrying oxygen for active tissues during physical activity are important. Most of studies have shown that increase of lung capacity has high importance in increase of  $VO_2\text{max}$  (31, 32). However, ability of oxygen carrying by blood red cells through increase of their amount, increase of blood flow and ability of receiving more oxygen of most of these cells are considered as factors that are effective in increase of ability of aerobics (7). Baghaei et al. (2012) has reported in a research that athletes have been facing to increase of norms of oxidative stress in the process of aerobic activity and damages resulting from it (14). Increase of free radicals is accompanied with different damages such as oxidation of hemoglobin and this causes anomaly in ability of oxygen carrying (15). Hence, according to role of glutamine in increase of activity of immune cells, it is expected that glutamine can be effective in decrease of oxidation of hemoglobin. Although some studies have referred to increase of Turin

level after consumption of glutamine and role of Turin in decrease of oxidative pressure (33). However, it is vital to pay attention to this point that a part of hemoglobin forms a protein that is called "globin". Some studies have shown that decrease of proteins leads to decrease of amount of hemoglobin (16). Although no studies related to change of glutamine to globin are found, another mechanism is found. Different findings have shown that increase of hemoglobin depends on change and increase of IGF-I and IGF-II (17). On the other hand, some studies have emphasized on role of glutamine in increase of hormone GH and increase of IGF-II and IGF-I (18). Hence, it seems that glutamine may be effective in changes of hemoglobin density through increase of growth hormone. However, role of glutamine is not exactly clear in amount and density of hemoglobin and the mentioned mechanisms are only guessed and it is not clear of how consumption of glutamine can be effective in changes of hemoglobin and increase of  $VO_2\text{max}$  in athletes. Use of glucose has been analyzed in different studies. Different findings have analyzed use of carbohydrates and glucose on performance level of sports and  $VO_2\text{max}$  and have reported its positive effects through increase of amount of blood glucose, intramuscular reserves and insulin sensitivity (19). However, it seems that combination of protein and Glucose has different results. Lee et al. (2003) analyzed combination of protein and carbohydrates on performance of athletes and have reported that consumption of this supplementation can lead to increase of performance, but they have not mentioned a clear reason related to their findings (11). McCleave et al. (2011) have reported increase of aerobic power in effect of use of combination of proteins and carbohydrates and one of its reasons is increase of Albumin and increase of activity of intramuscular oxidative enzymes (21).

It can be concluded from the findings of the present study and the findings of other studies in this area that short-term supplementation of Glutamine can have positive effects in improvement of performances of female athletes. Of course, contrast results can be due to some reasons such as period of supplementation, dose of consumption, preparation for tests and gender. However, use of protein and carbohydrates

supplementations for their probable effects on harmful side effects during doing prolonged aerobic exercises, especially with high intensity, can prevent from decrease of aerobic performance and in some cases, it can lead to improvement of this performance. According to physiological aspect and mechanism involved in synthesis of proteins of Hemoglobin and Myoglobin and effect of protein supplementations especially Glutamine on these kinds of mechanisms, it seems that there are

some ambiguous points still and it is felt that more accurate studies should be done so that the ambiguous points can become clear.

#### APPLICABLE REMARKS

- Short-term supplementation of glutamine and glucose may improve aerobic performance.

#### REFERENCES

- 1- Goran M1, Fields DA, Hunter GR, Herd SL, Weinsier RL. (2000). Total body fat does not influence maximal aerobic capacity. *Int J Obes Relat Metab Disord.*; 24(7):841-8.
- 2- James M Otto, Hugh E Montgomery, and Toby Richards. (2013). Haemoglobin concentration and mass as determinants of exercise performance and of surgical outcome. *Extrem Physiol Med.*; 2: 33.
- 3- Mosey, T. (2009). High intensity interval training in youth soccer players – using fitness testing .results practically. *Journal of Australian Strength and Conditioning*, vol. 17, no. 4, pp. 49-51
- 4- McMillan, K., Helgerud, J., Macdonald, R., Hoff, J. (2005). Physiological Adaptations to Soccer, Specific Endurance Training In Professional Youth Soccer Players. *British Journal of Sports Medicine* .vol. 39, no. 5, pp. 273–277 28
- 5- Bickham, D.C., Rossignol, P.F. (2004). Effects of high-intensity interval training on the accumulated oxygen deficit of endurance-trained runners. *Journal of Exercise Physiology online*, vol. 7, no .1, pp. 40-47.
- 6- Henderson, G.C., Horning, M.A., Lehman, S.L., Wolfel, E.E., et al., (2004). Pyruvate shuttling during rest and exercise before and after endurance training in men. *Journal of Applied Physiology*, vol .97, no. 1, pp. 317-325
- 7- Heimo Mairbäurl. Red blood cells in sports. (2013). effects of exercise and training on oxygen supply by red blood cells. *Front Physiol.*; 4: 332.
- 8- Joyner M. (2003). VO<sub>2</sub>max, blood doping, and erythropoietin. *Br J Sports Med. J*; 37(3): 190–191.
- 9- Mifflin BJ1, Habash DZ. (2002). The role of glutamine synthetase and glutamate dehydrogenase in nitrogen assimilation and possibilities for improvement in the nitrogen utilization of crops. *J Exp Bot.*; 53(370):979-87.
- 10- Bjerring PN1, Hauerberg J, Frederiksen HJ, Jorgensen L, Hansen BA, Tofteng F, Larsen FS. (2008). Cerebral glutamine concentration and lactate-pyruvate ratio in patients with acute liver failure. *Neurocrit Care*. [Neurocrit Care.](#); 9(1):3-7.
- 11- Lee YY, Yap MG, Hu WS, Wong KT. (2003). Low-glutamine fed-batch cultures of 293-HEK serum-free suspension cells for adenovirus production. *Biotechnol Prog.*; 19(2):501-9.
- 12- Hiscock N, Pedersen BK. (2002). Exercise-induced immunodepression- plasma glutamine is not the link. *J Appl Physiol* (1985). 93(3):813-22.
- 13- Flynn NE1, Wu G. (1997). Enhanced metabolism of arginine and glutamine in enterocytes of cortisol-treated pigs. *Am J Physiol*; 272(3 Pt 1):G474-80.
- 14- Baghaei, B., Tartibian, B., Baradaran, B. (2012). Effect of sexual differences on relationship between antioxidant and inflammatory enzymes due to intensive aerobic activities in young athletes. *Jour. of Med. Univ. Sabz.* 19 (4): 345-353.
- 15- Abdu I. Alayash, Robert E. Cashon. (1995). Hemoglobin and free radicals: implications for the development of a safe blood substitute. *Molecular Medicine Today*. Volume 1, Issue 3, Pages 122–127.
- 16- Hundal HS, Babij P, Taylor PM, et al. (1991). Effects of corticosteroid on the transport and metabolism of glutamine in rat skeletal muscle. *Biochem Biophys Acta*; 1092: 376-83.
- 17- Miniero R1, Altomare F, Rubino M, Matarazzo P, Montanari C, Petri A, Raiola G, Bona G. (2012). Effect of recombinant human growth hormone (rhGH) on hemoglobin concentration in children with idiopathic growth hormone deficiency-related anemia. *J Pediatr Hematol Oncol.*; 34(6):407-11.
- 18- Welbourne TC. (1995). Increased plasma bicarbonate and growth hormone after an oral glutamine load. *Am J Clin Nutr.*; 61(5):1058-61.
- 19- Tokmakidis SP, Volaklis KA. (2000). Pre-exercise glucose ingestion at different time periods and blood glucose concentration during exercise. *Int J Sports Med.*; 21(6):453-7.

- 20- Ivy JL, Res PT, Sprague RC, Widzer MO. (2003). Effect of a carbohydrate-protein supplement on endurance performance during exercise of varying intensity. *Int J Sport Nutr Exerc Metab.* 13(3):382-95.
- 21- McCleave EL1, Ferguson-Stegall L, Ding Z, Doerner PG 3rd, Wang B, Kammer LM, Ivy JL. (2011). A low carbohydrate-protein supplement improves endurance performance in female athletes. *J Strength Cond Res.*; 25(4):879-88.
- 22- Akbarnejad, A., Ravasi, A. A., Aminian Razavi, T., Nourmohammadi, I. (2006). Effect of consumption of glutamine and creatin supplement on performance of elite wrestlers after a period of acute weight reduction. *Jour. of Harakat.* (27): 173-188.
- 23- Ghanbarzadeh, Mohsen; Sedaghatpour, Mehdi. (2011). Effect consumption of Glutamine supplement on aerobic power, anaerobic power and body composition of soccer players. *Journal of Physical Education & Sport*; Vol. 11 Issue 3, p313.
- 24- Ferguson-Stegall L, McCleave E, Ding Z, Iii DoernerPG, Liu Y, Wang B, Healy M, Kleinert M, Dessard B, Lassiter DG, Kammer L, Ivy JL. (2011). Aerobic exercise training adaptations are increased by postexercise carbohydrate-protein supplementation. *J Nutr Metab.* 623182.
- 25- Marwood S, Bowtell J. (2008). No effect of glutamine supplementation and hyperoxia on oxidative metabolism and performance during high-intensity exercise. *J Sports Sci.*; 26(10):1081-90.
- 26- Mansour A, Mohajeri-Tehrani MR, Qorbani M, Heshmat R, Larijani B, HosseiniS. (2015). Effect of glutamine supplementation on cardiovascular risk factors in patients with type 2 diabetes. *Nutrition.* 31(1):119-26.
- 27- Church TS, Blair SN, Cocroham S, Johannsen N, Johnson W, Kramer K, Mikus CR, Myers V, Nauta M, Rodarte RQ, Sparks L, Thompson A, Earnest CP. (2010). Effects of aerobic and resistance training on hemoglobin A1c levels in patients with type 2 diabetes: a randomized controlled trial. *JAMA.*; 304(20):2253-62.
- 28- Sophie L., Patrick Y., Vitalie F., and Robert N. (2012). Pulmonary vascular distensibility predicts aerobic capacity in healthy individuals. *J Physiol*; 590(Pt 17): 4279–4288.
- 29- Coen PM1, Jubrias SA, Distefano G, Amati F and et al. (2013). Skeletal muscle mitochondrial energetics are associated with maximal aerobic capacity and walking speed in older adults. *JGerontol A BiolSci Med Sci.*;68(4):447-55.
- 30- Lafortuna CL1, Maffiuletti NA, Agosti F, SartorioA. (2005). Gender variations of body composition, muscle strength and power output in morbid obesity. *Int J Obes (Lond)*; 29(7):833-41.
- 31- Battikha M1, Sà L, Porter A, Taylor JA. (2014). Relationship between pulmonary function and exercise capacity in individuals with spinal cord injury. *Am J Phys Med Rehabil*; 93(5):413-21.
- 32- William R. Komatsu, Turibio L. Barros Neto, Antonio R. Chacra and Sergio A. Dib. (2010). Aerobic Exercise Capacity and Pulmonary Function in Athletes With and Without Type 1 Diabetes. *Diabetes Care.* 33(12): 2555–2557.
- 33- Ahmad MK, Mahmood R. (2014). Protective effect of taurine against potassium bromate-induced hemoglobin oxidation, oxidative stress, and impairment of antioxidant defense system in blood. *Environ Toxicol.* 1-12.