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EFFECTS OF ORAL GLUTAMINE CONSUMPTION ON STRENGTH AND CIRCUMFERENCE OF UPPER-ARM AND THIGH MUSCLES IN YOUNG ADULT MALE BOXERS

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ABSTRACT

Background and objective: The aim of this study was to investigate the effect of glutamine consumption on muscle strength and circumference of upper-arm and thigh muscles in young adult male boxers. It has been hypothesized that glutamine is utilized for muscle growth and protection against muscle breakdown and muscle tissue loss, and can thus improve muscle growth and performance of athletes. Method: This study was a double-blind, placebo-controlled randomized trial in which 30 physically active non-smoker male boxers were recruited and randomly assigned to two groups of 15 participants; control and glutamine groups. The participants underwent boxing workout protocol 3 times a week for a period of 8 weeks, and pretest and posttest forearm and thigh muscle strength and circumference were recorded. Participants in the glutamine group received glutamine supplement at 0.15 g / kg body mass plus 0.15 g of maltodextrin/kg of body mass and participants in the control group received 0.30 g maltodextrin/ kg body mass 30 minutes before each training session. Posttest measurements were compared between glutamine and control groups. Results: There were significant differences in the average forearm and thigh muscle strengths between the glutamine group and control group after 8 weeks of training ($P<0.005$), but no significant differences were observed when forearm and thigh circumferences were compared between the two groups ($p>0.005$). Conclusion: Our results show that taking glutamine supplements for boxing training can increase thigh and upper-arm muscle strength. Also, glutamine supplements alone may not be sufficient for increasing upper-arm and thigh circumference in male boxers in a short period of time.

Keywords: Boxing, Glutamine, Lower extremity, Upper extremity, muscles, strength, circumference,

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1. INTRODUCTION

The use of protein supplements has increasingly gained popularity among physically active individuals who believe that supplementation, combined with regular exercises, can help improve their physical performance and gain of lean body mass (Pasiakos, McLellan, & Lieberman, 2015). However, one of the important things that athletes pay attention to in professional sports is the effect of the type of exercise and the type of nutrition on increasing physical abilities, especially muscle strength and volume.Professional trainers often contemplate on whether exercising alone or to what extent can dieting be effective in increasing the strength and volume of upper, middle and lower muscles of the body.The issue that exercise leads to tissue damage through free radical generation was first raised in 1978, however, in addition to refuting this hypothesis, the last decade has seen the growth of knowledge about the impact of nutrition and exercise on increasing muscle strength and volume (Khosravi et al., 2019). Protein supplementation has been shown to effectively increase muscle strength and performance after 8-11 weeks of resistance training (Pasiakos et al., 2015).

Glutamine is an amino acid that is naturally present in plasma, muscle and skeleton. This amino acid makes up 60% of the amino acids in the cells of the human body. In the body, glutamine is utilized for muscle growth and protection of muscle against breakdown and loss of muscle tissue, as well as in immune system function(Poindexter et al., 2003). For this reason, the use of glutamine supplements in various sports and for athletes has gained the attention of many researchers over the past years.

Available literature claims that glutamine supplements may benefit athletes in a number of ways. Glutamine plays a key role in immune function and fight against infection in athletes. The acute depletion of plasma glutamine after strenuous exercises can expose athletes to infection and therefore, glutamine supplementation can be beneficial (Parry-Billings, Blomstrand, McAndrew, & Newsholme, 1990). It is hypothesized that decreased levels of plasma glutamine after strenuous exercise may be due to its increased usefor the process of cellular energy supply or gluconeogenesis, which in turn is associated with decreased glutamine synthesis. Thus, increase in physical activity can indirectly reduce glutamine synthesis. Consumption of glutamine by active cells of the immune system can also contribute to glutamine depletion after strenuous exercises. Also, glutamine has a physiological role in cell proliferation, acid-base balance, intercellular transport of amino acids, and the synthesis of antioxidants (Cruzat, Rogero, Borges, & Tirapegui, 2007; Cruzat, Rogero, & Tirapegui, 2010; Cruzat & Tirapegui, 2009; Powers, DeRuisseau, Quindry, & Hamilton, 2004). Glutamine is considered as a rate-limiting factor in the synthesis of glutathione. Glutathione is one of the most important antioxidants in the body that can protect the body against oxidative stress. The results of some studies show that muscle damage can be prevented by the use of glutamine supplements in dietswhich can help stabilize high levels of glutathione (Amores-Sánchez & Medina, 1999; Matés, Pérez-Gómez, Núñez de Castro, Asenjo, & Márquez, 2002).Glutamine supplementation was associated with less muscle damage in athletes involved in eccentric sports compared with a placebo group which had high levels of muscle damage enzymes (Córdova-Martínez, Caballero-García, Bello, Pérez-Valdecantos, & Roche, 2021).

Some studies have shown that after strenuous eccentric exercises, glutamine supplements can attenuate short-term strength loss(Street, Byrne, & Eston, 2011), which supports the suggestion that glutamine supplementation can help in muscle strength recovery after intense exercises (Castell & Newsholme, 1997).Also, oral glutamine supplementation has been found to attenuate injury and inflammation cause by exhaustive and intense aerobic exercises (Raizel & Tirapegui, 2018).Boxing is a high-intensity sport which involves highly specialized kinetic linking movements with the arms and legs in constant motion. Thus, the ability to maintain greater strength in the arms and legs is of great importance in boxing. A study that analyzed the kinetics in boxing indicated that punching power in boxing is highly dependent on leg strength as the legs generate power from lower parts of the body and transfer it to the fist(Cheraghi, Agha-Alinejad, Arshi, & Shirzad, 2014). Boxing involves high-intensity actions with short periods of recovery. Thus, ability to recover quickly following the high-intensity actions is of paramount importance, and the development of strength contributes to improvement in aerobic abilities.The punching arm momentum is also an important determinant of the punching

power.On the other hand, gain in weight may inhibit rapid movements displayed by boxers. However, gain in lean body mass is beneficial for boxers for speed and coordination(Hembrough et al., 2016).

The possible role of glutamine supplementation alone in improving muscle strength and volume is still debatable and has not been extensively investigated in different sports fields. Majority of the previous studies have focused on the role of glutamine in strength recovery and immune function in athletes. Therefore, the aim of the present study was to investigate the effect of oral glutamine supplements on the strength and circumference of upper-arm and thigh in young adult male boxers.

2. METHODOLOGY

2.1 Participants

The aim of this study was to evaluate the effect of glutamine supplementation on the strength and circumference of upper-arm and thigh muscles in male boxers aged 20 to 29 years in selected boxing clubs in Tehran, Iran. Thirty (30) healthy, non-smoker young adult male boxerswere randomly selected from 7 boxing clubs in Tehran, Iran, to participate in the study. The participants wererandomly assigned into two groups of 15 participants; glutamine group (intervention group) and control group.

2.2 Study protocol

This study was conducted as a double-blind, placebo-controlled randomized trials. The participants were randomized into 2 equal groups (15 participants each). The purpose of the study and need to cooperate with the study protocol was clearly explained to the participants. Each participant was provided written informed consent and those who agreed to participate in the study selected before randomization. The height (cm), body mass (Kg), and age (years) of the participants were recorded using a researcher designed form prior to the beginning of the study protocol. Also, Pretest measurements, including the circumference and strength of the upper-arm and thigh muscles were recorded using the plastic tape measure and dynamometer, respectively, before the supplement protocol was started.

The boxers underwent normal boxing training protocol 3 sessions per week for 8 weeks. Each training session lasted for 90 minutes and included jump roping, leg lifts, shadow boxing, pad work, compound lift, resistance and isometric exercises.The participants in each group underwent the same set of exercises with the same duration and intensity. The intervention group was given oral glutamine supplements whereas the participants in the control group were given a placebo (maltodextrin).The participants were supervised for eight weeks after which the circumference and strength of the thigh and upper-arm muscles were measured again and compared between the groups. The study protocol was approved by the ethics committee of the AllamehGhazvini Higher Education Institute.

2.3 Measurements

The push-pull ver. 2.0.1 dynamometer was used to measure muscle strength as seen in figure 1. The maximum isometric muscle strength for the upper-arm and thigh muscles were measured by trained physiotherapists who know how to use the dynamometer. Strengths of the left and right upper-armswere measured and the average was recorded for each participant. Similarly, the average strength of both left and right thighs was recorded for each participant. Muscle strength measurements were recorded in kilograms (Kg).

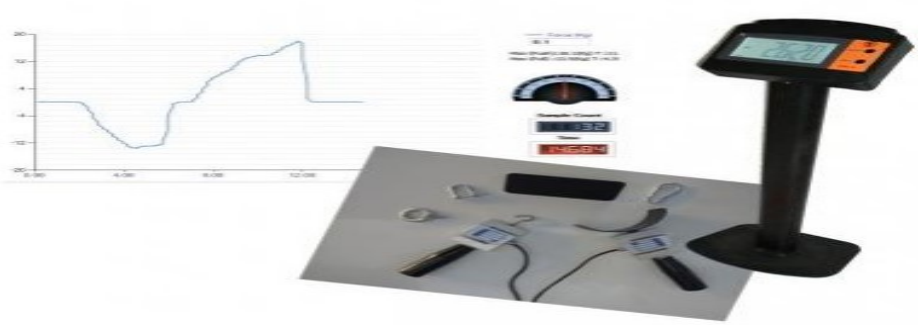

Figure 1. Dynamometer used for measuring muscle strength

The plastic tape measure was used to measure circumference of the upper-arm and thigh of the participants. Measurement of the thigh circumference was performed 15 cm proximal to the superior pole of the patella and the mid upper-arm circumference (MUAC) was measured at the midpoint between the acromion and olecranon processes on the shoulder blade and the ulna of the arm, respectively as shown in figure 2. Measurements of both arms and thighs were taken and the averages were recorded in centimeters.

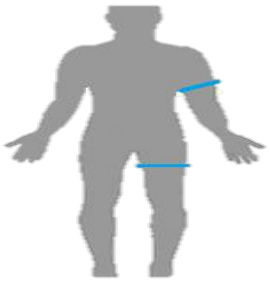

Figure 2. Measurement points of the upper-arm and thigh circumference

2.4 Supplement protocol

Glutamine powder ON was mixed with water and maltodextrin as an oral supplement for the participants in the experimental group; 0.15 g glutamine/ kg body mass plus 0.15 g maltodextrin/kg of body mass 30 minutes before each training session. Participants in the control group received a placebo; 0.30 g maltodextrin/ kg body mass 30 minutes before each training session.

2.5 Statistical analysis

Statistical analysis was performed using SPSS version 25. Scale variables have been reported as mean±SD. The Kolmogorov–Smirnov test was used to test for the normality of data. In this study, all data conformed to the hypothesis of normal distribution. The independent t-test was used to compare the anthropometric measurements between the 2 groups. P-values<were considered statistically significant.

3. RESULTS

The aim of the present study was to investigate the effects of glutamine supplement on strength and circumference of the upper-arm and thigh muscle in young adult male boxers aged 20-29. The results of this study have been presented in tables 1, 2, 3, 4, and 5. As seen in table 1, the average age of the participants was 25.45±2.5 yearsand 26.12±2.1 years**.** The overall mean age of the participants was 25.92±3.2 years. The mean body mass and height of the entire study participants were 74.87±6.9 kg and 174.75±10.1, respectively.

TABLE 1.
DESCRIPTIVE DATA FOR THE ENTIRE STUDY PARTICIPANTS

Variable	Intervention (n=15) Mean ±SD	Control (n=15) Mean ±SD	Total (n=30) Mean ±SD
Age (years)	25.45±2.5	26.12±2.1	25.92±3.2
Height (Cm)	179.11±9.4	178.42±10.3	178.75±10.1
Body mass (Kg)	83.52±8.6	85.43±6.4	84.87±6.9

TABLE 2.
COMPARISON OF POSTTEST THIGH MUSCLE STRENGTH BETWEEN THE INTERVENTION AND CONTROL GROUPS

Independent t test		Df	SD	mean	Group
Sig	t-value	27.66	*4.632*	47.80	Glutamine
0.036	2.201	28	*4.148*	44.27	control

As shown in table 2, after 8 weeks of exercise protocol, the mean muscle strengths of the thigh muscles in the control group and intervention (glutamine) group were 44.270±4.12 and 47.8±4.63 kg, respectively. The increase in thigh muscle strength was significantly higher than in the control group ($p< 0.05$).

TABLE 3.
COMPARISON OF POSTTEST UPPER-ARM MUSCLE STRENGTH BETWEEN THE INTERVENTION AND CONTROL GROUPS

independent t test		Df	SD	Mean	Group
Sig	t-value	*27.994*	*3.502*	*39.47*	Glutamine
0.007	*2.987*	*28*	*3.555*	*35.73*	control

As shown in table 3, after 8 weeks of glutamine and placebo consumption along with boxing exercises, the mean upper-arm strengths in the control and interventional groups were 35.73±3.56 and 39.47±3.50 kg, respectively. There was a significant difference ($p<0.005$) in upper-armstrength between the glutamine group and the control group.

TABLE 4.
COMPARISON OF POSTTEST THIGH CIRCUMFERENCE BETWEEN THE INTERVENTION AND CONTROL GROUPS

Independent t test		Df	SD	mean	Group
Sig	t-value	*23.955*	*3.529*	*65.80*	Glutamine
0.629	*0.556*	*28*	*5.462*	*64.87*	control

The mean thigh circumferences in the control and interventional groups were 64.87±5.46and 65.80±3.53 cm, respectively. Table 4 shows that even though glutamine supplementation increased the circumference of the thigh more than in the control group, the difference was not significant ($p> 0.05$).

TABLE 5.
COMPARISON OF POSTTEST UPPER-ARM CIRCUMFERENCE BETWEEN THE INTERVENTION AND CONTROL GROUPS

Independent t test		Df	SD	mean	Group
Sig	t-value	*27.345*	*2.854*	*43.00*	Glutamine
0.70	*1.882*	28	*3.335*	*40.87*	control

As seen in table 5, the mean upper-arm circumferences in the control and interventional groups were 40.87±3.34 and 43.00±2.85 cm, respectively. Even though circumference of the thigh increased more than in the control group, the difference was not significant ($p> 0.05$).

4. DISCUSSION

The last decade has seen the growth of knowledge about the impact of nutrition and exercise on increasing muscle strength and volume. In the present study, we investigated the effect of glutamine supplements on the strength and circumference of upper-arm and thigh muscles in young adult male

boxers. The results of this study show that glutamine supplementation can significantly increase upper-arm and thigh muscle strength in boxers. Also, our results indicate that glutamine supplements alone cannot increase muscle mass or circumference after 8 weeks of normal boxing exercises.

Exercises can differently affect muscle glutamine production and plasma glutamine availability. The change in plasma glutamine concentration during exercise depends on the duration and intensity of the exercise. Endurance and resistance exercises appear to be associated with acute depletion of available plasma glutamine due to intense and prolonged energy consumption. A significant decrease in plasma glutamine concentration in endurance runners after a marathon has been reported (Castell & Newsholme, 1997). Also, some studies have shown that at least 8 weeks of resistance training with appropriate frequency, intensity and duration is required for the improvement in muscle function even with supplementation (Pasiakos et al., 2015). In the present study, training protocols were performed for 8 weeks with 3 sessions per week. Moreover, some studies have indicated that the timing of the exercise and the type of protein supplement consumed are important factors that promote the synthesis of muscle proteins. Protein supplements taking immediately before, during or within few after exercises can effectively promote muscle protein synthesis(Pasiakos et al., 2015). In the present study, supplements were taken 30 minutes before each training session.

In 2011, effect of glutamine on aerobic and anaerobic capacities as well as body composition of soccer players was investigated. Compared to placebo, glutamine supplementation increased the aerobic and anaerobic capacities as well as gain of lean body mass. Also, glutamine supplementation decreased body fat percentage (Ghanbarzadeh & Sedaghatpour, 2011). As mentioned earlier, improved aerobic capabilities and gain in lean body mass are vital qualities of professional boxers. In the present study, glutamine supplementation resulted in a significant gain in muscle strength of both upper-arms and thighs similar to the study Ghanbarzadeh et al.(Ghanbarzadeh & Sedaghatpour, 2011). In contrast to our results, Candow et al. indicated that glutamine supplementation had no significant effect on muscle size, strength, or muscle protein degradation after 6 weeks of strength training exercises(Candow, Chilibeck, Burke, Davison, & Smith-Palmer, 2001). However, as mentioned earlier, many studies have reported that supplementations may exhibit their effects after at least 8 weeks of exercises (Pasiakos et al., 2015), and thus supplementation along with only 6 weeks of exercise may not yield significant results.A similar study in 2016, which was conducted on 40 handball players over a period of 6 weeks, examined the effect of glutamine supplementation on the strength, aerobic energy systems and plasma glutamine levels. The results of their study show that glutamine supplementation had a significant effect on VO2max ($P < 0.05$) and strength ($P < 0.05$), as well, glutamine had a modification effect on plasma glutamine depletion (Sajedi, Salari, Bas, & Bayram, 2016), which is similar to the findings of our study. The last decade has seen contrasting reports on the benefits of protein supplements on improving athlete performance. The effects of glutamine supplementation on muscle mass and strength remain debatable and unresolved. In 2003, Falk et al. indicated that enhancement of muscle strength and endurance in a group of athletes who were given a supplementation consisting of effervescent creatine, ribose and glutamine was not significantly different when compared with a placebo group (Falk, Heelan, Thyfault, & Koch, 2003) which is contrary to the findings of (Ghanbarzadeh & Sedaghatpour, 2011).

A major problem faced by athletes is strength loss and exercise-induced muscle injury or soreness. For a sport like boxing that requires highly specialized kinetic linking movements, attenuation of strength loss is very important. Street et al. indicted that glutamine supplementation was effective in reducing muscle pain and soreness after eccentric exercise-induced injury (Street et al., 2011). In a study conducted in 2018 by researchers to investigate the effects of glutamine supplementation on neutrophil function in 26 male judokas, 2-week consumption of 3000 mg glutamine per day prevented increased muscle damage and ROS activity produced even in strenuous exercises (Sasaki et al., 2013). There are various opinions about the effect of glutamine supplementation on athletes' performance. However, many researchers believe that glutamine has a significant effect on recovery from overtraining and prevents exercise-induced injuries or oxidative stress(Castell, Poortmans, & Newsholme, 1996; Sasaki et al., 2013; Vasilescu, 2014). Some also believe that taking glutamine supplement along with other supplements may be more effective on athletes' body composition [142,139]. Even though many studies have evaluated the

effects of glutamine on attenuating strength loss, muscle strength and immune function, only few studies have focused on muscle volume (Candow et al., 2001). In the present study, 8 weeks of glutamine supplementation combined with boxing exercises did not significantly improve the circumference of upper-arms and thighs, indicating that glutamine had no significant effect on muscle volume similar to the findings of Candow et al. Since many studies have shown that increase in strength and not mass may be beneficial for boxers, it seems that glutamine may be the ideal supplement for boxing training programs.

5. CONCLUSION

The results of this study showed that taking 8 weeks of glutamine supplementation could increase the strength of thigh and arm muscles in boxers who seek to improve the strength of upper arms and thighs. However, glutamine intake did not have any effect on increasing muscle mass or circumference.This study showed that glutamine supplementation can affect many factors in the body of athletes, including, increasing strength, reducing the severity of pain due to injury, increasing immunity, increasing lean body weight, and reducing percentage of body fat. Our study did not resolve the possible positive effects of glutamine on increasing muscle volume. Future studies are required to confirm these findings. Since many studies have shown that increase in strength and not mass may be beneficial for boxers, it seems that glutamine may be the ideal supplement for boxing training programs.

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