EFFECTS OF 12 WEEKS MUSCLE HIPERTROPHY TRAINING PROGRAM IN A YOUNG MALE ATHLETE: STUDY CASE

End of degree essay
presented by:

GIACCHI LEGARRA, MIKEL

Advisor:
MALDONADO MARTIN, SARA

Academic year: 2013/1014
Ordinary call

Faculty of Physical Activity and Sports Sciences (UPV/EHU)

ABSTRACT

PURPOSE: The main goals of the present study were: 1) to review some recommendations about how to increase lean body mass; 2) to analyse whether following scientific sources of current recommendations, visible changes can be shown or not in a participant (body composition, strength and blood analyses).

METHODS: One male athlete completed 12 weeks of resistance training program and following a diet protocol. Some test were determined such as, strength 6RM, blood analyses, skindfold measurements, body perimeters and impedance test. Body composition measurements were taken 3 times during the program (before-T1, after 6 weeks of intervention period-T2 and at the end of the program-T3). On the other hand, strength tests and blood analyses were performed twice (before and after the program).

RESULTS: Strength was increased in general; blood analyses showed that Creatine kinase was increased a 104% and Triglycerides level was decreased a 22.5%; in the impedance test, body mass (1.6%), lean body mass (3.5%) and Body mass index (1.7%) were increased, whereas fat mass was decreased (15.5%); relaxed and contracted biceps perimeters were also increased.

CONCLUSION: A muscle hypertrophy training program mixed with an appropriate diet during 12 weeks leads to interesting adaptations related to increase in body weight, lean body mass, biceps perimeters, strength and creatine kinase levels, and a decrease in fat mass.

CONTENTS:

1. INTRODUCTION:

1.1-What does hypertrophy mean?

Skeletal muscle is a dynamic tissue which is adapted to both the nature and intensity of muscle use (Flann, LaStayo, McClain, Hazel & Lindstedt, 2011). Repeated bouts of strength training produce compensatory growth of skeletal muscle, which is characterized by an increase in the cross-sectional area of individual fibres as well as the volume of the entire muscle (Drummond et al, 2008).This compensatory growth of the muscle is known as hypertrophy. The key to generate muscle strength and muscle mass increases is subjecting the system to overload. In other words, participating to a physical stress to which our body is not used. Since strength production is a function of the cross-sectional area of the muscle, muscle hypertrophy causes increasing strength (Flann et al, 2011).

1.2- How do we get it?

Many people want to be fit, but many factors, such as; genetic predisposition, somatotype and the behaviour of the person determine the success reaching a target (Baechle & Earle, 2007). It is said that the combination between a hyper caloric diet and a progressive resistance training program is the essence of increasing body mass and lean body mass (Hoffman, 2011). The optimal way of gaining muscle mass and strength is still unclear.

Many factors including training load, intensity, duration, rest, type of movement and diet might affect the effects of the resistance training program (Bird, Tarpenning & Marino, 2005; Wolfe, Lemura & Cole, 2004). While some studies have shown tiny effects of the training variables, such as, training intensity and rest periods between sets (Campos et al, 2002; Ahtiainen Pakarinen, Alen, Kraemer & Hakkinen, 2005), other studies state that these training variables affect to the hypertrophic response (De Souza et al, 1010; Mitchell et al, 2012).

There have been many studies that have explored the effects of resistance training in 8-14 weeks, without taking into account the diet (Flann et al, 2011; Higbie, Cureton, Warren, & Prior, 1996; Mitchell et al, 2012). Other studies have focused on the diet but not the training program specificity at all (Jazayeri & Amani, 2004; Thalacker-Mercer, Petrella & Bamman, 2009), or even others studies that have only focused on the supplementation (Cribb & Hayes, 2006; Joy et al, 2013). All these aspects are important when designing a hypertrophy program. This is the reason why it has been done a summary of which points must be considered when designing a program with the aim of gaining muscle mass.

Every recommendation is placed in one of these two blocks: resistance training program and diet, including supplementation.

- ***Resistance training program***

Resistance training program is a modality of training that has had a “boom” in popularity over the past two decades, especially for its role improving athletic performance by increasing hypertrophy, balance, motor performance, coordination, strength and power among others (Arazi & Asadi, 2012). Nowadays this modality of exercise is recommended by the best health associations in the world, including the American College of Sport Medicine and the American Heart Association, for all kind of populations (Hulmi, Lockwood & Stout, 2010).

Hypertrophy is associated with moderate to high intensity and volume. These training programs, which are high in total work, tend to stimulate a potent endocrine and metabolic response (Hoffman, 2011). It is widely believed that the resistance program with the aim of muscle mass gaining are designed to train between 6-12 reps (67-85% of 1RM) and with rests of 30-90 sec. between each set (Hoffman, 2011). Analysing which could be the optimal number of sets for each muscle group if the objective of the program is muscle hypertrophy, it appears that, multiple sets produce a greater improvement in body mass and a greater reduction in body fat. However, it is unclear up to which number of sets we should reach to obtain the optimal training session for hypertrophy. What it has been suggested is to increase training intensity and volume progressively to obtain the greatest outcome (Hoffman, 2011).

When analysing the training frequency, for beginners in resistance training the optimal frequencies would be 2-3 days alternating training days. An increase in training experience does not need a change in frequency, but it might be more dependent on alterations in the other acute variables, such as exercise selection, volume and intensity. Nevertheless, increasing training days might permit greater specialization per muscle group. While the experience in this kind of training programs is developing the frequency could be increased to 4-5 days per week (Hoffman, 2011).

Variation is another important factor to take into consideration when designing an effective muscle hypertrophy program. Even the best individualized program cannot indefinitely increase the muscle hypertrophy. It will reach to the moment were the improvement will stop and there will be a risk of excessive training and boredom. To experience continuous improvement, reduce the overtraining and the boredom, there is a need of variation in the program (Baechle & Earle, 2012). It should periodically switch the intensity, frequency, volume, rest time and training system to avoid all these previously mentioned aspects (Baechle & Earle, 2007).

In terms of muscle contractions there is a contradiction about which type of contraction is the best one and whether the type of contractions should be mixed in the same training session. Maximal concentric (only) and maximal eccentric (only) muscle actions are related to strength improvement (Higbie, Cureton, Warren, & Prior, 1996). However, it is said that the greatest muscle strength production occurs during eccentric contractions, exercise with high-strength eccentric actions may be the best stimulus to induce hypertrophy (LaStayo, Pierotti, Pifer, Hoppeler & Lindstedt, 2000; LaStayo, Ewy, Pierotti, Johns & Lindstedt, 2003). Thus, it has been suggested that heavy resistance training using eccentric muscle actions might be better than using concentric or isometric muscle actions in increasing strength (Colliander & Tesch, 1990). In contrast, other studies (Hather, Tesch, Buchanan & Dudley, 1991; O´Hagan, Sale, MacDougall, & Garner, 1995) suggested that coupled (eccentric-concentric) exercise is the greatest mode of training for muscle growth and neural activation. In other words, mixing concentric and eccentric actions in the same training program has been attributed to greater changes in both variables: neural activation and muscle hypertrophy.

- ***Diet: hyper caloric diet and supplementation***

Diet is an important complement of any physical fitness program. The primary dietary objective for active individuals is to obtain appropriate diet to optimize health, fitness and sport performance (Jazayeri & Amani, 2004). Diet is important to help to improve performance and also to promote healthy dietary practices in long-term (Jonnalagadda, Rosenbloom & Skinner, 2001).

Some studies state that macronutrients and micronutrients intakes influences resistance training efficacy. In other words, the daily intake of protein, carbohydrate, fat… augment or inhibit muscle hypertrophy in response to a resistance training program (Thalacker-Mercer, Petrella & Bamman, 2009).

- ***Hypercaloric diet:***

Regarding which kind of diet could be the best for muscle growth many studies mention the hyper caloric diet. This is a diet in which more kilocalories than needed to maintain body weight are consumed. It is also known as energy-rich or hyper energetic diet (Campbell & Spano, 2010). Therefore, if gaining muscle mass is the primary goal, apart from exerting an appropriate stimulus on the muscles, more calories need to be consumed than are expended. It is said that to obtain the optimal muscle increase with the minimal fat increase, it is needed an increased of calories predominately from protein and carbohydrates, with only very low increases in fat consumption (Campbell & Spano, 2010).

The recommendation of macronutrients ratio for bodybuilders is around 55-60% carbohydrate, 25-30% protein and 15-20% fat (Lambert, Frank & Evans, 2004). With this proportion of the total dietary intake, the participant will have enough protein to optimize muscle gaining, enough carbohydrates to permit the maximal performance during the resistance training, and enough fat to maintain adequate testosterone level in the blood (Lambert, Frank & Evans, 2004). This energy distribution is the optimal, but only if the total energy intake is increased a 15% above what is required to maintain weight (Lambert, Frank & Evans, 2004).

As it has recently said above, protein intake is one of the most important diet factors for muscle building. Many studies have established that excess of protein intake is needed for optimal muscle growth after resistance training (Greenwood, Kalman, & Antonio, 2008).

Muscle hypertrophy happens only when muscle protein synthesis exceeds muscle protein breakdown. Therefore, the body is in a constant state of protein turnover, because new proteins are created and old ones are destroyed or degraded (Campbell & Spano, 2010). It is said that the building blocks of proteins, amino acids, need to be available to ensure attainment of a positive balance (Campbell & Spano, 2010). In addition, resistance-trained athletes need to ingest a sufficient amount of protein to maintain a positive nitrogen balance and also anabolism (Kreider et al, 2010).

Recommended protein dietary intake for an adult is about 0.8 grams per kilogram of body weight. It is supposed that this amount of protein intake should be enough for meeting the nutrient requirement of healthy individuals (Joy et al, 2013).

In the case of individuals who want to gain lean body mass, it is needed to increase the total daily intake, by eating more in each meal and doing more meals per day. An increase of 350-700 kcal above the daily requirements will provide the necessary calories to increasing 450-900 gram of lean body mass (Campbell & Spano, 2010). Increasing the fat free mass is linked to an increase in the protein needs. It is calculated that the daily protein need is between 1.5 and 2 grams per kilogram of bodyweight in individuals who engage in resistance training and want to increase lean body mass (Campbell & Spano, 2010).

Protein has a limited role energy production, because its primary function is to increase and maintain lean body mass. There are many factors to consider when determining the optimal protein amount for exercising individuals. These factors include protein quality, total energy intake, carbohydrates intake, intensity and duration of the exercise, and the timing of the protein intake (Lemon, 1998).

The majority of the consumed proteins should be stemmed from animal sources (Baechle & Earle, 2012). These kinds of proteins are better to plant-based proteins. Therefore, animal-based proteins, such as, beef, milk, turkey, tuna, egg and chicken, are considered complete protein sources, because they contain greater amounts of essential amino acids (EEAs). These products are a good protein choice due to their relatively high protein content and low fat content (Campbell & Spano, 2010).

It is said that a long-term dietary protein intake and a resistance training program will lead to greater muscle growth than either resistance training or dietary protein alone (Cribb, Williams, Stathis, Carey & Hayes, 2007).

Another important macronutrient that we should consider is carbohydrates. Individuals who perform intense exercise many times a week should adequate carbohydrates intake to prevent glycogen depletion in trained muscle over time (Campbell & Spano, 2010). Therefore, consumption of high levels of carbohydrates during the day will improve muscle performance in high intensity physical activities (Balsom, Gaitanos, Söderlund, & Ekblom, 1999). The consumption of carbohydrates before and after resistance training is presumed to spare muscle glycogen stores as well as offer ergogenic benefit such as increased work capacity during subsequent workouts (Haff, Lehmkuhl, MCcoy, & Stone, 2003). Recommended carbohydrates for muscle building could come from pastas, starches, breads, rice and complex carbohydrates among others (Campbell & Spano, 2010).

Regarding the last macronutrient known as fat, it is known that fat content of a diet can move from 20% to 40% of the total dietary intake without affecting the strength performance (Campbell & Spano, 2010). It has been wrongly believed that fat intake is not good for muscle building, but fat intake is essential in this process to maintain adequate testosterone level in the blood among other reasons (Baechle & Earle, 2007).

- ***Supplementation:***

Some researchers have established that ingesting protein before, during or after the intense resistance training can influence protein synthesis pathways (Willoughby, Stout & Wilborn, 2007). Many studies support the use of protein supplementation within the context of the exercise, to improve the recovery of the muscle after heavy resistance training. It also helps to decrease proxy makers of muscle damage or soreness (Etheridge, Philp & Watt, 2008). It has also been shown that protein supplementation increases fat-free mass, strength, body mass and several markers of muscle hypertrophy (Willoughby, Stout & Wilborn, 2007).

It is suggested that supplementing the diet with protein brings greater training adaptations during the training session than ingesting an isoenergetic amount of carbohydrates (Andersen et al, 2005). The most popular reason for protein supplementation is to improve athletic performance, build muscle or meet extra demands of heavy resistance training (Krumbach, Ellis & Driskell, 1999).
Whey protein is the most popular source of protein used in nutritional supplements, especially in the sport nutrition market. It is available as whey protein concentrates isolates and hydrolysates. The differences among these forms are the amino acid profiles, ability to preserve glutamine residues and method of processing (Campbell & Spano, 2010).

In comparison to other types of protein, whey protein is digested faster, has better mixing characteristics and is a higher quality protein (Tipton & Ferrando, 2008). The most important component of high-quality protein is its large concentration of essential amino acids (Moore et al, 2009). Nevertheless, based on some studies with animals, only leucine is required to induce protein synthesis. Therefore, *in vivo* human studies are needed to validate this hypothesis (Kimball & Jefferson, 2006).

The type of protein consumed immediately after the resistance training can determine the acute amplitude of muscle protein synthesis and lean mass gains (Cribb & Hayes, 2006). It has been reported that milk consumption just after resistance training has greater effects on muscle hypertrophy than consumption of an equivalent amount of soy protein or isoenergetic carbohydrate drink (Hartman et al, 2007).

Other studies have established that the protein-carbohydrates supplements might provide the ideal anabolic conditions for muscle building when are taken immediately before and after the resistance training program (Volek, 2004). Therefore supplement timing would provide greater chronic adaptations compared to same supplementation in other our far from resistance training sessions (Chromiak et al, 2004; Esmarck et al, 2001).

The unique aspect of the present study, compared with previous research, is the attempt to following all the recommendations of the last 25 years in order to get the best result in 12 weeks of resistance training. Up to my knowledge there is not any other study that combines strength tests, anthropometrical tests and blood analyses. Furthermore, it can be said that instead of being a research with many participants and only one or two different measurements, this study is focused on many adaptations related to a hypertrophy program in a case study with a man. Therefore, two were the main aims of this study: firstly, to review some recommendations about how to increase lean body mass; secondly, to analyse whether following scientific sources of current recommendations, visible changes can be shown or not in a participant (body composition, strength and blood analyses).

2. METHODS:

2.1- Participant.

A 21 years old man took part in the present study case. He was active but had not participated in any resistance training for at least 1 year. Nevertheless, he was familiarized with exercise technique, because he had experience in some resistance training programs previously. The participant was enrolled in a football team and this meant 4 days of high intensity aerobic exercise per week.

2.2- Testing.

Body composition measurements were taken 3 times during the program (before-T1, after 6 weeks-T2 and at the end of the program-T3). On the other hand, strength tests and blood analyses were performed twice (before and after the program).

- ***Body composition measurements (impedance and skinfold measures).***

Body mass, lean mass, fat mass and body fat percentage were determined by impedance and skinfold thicknesses. Six skinfold thicknesses on the right side (subscapular, triceps brachii, supraspinale, abdominal, anterior thigh, medial calf), were performed by the same experienced investigator in accordance with guidelines from International Society for the Advancement of Kinanthropometry (Norton et al., 1996).

Another used measurement was the bioelectrical impedance. This measures the impedance to the flow and distribution of radiofrequency alternating current both water and electrolytes influence the impedance of the applied current. Therefore, measuring total body water indirectly determines fat-free mass and body fat. This is the best method to determine the body composition currently (Lukaski et al, 1985).

In terms of body composition measurements, some perimeters were also measured: waist, hip, relaxed arm, contracted arm and thigh perimeters.

- ***Strength measurements (6 RM test of upper and lower body)***

Strength testing was conducted to determine voluntary isotonic strength. Normally strength measurements are done with the 1 RM strength test. But, in this case the measurements were performed with a 6 RM test and the outcomes were validated with the 1RM test *(Figure 1)* (Baechle & Earle, 2012). The 6 RM test was performed in 6 exercises: chest bench press, shoulder press, biceps curl, bench row, leg curl and leg press. Before each text a warm up of 8-15 repetition was performed with a light load. If the repetitions performed were higher than 4, there was a rest of 2-3 minutes and the same exercise was performed again with higher loads (Baechle & Earle, 2012).

# Repetitions	% 1RM
1	100
2	95
3	92.5
4	90
5	87.5
6	85
7	82.5
8	80
9	77.5
10	75
12	70
15	60

Figure 1. Relation between 1RM percentages and number of repetitions. *(Baechle and Earle, 2012)*

- ***Blood analysis. (Biochemical)***

Blood samples were obtained from a catheter inserted into an antecubital vein. These blood samples were analysed for general hematology and general biochemistry. Therefore, component such as hemoglobine, cholesterol and creatincinasa were analysed.

2.3- Intervention program:

- ***Resistance training program.***

The participant underwent 12 weeks of progressive full body resistance training consisting of 3 phases and each one lasted for four weeks. During these weeks, training intensity and volume was progressively increased and training mode was changed monthly (different exercises, different routines...). In general, loads were established around 68-85%1RM, with 6-12 reps and rests of 30-90 seconds between each set (Hoffman, 2011). The last set for each exercise was performed to the point of momentary muscular failure. Exercises order was an important factor to take into consideration: large muscle group exercises were performed before smaller muscle group exercises, multiple-joint exercises were performed before single-joint exercises and higher-intensity exercises were performed before lower-intensity exercises (Hoffman, 2011). The training program was divided in 3 phases because variation in exercises, sets, intensity and rest periods are essential for achieving great results (Hoffman, 2011).

As mentioned before the program was divided in the following three phases:

- Overload phase one: this first phase consisted of three sessions per week having a rest of at least one day between training sessions. During these weeks, eight basic exercises were used: Chest bench press, shoulder press, biceps curl, triceps extension, bench row, leg curl, leg press, and abdominals. Each training day, all these exercises were performed. Six sets of 12 repetitions with loads around 70%1RM were performed for main muscles (chest, back, shoulder and quadriceps) and three sets for smaller muscles, such as, biceps, triceps and hamstring.
- Overload phase two: the second phase consisted of three sessions per week, adding a rest of at least one day between training sessions. Training session were divided by two muscle groups (back-biceps), (shoulder-lower body muscles),(chest-triceps). During these weeks loads were increased to 75-80%1RM. For back, chest and shoulder 12-15 sets of 10 reps were performed, and for triceps, biceps, hamstring, and quadriceps 6-9 sets of 10 reps were performed. At the end of each training session 10 minutes of abdominal exercises were performed.
- Overload phase three: this last block consisted of four sessions per week. Training session days were divided by muscle groups: first day (chest), second (back), third (shoulder- quadriceps), last (biceps-triceps-hamstring). During these weeks loads were increased to 80-85%1RM. For back, chest and shoulder 16-20 sets of 6-8 repetitions were performed. In contrast, for triceps and biceps 10-12 sets of same repetitions were performed. Finally, for hamstring and quadriceps previous phase's loads were maintained. At the end of each training session 15 minutes of abdominal exercises were performed.

- ***Diet protocol***

In general, a hyper caloric diet based on a high intake of protein and carbohydrates was established. During the day, five meals were done: a high caloric breakfast (corn flakes, skimmed milk, fruit juice, toasts...), some snacks at mid morning (peanuts, energetic bars...), a lunch based on carbohydrates (rice, pasta...), some fruits and snacks at mid afternoon, and a protein/ vegetables based dinner (chicken, fish, eggs omelette, spinach, grilled vegetables...). It was a balanced diet, specially based on proteins and carbohydrates, but the total dietary intake was increasing every two weeks.

During the last month a supplementation of whey protein was added to the diet, because increasing even more the ingested food was quite difficult. This supplementation was taken just before and after the resistance training sessions. Each protein shake contained 30 grams and 120 calories, from which 22 grams were proteins, four grams were carbohydrates and the rest were sugars, fat, potassium, L-glutamine, taurine and sodium among others. Hydration was taken into consideration and at least two litres of liquid were ingested per day. The most important aspect of the hydration was before, during and after training sessions. It was ingested at least 0.5 litres of liquid during the two hours before the performance. During the training every 15 minutes 150-200 ml was ingested and after the training session 300-500 ml of water was ingested too.

3. RESULTS:

Twelve weeks of resistance training resulted in many changes related to strength and anthropometrical measurements, there were not many visible changes in the blood analysis results changes were observed for creatine kinase and triglyceride values. The differences between baseline and follow-up were evaluated, including percentage of change into variables.

First of all, regarding strength adaptations, improvements were visible in all the strength exercises done, such as, 20kg in bench chest press, 8kg in shoulder press, 14kg in seated row, 7.5kg in biceps curl, 20kg in leg press and 20kg in leg curl. Therefore, general and specific strength was improved at this 12 week period *(Table 1).*

Table 1. Strength changes in the 6RM test.

STRENGTH EXERCISE	BASELINE	FOLLOW-UP	Pre-Post Tests difference	% OF CHANGE
Leg press (kg)	125	145	+20	16%
Leg curl (kg)	48	68	+20	41.6%
Seated shoulder press (kg)	20 x 2	24 x 2	+8	20%
Bench chest press (kg)	53 + bar	67.5 + bar	+14,5	27.35%
Bench row (kg)	61	75	+14	22.9%
Biceps curl (kg)	25 + bar	32.5 + bar	+7,5	30%

RM= maximum repetition.

Secondly, there were observed changes in anthropometrical measurements such as, an increase in body mass (1.2 kg), body mass index (0.4 kg), and lean body mass (1.4 kg). Conversely, a decrease in fat body mass (0.9kg) was observed. When comparing the three tests, lean body mass, body weight and body mass index were proportionally increased in the same way, whereas fat body mass was lower at the second test than at the last one (Table 2).

Table 2. Body composition changes in the impedance.

PARAMETERS	BASELINE	AFTER 6 WEEKS	FOLLOW-UP	Pre-Post Test difference	% OF CHANGE
BMI (kg/m2)	22.4	22.4	22.8	+0.4	1.7%
Body mass (kg)	75	75.1	76.2	+1.2	1.6 %
Lean body mass (kg)	39.9	40.9	41.3	+1.4	3.5%
Fat body mass (kg)	5.8	4.5	4.9	-0.9	15.5%

BMI= body mass index.

Regarding perimeter test, there were changes in some measurements *(Table 3),* such as relaxed biceps (1cm) and contracted biceps (1.2 cm). On the other hand, there were not visible changes in upper thigh, waist and hip perimeters (Table 3) and skinfold measurements (Table 4).

Table 3. Changes in the perimeter test.

PERIMETERS	BASELINE	AFTER 6 WEEKS	FOLLOW-UP
Biceps (relaxed) (cm)	30	30.8	31
Biceps (contracted) (cm)	34	34.2	35.2
Waist (cm)	78.5	78.4	75.7
Hip (cm)	95.5	95.4	95.5
Thigh (cm)	35	36	35

Table 4. Changes in the skinfold calliper test.

SKINFOLDS	BASELINE	AFTER 6 WEEKS	FOLLOW-UP
Subscapular (mm)	10	10.2	10.1
Suprailiac (mm)	8	9	9
Abdominal (mm)	20	19	19
Upper thigh (mm)	8.2	8	8
Chest (mm)	7.8	7.5	7.9
Triceps (mm)	9	8	8.5
In total (mm)	63	61.7	62

Finally, analysing the blood analysis *(Table 5),* there were no changes in the majority of the analysed parameters including general hematology and general biochemistry. Nevertheless, there is a great change in creatine kinase levels between baseline (380 b) and follow-up test (778 b) and another great change in triglycerides level (Table 5).

Table 5. Changes in blood analysis (hematology and biochemical).

BLOOD ANALYSIS	BASELINE	FOLLOW-UP	Pre-Post Test Relation	% OF CHANGE
Creatine kinase (b)	380	778	+398	104%
Triglycerides (g)	80	62	-18	22.5%
Total cholesterol (g)	189	196	+7	3.7%
LDL cholesterol (g)	119	124	+5	4.2%

LDL= low density lipoprotein.

4. DISCUSSION

The purpose of this study was to determine whether following diet and training recommendation of scientific sources, we will obtain great adaptations in 12 weeks in strength, blood analyses and anthropometric measurements.

In general, the results of our study have been satisfying because the vast majority of the tested aspects were improved. Nevertheless some other aspects, such as, skinfold measures and part of the blood analyses have not shown visible adaptations. This could be because skindfold test is quite subjective and unreliable, because the baseline measurements were quite low or because of the short period that the intervention program lasted.

Nevertheless, there was an incredibly great adaptation in creatine kinase levels. It is said that creatine kinase is linked to muscle fatigue and the levels of this substance usually increase when more physical exercise is done (Flann et al, 2011). As the participant has increased in four more hours a week his training, the creatine kinase level have increased consequently. Another great adaptation was a decrease in the triglycerides level. As the fat percentage has decreased, the triglycerides level would have decreased at the same time (Baechle & Earle, 2007).

In addition to these adaptations, in the present study, it has been demonstrated that following many tips about diet and resistance training, strength increases and many anthropometric adaptations can be visible in only 12 weeks. These anthropometric adaptations are muscle hypertrophy (increased lean body mass), decreases in fat body mass and increased in some perimeters, such as, relaxed biceps, contracted biceps and upper thigh.

All these adaptations were previously seen in other studies. For example, according to Jones and Rutherford increased strength and muscle hypertrophy are known consequences of functional overload. Nevertheless, it is unclear which one is the aspect that stimulates the growth, mechanical stress or increased metabolic flux. Although progressive resistance training causes increases in lean body mass, humans demonstrate large variability in their responsiveness to the program. Factors such as sex, physical fitness, previous training status and age could affect the range of muscular adaptation (Folland & Williams, 2007; Wernbom, Augustsson & Thomeé, 2007).

The hypertrophy of the muscular cells is not usually measurable before 8-12 weeks since the start of the program (Baechle & Earle, 2012). During the initial phases of the training program, the neural factors, such as, the improvement in the execution, motor recruitment and activation rhythm, are the most important reason for the strength increases. Whereas, during the next weeks the strength increases will be caused by the muscle hypertrophy (Baechle & Earle, 2012). Thus, increasing strength after high intensity resistance training might be due to hypertrophy and/ or increased neural activation of the muscle (Higbie et al, 1996).

Training eccentric-concentric muscle actions could be one of the causes of the great adaptations shown in the results in terms of strength and muscle hypertrophy. It is said that the greater force and stretch placed on muscle fibres, sometimes resulting in fibre damage in muscle could be the signal leading to greater muscle hypertrophy (O´Hagan et al, 1995). This greater force is done in eccentric muscle actions and this has been shown as the best way of training for lean body mass increases (Jones & Rutherford, 1986). Nevertheless, training coupled, concentric and eccentric actions produce greater improvements in muscle hypertrophy than training with concentric muscle actions only (Hather et al, 1991; O´Hagan et al, 1995). In contrast, training with eccentric muscle actions only, does not always lead to greater muscle hypertrophy (Hather et al, 1991).

A limitation of the present program is that it does not known which type of muscular fibre has been created, either type I or type II.

In terms of strength we could say that the improvement would be higher if the participant was not an athlete. It is known that strength levels of previous untrained men or women can increase, if training loads easily surpass the usual work of a muscle (Hakkinen, 2000). But it is not that clear these improvements in previous trained people.

It is said that improvements in previous trained people will be lower comparing to the ones in previous untrained people (Hakkinen, 2000).

Another negative factor was that the participant played football during the study period and trained 3-4 days a week, which had negative consequences in the final adaptations. It is established that aerobic exercise has a negative result in muscle strength, power and size induced by resistance training (Putman, Xu, Gillies, MacLean & Bell, 2004; Coffey et al, 2009). It has been recently proved that this interference effect could be due to incompatibility between cellular pathways controlling turnover (Coffey et al, 2009). Lundberg and colleagues stated in 2012 that intense aerobic training can be executed prior to resistance training without compromising performance outcome. However, if the order of the training session is changed, adaptations related to resistance training will decrease (Lundberg et al, 2012).

Body fat mass decrease was another result of the study. Among the body composition adaptations related to this kind of training program, highlights the increase of the cross-area of muscles (hypertrophy) and the decrease in body fat percentage (Brandergurg & Docherty, 2006; Ahtianen, Pakarinen, Alen, Kraemer & Hakkinen, 2005; Folland & Williams, 2007). These two adaptations are not related only to the training program, but also to the diet.

In terms of diet, the participant of the study followed a hyper caloric diet, based on high quantity of high quality proteins and carbohydrates. The optimal daily protein intake and total dietary intakes to support muscle gain related to resistance training are yet unclear.

Many studies say that higher daily protein intakes improve the magnitude of skeletal muscle growth during resistance training (Cribb et al, 2007; Campbell et al, 1999). Among the dietary protein intake, an inadequate protein intake has been shown to affect muscle metabolism, strength, mass and function (Campbell et al, 1999). As previously said, dietary proteins have also been shown to stimulate muscle protein synthesis and have an additive effect when mixed with resistance training (Tipton et al, 2001; Paddon-Jones, Sheffield-Moore, Aarsland, Wolfe & Ferrando, 2005).

Some studies suggest that when dietary protein and/or amino acids are consumed within the immediate time frame of the resistance training, the improvement will be greater

(Biolo, Tipton, Klein & Wolfe, 1997; Hartman, Moore & Phillips, 2006; Cribb & Hayes, 2006). Therefore, supplementation before and/or after resistance training will increase anabolic response by increasing muscle protein synthesis rates, decreasing protein degradation and providing a higher net protein balance (Tipton, Borsheim, Wolf, Sanford & Wolfe, 2003). The recommendation is to abstain from consuming protein supplementation for up to 3 hours before and after exercise, because the effects will be lower (Cribb & Hayes, 2006).

Many other studies suggest that supplementation of whey protein alone or with carbohydrates just after, before and during the resistance training can increase muscle hypertrophy levels in healthy adults (Hulmi, Lockwood & Stout, 2010). These studies also suggest that whey protein may improve recovery from heavy resistance training and probably decrease muscle damage and soreness (Hulmi, Lockwood & Stout, 2010). Taking into account that during the last four weeks the participant did follow this recommendation of whey protein supplementation before and after the training sessions, the results appear to be higher than if he did not.

According to many studies if the participant had supplemented his diet with creatine, the result would have been greater. Supplementing your diet with creatine have been shown greater improvements in performance, lean body mass and has a safety profile when consumed in recommended dosages (Greenwood, Calman & Antonio, 2008). Chemically creatine is derived from amino acidsglycine, arginine and methionine. When creatine enters the muscle cell, it accepts a high-energy phosphate and forms phosphocreatine, which helps to the rapid formation of ATP (Campbell & Spano, 2010).

Hydration was taken into consideration too. Hydration is another important factor in resistance training because our system needs to recover from the electrolyte level decrease and minerals among others. Interesting enough hydration will benefit athletes performing resistance training. It is very important to remain well hydrated during the day and obviously before, during and after training (Campbell & Spano, 2010). There are some recommendations for athletes in terms of hydration before, during and after training sessions. It is recommended to drink at least 0.5 litres of liquid during the 2 hours before the performance. During the training the recommendation is to drink around 250 ml per hour if the environment condition is normal. It is also recommended to drink 0.45 litres of liquid per 0.45 kilograms of body weight lost during the activity (Baechle & Earle, 2012).

5. CONCLUSION:

Overall, in this study it was found that 12 weeks of an effective muscle hypertrophy training program mixed with an appropriate diet, many adaptations can occur, such as, an increase in body weight, lean body mass, biceps perimeters, strength and creatine kinase levels, and a decrease in fat mass. Anyway all these adaptations would have never been possible if all the next recommendations had not been taken into consideration:

PRACTICAL RECOMMENDATIONS	
DIET PROGRAM	**RESISTANCE TRAINING PROGRAM**
✓ Hyper caloric diet (progressively increased)	✓ Varied and progressive training program
✓ Protein and Carbohydrate based diet, without forgetting fat	✓ 6-12 reps, 67-85% 1RM, 30-90 rest seconds
✓ Carbs. And Proteins before and after training sessions	✓ Volume and intensity is increased progressively
✓ Whey protein is a good supplementation (Creatine too)	✓ 3-5 days a week and alternating same muscle group session (2 days at least)
✓ Hydration during the day and especially before, during and after training sessions	✓ Do not practice too much aerobic exercise

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