A comparison of two short training programs, strength versus hypertrophy, to increase the 1RM in two different upper body exercises.

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Abstract

Background
Muscle strength is a regular feature in many sports and activities and is often of great significance when it comes to performance. To develop muscular strength resistance training is a commonly used method but there are several ways to train in order to gain muscle strength. Two different training schedules are strength training and muscular hypertrophy training. However there are divided opinions whether there really is any major difference between these two training schedules in order to develop muscular strength. Furthermore the general view is that it takes several weeks before any significant changes in muscular strength can be noticed. But some research indicates that an increase in muscular strength can be seen much earlier which is what this study will examine.

Aim
The aim of this study was to examine the effect of two short resistance training programs on maximal strength in the barbell bench press exercise and seated barbell shoulder press exercise. A second aim was to compare differences in the strength gain between a hypertrophy training program and a strength training program after two weeks of resistance training.

Methods
A two week long experimental intervention study with 20 healthy resistance training men in the age 18-27 was conducted. The subjects were randomly divided into two groups and performed resistance training three times a week. One group followed a strength training program and the other a hypertrophy program. Every subject performed a one repetition maximum (1RM) pre- and post-test in bench press and seated shoulder press with two weeks between to determine any change in maximal strength.

Results
The results from this study showed a significant muscular strength increase in both groups in both exercises after two weeks of resistance training. There was a significant difference in strength increase in the bench press exercise with the greatest strength improvement in the strength training group. No difference between the groups in the seated shoulder press could be seen.

Conclusion
This study showed that it is possible to make a significant strength increase after only two weeks of resistance training and that the muscular strength gain is greater when training on the basis of a strength training program rather than hypertrophy training.
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Introduction
In science there is no doubt that physical activity has a positive effect on people's health and it doesn't matter whether the activity consists of running, walking, swimming, cycling and so on as long as one is active (Jekauc, Niermann, Reiner & Woll, 2013). A popular activity among people nowadays is resistance training to develop strength. The goal among athletes and other resistance training individuals are often to gain muscle mass and get stronger in order to perform better in a specific sport or just to facilitate the management of different tasks in life. Two different ways to do resistance training are strength training to improve strength and hypertrophy training to gain muscle mass. But regardless of how one trains it usually takes several weeks before significant results like muscle gain and strength development start to show (Contreras, Ogborn, Peterson, Schoenfeld & Sonmez, 2015; Angelopoulos, Clarkson, Gordish-Dressman, Hoffman, Hubal, Price & Thompson, 2005). Furthermore depending on the goal of the individual a training program might differ a bit when it comes to number of repetitions, sets, load, rest and so on. The recommendations often range between different numbers since a lot of individual factors such as experience, goals and training status all affect how to design a training program. But since there are different opinions regarding the best way to train in order to develop strength and few studies have been made on short resistance training interventions. Therefore, the overall purpose of this research is to study this more thoroughly.

Background

Resistance training
The use of resistance training to develop strength goes way back and was used already thousands of years ago by soldiers in ancient Rome, China, India and Japan as a preparation of war. It also became part of the training process among athletes that competed in the first Olympic Games in ancient Greece. During the 19th century resistance training was developed and machines designed to train strength were invented. In the United States muscular strength became an indicator to measure and estimate physical condition during the latter half of the 19th century. Strength training continued to develop and by the mid-1900s weightlifters, body-builders and wrestlers among others used various exercises to increase strength (McArdle et al., 2008). Since then the popularity of resistance training has spread among athletes and other individuals. Science implies that it has a positive effect on health by prevention of chronic disease, increased insulin sensitivity, decrease of sarcopenia among elderly and overall facilitates daily activities (Aagard, Caserotti, Kjaer, Magnusson & Suetta, 2009; Feigenbaum,
Franklin & Hass, 2001). The daily recommendations of resistance training vary a bit depending on training status and experience. For a person whose goal is to stay healthy two training sessions per week performing 8-10 exercises with one set of 8-12 repetitions per exercise is sufficient according to Feigenbaum et al. (2001).

**Physiology during an early phase of resistance training**
When performing resistance training both neural and muscular adaptations occur. During the first weeks of resistance training when the body is exposed to regularly and recurrent physical stress a number of neural adaptations occur. Increased activation, more effective recruitment and increased synchronization of motor neurons develop and improve (McCardle et al., 2008). These factors along with muscular growth and increased levels of hormones all affect the development of muscular strength. In a study Falkel et al. (1994) examined the muscle adaptations during early phase of resistance training. They found an increase of the subjects' one repetition maximum (1RM) in leg press, leg extension and squat after only two weeks of resistance training. Falkel et al. (1994) also found that within the first three weeks of resistance training there was an increase of the cross-sectional area of different muscle fibres which continued to increase and reached its peak after seven weeks. There was also an increase in resting levels of testosterone after three weeks and a decrease of cortisol and growth hormones. Falkel et al. (1994) explain that the increased levels of testosterone and decreased levels of cortisol probably result in a suitable environment for protein synthesis which in turn favours muscular growth.

While performing a muscle action a complex process occurs. A skeletal muscle consists of a muscle belly which surrounds several wrappings of fasciculus embedded into a tissue named epimysium. Inside the fasciculus there are endomysium which contain several muscle fibres. The muscle fibre in turn is connected to a motor neuron that transmits information from the nervous system (McArdle et al., 2008). The origin of a muscle contraction within a muscle comes from a process called the action potential. The action potential, to sum up, is a depolarization and repolarization of the cell membrane involving sodium ions (Na+) and calcium ions (Ca+), which travels through a muscle cell membrane causing an impulse. The impulse is a form of electrical signals which move along the muscle fibre and makes the muscle contract (McArdle et al., 2008; Konrad, 2006).

**Method to determine muscle strength**
An essential aspect when it comes to designing a resistance training program is to know the individual's strength in the upper- and lower body. A commonly used method to do this is to
perform a one repetition maximum (1RM) test. The 1RM strength is the load that only allows the individual to perform one repetition of an exercise. When the 1RM test is completed a training load is determined based on a percentage of the 1RM test (Baechle & Earle, 2008). A frequently used method to measure and develop upper-body strength is the barbell bench press exercise which chiefly involves the m.pectoralis major, m.triceps brachii and m.deltoides anterior (Brown, Coburn, Judelson, Khamoui, Schick, Tran & Uribe, 2010). Another exercise that also can be performed to increase strength in the upper-body is the seated barbell shoulder press. The exercise mainly targets the m.deltoides but also involves the m.triceps brachii and m.biceps brachii (Fimland & Saeterbakken, 2013a). Both barbell bench press and seated barbell shoulder press are two exercises that, along with many others, can be used by athletes in a resistance training program. Irrespective of whether the program focuses on strength training or hypertrophy training the same exercises can be used during the training process. In the study by Brown et al. (2010) and the study performed by Fimland & Saeterbakken (2013) the bench press exercise respectively the seated barbell shoulder press were used to measure and compare 1RM in the upper body.

**Strength training**

When it comes to resistance training in order to improve strength versus hypertrophy training the training schedule might differ and the numbers of repetitions are often different from hypertrophy. A general opinion in resistance training is that in order to increase strength the resistance load should be 85% or more of 1RM while performing one to six repetitions. When training at heavier load than 85% of 1RM neural adaptations like increased recruitment and synchronization of motor units occur. These neurological adaptations have shown to be of great importance when it comes to develop maximal strength (Kraemer & Ratamess, 2004). According to Kraemer and Ratamess (2004) the same neural adaptations do not occur when training at lighter load which is the case in hypertrophy training. The range of rest interval between sets and exercises also has an impact on the training progress. In a review article by da Silva Novaes, Freitas de Salles, Lemos, Miranda, Simao & Willardson (2009) an attempt to determine the most favourable rest interval between sets was made. Their findings were that a rest period between each set when training to increase strength was 3-5 minutes. Almost the same recommendations are given by Baechle and Earle (2008) with the slightly difference of 2-5 minutes.

**Hypertrophy training**

Training for hypertrophy is a common way among athletes and other individuals to improve
muscle function. Increases in muscle size are often positively related to strength improvement and power development which is essential in many sports. By stressing the muscles mechanically through prolonged regular resistance training the muscle fiber becomes injured. This causes a physiological process called protein synthesis which is the production of new proteins which occur within the cells. Proteins such as actin and myosin along with other proteins inside the myofibril increase which cause a thickening in the cross-sectional area of the muscle fibers, i.e. an enlargement of muscle size occur (Baechle & Earle, 2008; McArdle et al., 2008).

Hypertrophy training usually has a load somewhere between 67-85% of 1RM and about six to twelve repetitions (American College of Sports Medicin, 2009; Baechle & Earle, 2008). While training for hypertrophy the rest should be between 30-90 seconds (da Silva et al., 2009; Baechle & Earle, 2008).

The effects of different training interventions

Strength versus hypertrophy

Even though it is a commonly applied training method that one should train heavy to increase in muscle strength there are some indications that it is possible to increase equally regardless of whether the training program is based on hypertrophy or strength. In a study by Aarskog, Bjordal, Skogen, Wilhelmsen and Wisnes (2011) 62 subjects of both genders in essentially the same age were randomized into two groups with equal distribution of men and women. Both groups were given an 8-weeks resistance training program. One group was given a program based on strength training (6RM) and the other group got a program based on hypertrophy training (12RM). The main focus was training to volitional exhaustion in both groups. If the subjects managed more than the settled repetitions the load was increased for the next training session. The exercises that were used were the bench press and the squat exercise. The aim of the study was to see if there was any difference in strength gain between the groups after 8 weeks. The results showed that there were no significant differences in strength gain between the groups which, according to Aarskog et al. (2011), might depend on the fact that both groups produced a maximal activation of motor units due to the volitional exhaustion.

Short and long interventions

In a study from 2001 Kamen and Knight measured muscular activation and strength gain of the knee extensor muscles among young (18-29 years) and older (67-81 years) adults of both genders divided into two groups depending on age. In the study four test sessions were made.
The two first sessions were baseline tests followed by six weeks of strength training. Two more tests were made after two respectively six weeks of the strength training program. Even though the 1RM method was not used in this study the results showed an increase in maximal voluntary contraction (MVC) and muscle activation already after two weeks and it continued to increase during the last part of the study as well. Kamen and Knight highlighted rapid neural adaptations to resistance training as the possible reason to the early strength increase among the subjects.

An effect in strength was also found early in the resistance training progress by Buford, Rossi, Smith and Warren (2007). They compared the effect on strength using three different periodization models. In the study 28 subjects of both genders participated and did resistance training three times a week during nine weeks. The number of repetitions varied from week to week. Their maximal strength (1RM) in the bench press and leg press exercises were measured three times, before the training period, four weeks into the training period and finally in the end of the training period. The results showed a significant increase in strength in both exercises among all three groups after both four and nine weeks. It could therefore also be interesting to look at shorter interventions to further investigate the possibility of a strength increase after only two weeks. Another angle of approach worth considering would be to study if there are any difference in strength increase between a hypertrophy program and a strength training program.

**Rationale**

It is difficult to find studies whose purpose is to study and compare the effect on maximal strength on the upper-body after a short time of strength training contra hypertrophy training on experienced resistance-trained individuals. Nevertheless there are some indications, with reference to the recently mentioned studies, that there might be an increase in strength during the early stage of a resistance training period, perhaps as early as within two weeks. This study will further examine if this is possible and thus contribute with knowledge in the area.

**Aim**

The aim of this study was to examine the effect of two short resistance training programs on maximal strength in the barbell bench press exercise and the seated barbell shoulder press exercise. A second aim was to compare differences in the strength gain between a hypertrophy training program and a strength training program after two weeks of resistance training.
Research questions

1. Does the maximal strength increase in the barbell bench press and the seated barbell shoulder press exercise after two weeks of resistance training in the strength training group?

2. Does the maximal strength increase in the barbell bench press and the seated barbell shoulder press exercise after two weeks of resistance training in the hypertrophy training group?

3. Are there any differences in strength gain in the barbell bench press and the seated barbell shoulder press exercise between the hypertrophy training program and the strength training program after two weeks of resistance training?

Method

Study Design
The study was an experimental intervention study on healthy resistance training men in the age of 18-27 where the effect of two short resistance training programs on maximal strength in two upper body exercises was examined. The study was executed by randomly dividing the subjects into two groups with equally amount of subjects in each group, one performing the strength training and one the hypertrophy training program. Every subject performed a 1RM pre- and post-test with two weeks between to determine the change in maximal strength. The tests were performed at Träningskompaniet in Halmstad, Take Care in Laholm and a few tests were also performed in the laboratory at Halmstad University. Irrespective of where the test took place the equipment used for the barbell bench press were 20 kg bars and weights from Eleiko. The seated barbell shoulder press were performed in a Smith-machine from Eleiko in all premises. Two test leaders were responsible and engaged in the study. Both were present during the tests in the laboratory but only one of the test leaders were present at the tests performed at Träningskompaniet respectively Take Care. Both tests were performed during the evening for all participants except for two subjects who performed the tests in late morning. During the two weeks between the tests the subjects performed resistance training on the basis of two different resistance training program. The study was executed and accomplished during the month of April 2016. Information about the subjects such as age, weight and height was also collected in order to describe the group.

Subjects
If the subjects were interested in participating in the study they received a written paper with
information about the study. As inclusion criteria the subjects had to be aged 18-30, done
resistance training at least twice per week during the last 12 months, be free from any illness
or injuries that could affect the performance and be familiar with the barbell bench press and
the seated barbell shoulder press exercises. The exclusion criteria were that the subjects had to
refrain from any resistance training exercises 48 h before the tests (Brown et al. 2010). During
the duration of the intervention studies the subjects were instructed to refrain from any other
exercises of the upper body that could affect the outcome of the study.

**Procedure**
The subjects were randomly divided into one of the two groups. Depending on which group
the subjects were part of they received either a strength training program or a hypertrophy
training program consisting of the same eight exercises to be performed three times a week
during two weeks. Two test occasions per subject were used to determine the subject's
maximal strength (1RM) in the flat bench press exercise and the seated barbell shoulder press
exercise. The first occasion occurred at the start of the study. Anthropometric data such as
age, weight and height along with the results from the 1RM test of both exercises, i.e. how
many kilograms each subject manage to lift, were noted and saved. Thereafter the subjects
were instructed to follow their respective training program during the following two weeks.
During the second occasion the same procedure was followed and the results from this
occasion were compared with the results from the first occasion to determine if there had been
any increase in maximal strength in the two exercises. Both test occasions together took
approximately one hour per subject. Determine the maximal strength in both exercises was
done according to NSCA:s “1RM Testing Protocol”(Table 1) (Baechle and Earle, 2008).

<table>
<thead>
<tr>
<th>Step</th>
<th>Load (% of 1RM)</th>
<th>Repetitions</th>
<th>Set</th>
<th>Rest (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Warm-up</td>
<td>40 - 65</td>
<td>5-10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2. Warm-up</td>
<td>66 - 79</td>
<td>3-5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3. Load Increase</td>
<td>80 - 90</td>
<td>2-3</td>
<td>1</td>
<td>2-4</td>
</tr>
<tr>
<td>4. 1RM attempt</td>
<td>100</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Testing**
In the early stages of the process a pilot study was performed to test the 1RM method to make
sure that everything worked as planned and to exclude any possible error sources that might occur later on while testing of the subjects. The 1RM protocol was tested along with the instructions that were to be used during the performance of the bench press and the seated shoulder press. The pilot study worked out well without any errors that could have forced a change of the 1RM method.

Before testing the 1RM the subjects had to do a general warm-up to prepare the body (Baechle & Earle, 2008). They started with ten minutes cycling with easy self-selected intensity (Fimland, Saeterbakken & van den Tillar, 2011). Thereafter the subjects started with the barbell bench press exercise to follow the 1RM protocol. In research by Doscher, Jenkerson, Langford and McCurdy (2008) and Campbell, Clemons and Jeansson (2010) the 1RM bench press test is a valid and reliable test to determine the maximal strength of the upper-body. The subjects were instructed to lay down with the back on the bench and the feet on the floor. While performing the bench press exercise the subjects were instructed to use a self-selected pronated grip and lower the bar towards nipple level in the same vertical path as possible. The grip width was marked by the test leaders to make sure that the same grip was used during the whole procedure as well as during both test occasions. The bar had to touch the chest but was not allowed to bounce of the chest (Fimland & Saeterbakken, 2013b; Bird, Mayhew and Welsch, 2005). The subject started with a warm-up at light resistance by performing 5-10 repetitions. The subjects then had to rest one minute before once again perform a warm-up set, this time with a slight load increase (4-9 kg) that allowed three to five repetitions. This was followed by two minutes rest. The load was then increased to a load near their self-estimated 1RM which allowed two to three repetitions followed by two to four minutes rest. Thereafter some load (4-9 kg) was added to the barbell and the subject made a new try before resting followed by adding or removing loads depending on whether the lift was successful or not. The test continued like this until the 1RM for the bench press exercise was determined (Baechle & Earle, 2008). A repetition was considered complete when the elbows were fully extended (Baechle & Earle, 2008). The test leaders were present as spotters during all repetitions to provide a safe environment for the subjects (Fimland et al., 2011).

The seated barbell shoulder press followed the same protocol when determined the 1RM. The exercise was performed in a smith-machine to make sure that every subject lifted the bar in the same vertical path. The subjects sat down on a bench (75° upward angle) in the five-point body contact position and grasped the bar with a self-selected pronated grip, a bit wider than shoulder-width. The grip width was marked by the test leaders so the same grip was used
during the whole procedure as well as during both test occasions. The exercise started with the bar above the head on fully extended elbows. The bar was then lowered to the same level as the acromion. The subjects then pressed the bar upwards above the head until the elbows were fully extended. The subjects were not allowed to hyper extend the back or rise of the seat (Baechle & Earle, 2008; Fimland & Saeterbakken, 2013a).

Training Intervention
The training programs were designed to increase the strength in barbell bench press and seated barbell shoulder press. Both training interventions consisted of eight exercises totally. The exercises for training the chest were barbell bench press, barbell bench press with close grip width, dumbbell bench press on incline bench and machine chest press (Figure 1) (Baechle and Earle, 2008; Chilakos, Faigenbaum, Hoffman, Kang, Mangine and Ratamess, 2008). The exercises for training the shoulders were seated barbell shoulder press, dumbbell shoulder press, upright row and dumbbell lateral raise (Figure 2) (Baechle and Earle, 2008; Chilakos, Faigenbaum, Hoffman, Kang, Mangine and Ratamess, 2008). The numbers of training sessions were determined on the basis of American College of Sports Medicin (2009), Baechle and Earle (2008), and McArdle et al. (2008). After each session at least one rest day but not more than three had to be undertaken to provide sufficient recovery (Baechle and Earle, 2008; Appendix1, Appendix 2).
Figure 1. Chest exercises. Barbell bench press, barbell bench press with close grip width, dumbbell bench press on incline bench and machine chest press.

Figure 2. Shoulder exercises. Seated barbell shoulder press, dumbbell shoulder press, upright row and dumbbell lateral raise.

The exercises were performed in the same order as described above. The sequence of the exercises in the study were based on the recommendations that exercises that target large muscles before small muscle groups and multiple-joint exercises before single-joint exercises should ideally be performed first (College of Sports Medicine, 2009; Baechle & Earle, 2008; McArdle et al., 2008). Training load, number of repetitions, number of sets and rest between sets differed between the two interventions. The ones in the hypertrophy group were instructed to use a load between 70-85 % of their 1RM and perform 8-12 repetitions per set. The rest period between set and exercise was 30-90 seconds. In the strength training group the subjects used a load of 85-100% of their 1RM while performing 1-6 repetitions per set. The rest period between set and exercise was 2-5 minutes (Table 2). The load, repetitions and rest chosen in the study were based on resistance training recommendations from American
Table 2. Training program for both groups including load, repetitions, set and rest.

<table>
<thead>
<tr>
<th>Load (% of 1RM)</th>
<th>Repetitions</th>
<th>Set</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength Training</td>
<td>≥ 85</td>
<td>1-6</td>
<td>4</td>
</tr>
<tr>
<td>Hypertrophy Training</td>
<td>70-85</td>
<td>8-12</td>
<td>4</td>
</tr>
</tbody>
</table>

In both intervention groups the chosen amount of sets per exercise were four since several studies have shown that multiple-sets are favourable over single-set to promote strength and hypertrophy among experienced resistance-trained individuals (Baechle & Earle, 2008; Emrich, Fröchlich & Schmidtbleicher, 2010; Krieger, 2010). The subjects were instructed to perform every repetition in a controlled way with a velocity of approximately one second in the concentric and eccentric phase respectively since performing a movement with high velocity instead of a low velocity imply a greater strength improvement according to Chilibeck and Farthing (2003) and McArdle et al. (2008).

Data Collection
Four tests per subject were performed in this study. During the baseline test occasion the 1RM in kg of every subject in the two exercises were determined. This was achieved by loading the bar with as much weights that the subject could only perform one repetition. During the post intervention test occasion the same procedure was followed to once again determine the 1RM in both exercises. The load in kilograms was compared with the load from the first occasion in order to see if there had been any increase in strength among the subjects.

Statistical Analysis
In this study quantitative data on a ratio scale was collected and saved. The software IBM SPSS Statistics 20 were used for the statistical analyse. Descriptive statistics were used to describe the groups. To determine whether the population was normally distributed or not the Shapiro-Wilk test was used. The Shapiro-Wilk test showed a p-value greater than 0.05 which indicated that the sample was normally distributed. In order to compare the results between pre- and post tests paired sample T-test was used. An independent sample T-test was used to compare any differences between the two groups. The level of significance was set to 0.05.

Ethical and Social Considerations
Before the start of the study all subjects were informed both written and verbally of the
procedure, the method and what was expected of them. The subjects also had the opportunity to ask questions before the study, both written and verbally. The author ensured that the subjects had understood the information before they gave a written consent to volunteer in the study with the knowledge that they could drop out of the study at any time without any consequences. The subjects were all healthy and free from any conditions that could worsen by participating in the study. When the study was finished every subject was given the opportunity to be informed about their results from the study. All individual information about the subjects and results from tests were saved on an usb-stick and were used only in the purpose of this study. The information was handled strictly confidential in order to shelter it from unauthorized persons. Halmstad University approved the study and took the responsibility to handle and store the usb-stick and the written consents in order to prevent the information from disseminate. There were no funding, sponsors or institutional affiliations in the study and the author can confirm that there were no personal or political conflicts of interest. The ethical principles of this study were based on the Declaration of Helsinki (World Medical Association [WMA] Declaration of Helsinki, 2016). Depending on the outcome of this study the results and knowledge can be used by coaches and athletes to design training programs that might generate a rapid strength development. This in turn can be used to boost the capacity of an athlete shortly before a competition.

Results

The study consisted of 20 men. The age, weight and height of the subjects were 24.1± 2.4 years, 85.2 ± 9.2 kg and 182 ± 7 cm (Table 3). The subjects were from various gyms in Halmstad and Laholm. All individuals that fulfilled the inclusion criteria were asked and informed verbally.

Table 3. Compilation of mean ± standard deviation in age (years), weight (kg) and height (cm) within the groups.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Age</th>
<th>Weight</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength Training</td>
<td>24.2 ± 3.0</td>
<td>82.0 ± 9.5</td>
<td>181 ± 6</td>
</tr>
<tr>
<td>Hypertrophy Training</td>
<td>23.9 ± 1.7</td>
<td>88.3 ± 8.4</td>
<td>182 ± 8</td>
</tr>
</tbody>
</table>

The total load lifted among the subjects during the study was calculated by adding the total training volume in the training programs submitted from the subjects. The results showed that the strength training group had lifted 22953 kg in the chest exercises and 13105 kg in the shoulder exercises. The hypertrophy group had lifted 35769 kg in the chest exercises and
17076 in the shoulder exercises (Table 4). Altogether the hypertrophy group had lifted 12816 kg more in the chest exercises and 3971 kg more in the shoulder exercises than the strength training group.

Table 4. Total load lifted (kg) after the intervention, presented in mean ± standard deviation. 10 subjects from the hypertrophy group and 6 subjects from the strength training group.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Chest</th>
<th>Shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength Training</td>
<td>22953 ± 1264.7</td>
<td>13105 ± 1355.7</td>
</tr>
<tr>
<td>Hypertrophy Training</td>
<td>35769 ± 2579.3</td>
<td>17076 ± 1744.4</td>
</tr>
</tbody>
</table>

The results from the strength training group showed an significant increase (p= <0.00) in both the bench press exercise and the seated shoulder press after two weeks of resistance training in the strength training group (Table 5). In the bench press exercise there was an increase of 4.7 kg and an increase of 4.8 kg in the shoulder press exercise.

Table 5. Maximal strength (1RM) in kg ± standard deviation in bench press and shoulder press before and after the intervention within the strength training group.

<table>
<thead>
<tr>
<th>Strength Training</th>
<th>Pre Test (1RM)</th>
<th>Post Test (1RM)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press</td>
<td>87.1 ± 12.9</td>
<td>91.8 ± 12.8</td>
<td>0.000</td>
</tr>
<tr>
<td>Shoulder Press</td>
<td>58.6 ± 13.3</td>
<td>63.4 ± 12.8</td>
<td>0.000</td>
</tr>
</tbody>
</table>

The results from the hypertrophy training group showed an significant increase (p= <0.00) in both the bench press exercise and the seated shoulder press after two weeks of resistance trainings in the hypertrophy group (Table 6). In the bench press exercise there was an increase of 2.4 kg and an increase of 3.5 kg in the shoulder press exercise.

Table 6. Maximal strength (1RM) in kg ± standard deviation in bench press and shoulder press before and after the intervention within the hypertrophy training group.

<table>
<thead>
<tr>
<th>Hypertrophy Training</th>
<th>Pre Test (1RM)</th>
<th>Post Test (1RM)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench Press</td>
<td>89.3 ± 12.6</td>
<td>91.7 ± 12.7</td>
<td>0.001</td>
</tr>
<tr>
<td>Shoulder Press</td>
<td>55.0 ± 5.5</td>
<td>58.5 ± 5.9</td>
<td>0.000</td>
</tr>
</tbody>
</table>

The results of the independent t-test showed a significant difference (p=0.024) in strength gain in the bench press exercise between the two groups. The greatest strength gain could be
seen in the strength training group where the increase was in mean 4.7 kg compared to 2.4 kg in the hypertrophy group. There was a trend but no significant difference (p=0.059) in strength gain in the seated shoulder press exercise where the improvement were slightly higher in the strength training group. The mean increase was 4.8 kg in the strength training group and 3.5 kg in the hypertrophy training group.

**Discussion**

**Results Discussion**

Both training groups showed an increase in maximal strength in both exercises after the two week long training intervention. However the maximal strength increase was slightly greater in the strength training group compared with the hypertrophy training group. In the present study a strength gain could be seen after only two weeks of resistance training. This finding is well matched with the results from Kamen and Knight (2001) and Buford el al. (2007) which indicates that an increase in maximal strength is fully possible after such a short time period as two weeks. According to Kraemer and Ratamess (2004) this early strength increase largely depends on neurological adaptations. The same neural adaptations that elicit muscular strength when training at heavier loads does not occur to the same extent when training at lighter loads. This might be an explanation to the greater strength increase in the strength training group.

Furthermore this study showed a significant difference in strength gain in the bench press exercise between the two groups but no difference in the shoulder press exercise. The reason to why the maximal strength gain differed between the groups is hard to say, there might be a number of factors affecting the outcome. Interesting is that the hypertrophy group altogether lifted 12816 kg more in mean than the strength training group which is quite a lot. One could presume that the greater load lifted in the hypertrophy group would indicate a greater strength increase but as the results showed the outcome was the opposite. This strengthen the belief that one should train with heavy weights to achieve the most favourable muscular strength increase (Contreras et al., 2015). The total load lifted in the exercises targeting the shoulders was 3971 kg more in the hypertrophy group. Even though the hypertrophy group lifted more than the strength training group the difference was not as much as in the chest exercises and that could be an explanation to way there was no significant difference in strength gain between the groups in the shoulder press exercise.
A second reason to why the strength increase was greater in the bench press exercise than in the shoulder press exercise in both groups might depend on the fact that the subjects were instructed to perform the chest exercises first and the shoulder exercises thereafter during the training sessions. This could have led to an exhaustion of the shoulder muscles while performing the chest exercises due to increased lactate levels and inhibition of activation signals to the muscles from the nervous system (Allen, Lamb & Westerblad, 2008; Baudry, Duchateau, Enoka, Farina, Klass & Rudroff, 2010). This in turn might have implied a lack of stamina while performing the shoulder exercises and thus a less strength increase in the shoulder muscles. If the subjects would have been instructed to start with the chest exercises respectively the shoulder exercises every other session, or start with a chest exercise and then a shoulder exercise and so on, the possible fatigue of the shoulder muscles could have been avoided (Baechle & Earle, 2008).

Another possible cause might be that the subjects have different training experience in the bench press and shoulder press exercises which could lead to different adaptations to the training programs. A person that regularly performs resistance training with the bench press exercise and the shoulder press exercise as a constant part of their training schedule will probably not get the same effect from the training program in this study as a person with much less experience in the exercises. The effect would probably be greater for a person with less experience due to neural adaptations and increased levels of hormones like testosterone that occur early in the training process and which promote strength gain (Falkel et al., 1994).

While comparing the findings in this study with the results from the study made by Aarskog et al. (2011) the two studies differ in terms of strength gain between strength training and hypertrophy training. Aarskog et al. (2011) did not find any difference between their strength training and hypertrophy training groups after eight weeks of resistance training. However their study lasted six weeks longer than this study. There is a possibility that the strength increase in this study would have developed to the same extent as in the study by Aarskog et al if it had continued over a few more weeks. But at the same time findings from research by Contreras et al. (2015) showed that groups training with higher loads have a greater strength increase than groups training with lower loads after eight weeks.

Another factor that should be considered is that the subjects performed three training sessions per week targeting the same muscles at every session. This could have had an effect on the
results. Not allowing the muscles to fully recover after each session increases the risk of overreaching which in turn could have a negative effect on the training response and thereby the strength increase (Hassmén & Kenttä, 1998). There is a possibility that the results would have been different if the training session had consisted of two weekly training sessions instead of three or if there had been four weekly sessions targeting either the shoulder muscles or the chest muscles every other session. The fact that the two groups had different rest intervals between sets and exercises might also have affected the results. The strength training group was allowed longer rest intervals than the hypertrophy training group during the training sessions. According to da Silva Novaes et al. (2009) and Baechle and Earle (2008) a rest interval between 2-5 minutes is best in order to increase muscular strength.

**Method Discussion**

The outcome of the 1RM tests might have been affected by the fact that the tests were held and performed on different places and was supervised by two different test leaders. The subjects were also instructed to perform both tests at the same test occasion starting with the bench press and then followed by the shoulder press. This might have led to fatigue in the shoulder muscles after the bench press performance affecting the shoulder press test. A more ideally scenario would have been if the subject performed the 1RM in bench press one day and then came back a day later to perform the 1RM test in the seated shoulder press. In that way a possible fatigue of the shoulder muscles could have been avoided. In future studies these factors would preferably be much more standardized in order to receive even more trustworthy results.

A limitation in this study was that during the intervention the test leaders were only present during the 1RM test. The subjects then performed all the training sessions on their own which mean that there is no possibility for the test leaders to fully control that the subjects have lifted as much as the subjects' training programs show. Unfortunately there is a risk that the subjects may have lied about their training but since they have volunteered for the study one can hope that they are honest. The best scenario would have been if the test leaders could be present during each session of every subject to control that the training program was followed correctly.

It is also possible that different standardized training programs might have had another effect on the outcome of the study. By defining an exact number of repetitions and an exact percentage of the 1RM the total load lifted between the groups would be more of the same
when summarized. That way the possibility that different amounts of load may affect the results of the study would be avoided. As for now, the subjects had the possibility to choice between a certain range of repetitions and percentage of 1RM which, as showed in table 3, led to a difference of total load lifted between the groups. This is something to consider in future studies.

**Conclusions**

This study shows that it is possible to make a significant strength increase after only two weeks of resistance training. Furthermore the study shows that the strength gain is greater when training on the basis of a strength training program rather than a hypertrophy program. In future studies a slightly more standardized and supervised training program could be of value in order to make sure that the subjects lift the same total weight during the intervention. More subjects would also be something to consider to see if that changes the outcome of the study. It could also be interesting to study the effect on the lower-body muscles as well to see if there is any difference between strength gains in the lower- and upper-body. However one should always have in mind that a training program should ideally be individualized in order to create the best conditions to facilitate the possibilities for optimal results for the athlete.
References


Träningsprogram Styrka

Namn:_________________________

Övningar
- Bänkpress
- Bänkpress med smalt grepp
- Bänkpress med hantlar på lutande bänk
- Bröstpress i maskin
- Sittande axelpress i Smith-maskin
- Axelpress med hantlar
- Stående rodd
- Hantellyft åt sidan

Träningsupplägg
Samtliga övningar skall genomföras vid samma träningstillfälle och i samma ordning som i listan ovan. Totalt skall 3 träningspass/vecka genomföras. Mellan varje träningspass ska minst 1 men högst 3 vilodag(ar) vidtas.

Vikt – Set – Reps – Vila
Samtliga övningar genomförs med en vikt på 85-100% av ditt RM i respektive övning. Totalt utförs 4 set per övning och 1-6 repetitioner per set. Viloperioden mellan varje set och övning sträcker sig mellan 2-5 minuter. Tiden för den excentriska respektive koncentriska fasen vid varje repetition är 1 sekund, vilket blir totalt 2 sekunder för hela rörelsen.

Beskrivning av övningar

*Bänkpress*
Ligg på en bänk med skivstången rakt ovanför bröstet, fotterna i golvet, huvudet mot bänken och ryggen neutral. Fatta stången med ett pronerat grepp något bredare än axelbrett. Sänk stången ner mot bröstet i höjd med bröstvårtorna men utan att låta stången ”studsa” mot bröstet. Pressa sedan stången uppåt tillbaka till startpositionen.

*Bänkpress med smalt grepp*
Ligg på en bänk med skivstången rakt ovanför bröstet, fotterna i golvet, huvudet mot bänken och ryggen neutral. Fatta stången med ett pronerat grepp med ungefär en handbredd emellan händerna. Sänk stången ner mot bröstet strax nedanför bröstvårtorna men utan att låta stången ”studsa” mot bröstet. Pressa sedan stången uppåt tillbaka till startpositionen.

*Bänkpress med hantlar på lutande bänk*
Sitt på en lutande bänk (45°) med fotterna i golvet, huvudet mot bänken och ryggen neutral. Håll hantlarna ovanför bröstet på raka armar med ett pronerat grepp. Sänk därefter hantlarna neråt till sidorna av bröstkorgen och pressa sedan hantlarna uppåt tillbaka till startpositionen.
**Bröstpress i maskin**
Sitt upprätt med ryggen och huvudet mot ryggstödet och fötterna i golvet. Fatta handtagen så att armar är parallella med golvet och armbågarna befinner sig rakt bakom och i jämnhöjd med handtagen. Pressa därefter handtagen långsamt bort från kroppen tills armar är utsträckta. Låt sedan handtagen föras tillbaka mot dig genom att böja på armbågarna.

**Sittande axelpress i Smith-maskin**
Sitt på en bänk med rygg och huvud mot ryggstödet, fötterna i golvet och stången precis ovanför bröstet. Fatta stången med ett pronerat grepp något bredare än axelbrett. Pressa därefter stången uppåt ovanför huvudet tills armar är utsträckta. Sänk sedan stången tillbaka till utgångspositionen genom att sänka armar och böja på armbågarna.

**Axelpress med hantlar**

**Stående rodd**

**Hantelflyt åt sidan**
<table>
<thead>
<tr>
<th>Övning</th>
<th>Vikt</th>
<th>Antal repetitioner</th>
<th>Antal set</th>
<th>Vila</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bänkpress</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bänkpress smalt grepp</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Bänkpress med hantlar på lutande bänk</td>
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<td></td>
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<tr>
<td>Bröstpress i maskin</td>
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<td></td>
</tr>
<tr>
<td>Sittande axelpress i Smith-maskin</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Axelpress med hantlar</td>
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<td></td>
</tr>
<tr>
<td>Stående rodd</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hantellyft åt sidan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2 – Träningsprogram Hypertrofi

Träningsprogram Hypertrofi

Namn: ___________________________

Övningar

• Bänkpress
• Bänkpress med smalt grepp
• Bänkpress med hantlar på lutande bänk
• Bröstpress i maskin
• Sittande axelpress i Smith-maskin
• Axelpress med hantlar
• Stående rodd
• Hantellyft åt sidan

Träningsupplägg

Samtliga övningar skall genomföras vid samma träningstillfälle och i samma ordning som i listan ovan. Totalt skall 3 träningspass/vecka genomföras. Mellan varje träningspass ska minst 1 men högst 3 vilodag(ar) vidtas.

Vikt – Set – Reps – Vila

Samtliga övningar genomförs med en vikt på 70-85% av ditt RM i respektive övning. Totalt utförs 4 set per övning och 8-12 repetitioner per set. Viloperioden mellan varje set och övning sträcker sig mellan 30-90 sekunder. Tiden för den excentriska respektive koncentriska fasen vid varje repetition är 1 sekund, vilket blir totalt 2 sekunder för hela rörelsen.

Beskrivning av övningar

Bänkpress

Ligg på en bänk med skivstången rakt ovanför bröstet, fotterna i golvet, huvudet mot bänken och ryggen neutral. Fatta stången med ett pronerat grepp något bredare än axelbrett. Sänk stången ner mot bröstet i höjd med bröstvårtorna men utan att låta stången ”studsa” mot bröstet. Pressa sedan stången uppåt tillbaka till utgångspositionen.

Bänkpress med smalt grepp

Ligg på en bänk med skivstången rakt ovanför bröstet, fotterna i golvet, huvudet mot bänken och ryggen neutral. Fatta stången med ett pronerat grepp med ungefär en handbredd emellan händerna. Sänk stången ner mot bröstet strax nedanför bröstvårtorna men utan att låta stången ”studsa” mot bröstet. Pressa sedan stången uppåt tillbaka till utgångspositionen.

Bänkpress med hantlar på lutande bänk

Sitt på en lutande bänk (45°) med fotterna i golvet, huvudet mot bänken och ryggen neutral. Håll hantlarna ovanför bröstet på raka armar med ett pronerat grepp. Sänk därefter hantlarna neråt till sidorna av bröstkorgen och pressa sedan hantlarna uppåt tillbaka till startpositionen.

Bröstpress i maskin
Sitt upprätt med ryggen och huvudet mot ryggstödet och fotterna i golvet. Fatta handtagen så att armar är parallella med golvet och armbågarna befinner sig rakt bakom och i jämnhöjd med handtagen. Pressa därefter handtagen långsamt bort från kroppen tills armar är utsträckta. Låt sedan handtagen föras tillbaka mot dig genom att böja på armbågarna.

**Sittande axelpress i Smith-maskin**
Sitt på en bänk med rygg och huvud mot ryggstödet, fotterna i golvet och stången precis ovanför bröstet. Fatta stången med ett pronerat grepp något bredare än axelbrett. Pressa därefter stången uppåt ovanför huvudet tills armar är utsträckta. Sänk sedan stången tillbaka till utgångspositionen genom att sänka armar och böja på armbågarna.

**Axelpress med hantlar**

**Stående rodd**

**Hantellyft åt sidan**
<table>
<thead>
<tr>
<th>Övning</th>
<th>Vikt</th>
<th>Antal repetitioner</th>
<th>Antal set</th>
<th>Vila</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bänkpress</td>
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</tr>
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<td>Bänkpress smalt grepp</td>
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</tr>
<tr>
<td>Bänkpress med hantlar på lutande bänk</td>
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<td>Hantellyft åt sidan</td>
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</tbody>
</table>
Appendix 3 – Written Consent

Information till deltagare
Hej!


Det råder delade meningar om hur man bör träna för att utveckla maximal styrka och hur man bör träna för att öka i muskelvolym, s.k. hypertrofi. I denna studie kommer två olika träningsschema tillämpas för att undersöka om en ökning av maximal styrka sker olika mycket beroende på om man tränar styrka eller hypertrofi.

Syftet med studien är dels att undersöka om det sker någon ökning av styrkan efter två veckor, dels att se om det är någon skillnad i styrkeökning beroende på om man tränar styrka eller hypertrofi.

Förfrågan om deltagande

Du tillfrågas för att du aktivt håller på med styrketräning minst två gånger i veckan och har gjort så under de senaste 12 månaderna samt är bekant med ovannämnda övningar. För att delta i studien krävs att du är skadefri och utan andra åkommor som kan påverka testresultaten, exempelvis sjukdom eller dylikt. Du bör inte heller vara fysiskt aktiv under de senaste 48 timmarna innan testerna ska göras. Slutligen rekommenderas dessutom att du ätit ordentligt innan testerna för att du ska ha tillräckligt med energi i kroppen.

Tillvägagångssätt

Studien kommer innehålla två testtillfällen för din del med två veckors mellanrum. Under det första tillfället mäts din maximala styrka (1RM) i bänkpress samt axelpress. Du tilldelas därefter ett två veckors styrketräningsprogram med övningar som du ska utföra. Vid det andra
tillfället kommer återigen din maximala styrka i de två övningarna mätas för att på så vis se hur din styrka har utvecklats. Ditt deltagande i studien medför inga risker som inte förekommer under dina vanliga träningspass. Testerna kommer ske på Träningskompaniet i Halmstad eller Take Care i Laholm.

**Frivilligt deltagande**

Du som testperson har rätt att avbryta testet när som helst utan att ange orsak. Om så önskas kommer då redan insamlad data att förstöras.

**Sekretess**


Vänligen,

Olle Larsson

**Ansvariga**

Ansvariga för studien är:

Olle Larsson

Biomedicin – inriktning fysisk träning

Högskolan Halmstad

Tel: 070-6543721

Mail: larssonolle91@gmail.com

Handledare: Emma Haglund, lektor vid högskolan i Halmstad.
Samtycke till deltagande i forskningsstudie

Nedan ger du ditt samtycke att delta i den studien som undersöker ökning av maximal styrka i 2 olika övningar. Läs igenom informationen noga och ge ditt medgivande genom att signera ditt namn nederst på sidan.

Jag medgiver att jag:

- Har tagit del av informationen kring studien förstår vad den innebär.
- Har fått ställa de frågor jag önskar och vet vem som är ansvarig huvudman om jag har fler frågor.
- Deltar frivilligt i studien och förstår varför jag har blivit tillfrågad.
- Vet att jag när som helst kan avbryta mitt deltagande i studien utan att ange orsak.

Jag intygar att jag har läst det informerade samtycket och tagit del av informationen kring studien. Jag förstår vad deltagande i studien innebär och ställer upp frivilligt.

Ort och datum_________________________________________________________________________

Namn____________________________Underskrift__________________________________________