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BACHELOR THESIS

# The weight lifting belt’s impact on power output, velocity and range of motion in a squat

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School of Business, Engineering and Science

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# Abstract

**Background:** Using a weight lifting belt when performing a variety of resistance exercises is becoming more and more common. The purpose of using a weight lifting belt is its supposed ability to reduce compressive forces on the lumbar spine and enhancement of athletic performance. Although the weight lifting belt has been proven to increase the intra abdominal pressure that helps reduces the shear forces during a squat, little is known about the weight lifting belts effect on the performance.

Studies have suggested that wearing a weight lifting belt during a squat can increase the vertical velocity and range of motion. Few studies have focused on the power output, but improvements have been seen while wearing a weight lifting belt when performing a deadlift. Variables such as power, velocity and range of motion are of importance for an athlete when making individual training plans as well as measuring the progress. Therefore more research is needed to identify the actual influence of the weight lifting belt on the performance.

**Aim:** The purpose of this study was to examine if weight lifting belts have an impact on an athletes ability to develop power, velocity or improve range of motion in a squat.

**Methods:** Fifteen healthy men and women familiar with the squat exercise participated in the study. During the study they performed six repetitions of the squat divided into two sets, one set without a weight lifting belt and one with a weight lifting belt. Power and velocity were measured during every squat with a linear encoder and videotapes were made to later calculate the angles in the hip- and knee joints at the lowest position of the exercise.

**Results:** No significant differences were found in power ($p = 0.25$) or concentric and eccentric velocity ($p = 0.61$, $p = 0.16$) with or without a weight lifting belt. Range of motion in the knee joint was greater when not wearing a weight lifting belt ($p = 0.03$), but no differences in the hip angles were found ($p = 0.70$).

**Conclusion:** The result from the current study shows that when performing a squat the weight lifting belt has little to no effect on power, velocity or range of motion. Although a noticeable change in range of motion of the knee joint were observed, further studies on larger populations are needed to determine if it is of clinical value.

# Abstrakt

**Bakgrund:** Att använda sig av hjälpmedel såsom lyftarbälte blir allt mer vanligt inom styrketräning. Syftet för användningen är lyftarbältets antydda förmåga att minska de kompressionskrafter som lumbalryggen utsätts för vid tunga lyft samt att det tros förbättra atletens prestation. Trots att lyftarbältet har bevisats öka buktrycket som i sig reducerar de skjuvkrafter som uppstår är kunskapen kring lyftarbältets påverkan på prestationen bristfällig.

Tidigare studier har visat tendenser till en ökad vertikal hastighet samt ett ökat rörelseomfång, gällande vinklarna i höft- och knäled, vid användandet av ett lyftarbälte. Av dessa studier har få undersökt påverkan på kraftutvecklingen, speciellt under en knäböj. Dessa variabler, kraftutveckling, hastighet och rörelseomfång, är av vikt för en atlet då en träningsplan ska läggas upp samt för att kunna mäta progressionen. På grund av detta krävs det ytterligare forskning för att kunna kartlägga de faktiska effekterna av ett lyftarbälte på prestationen.

**Syfte:** Syftet med studien var att undersöka om lyftarbältet har en påverkan på atletens förmåga att utveckla kraft, hastighet eller förbättra rörelseomfånget.

**Metod:** Femton friska män och kvinnor vana att utföra knäböj deltog i studien. Under testtillfället genomförde alla deltagare sex repetitioner av knäböj fördelat på två set, ett set utan lyftarbälte och ett set med. Kraftutveckling och hastighet mättes vid varje knäböj med hjälp av en linear encoder och alla knäböj filmades även för att göra analysen av höft- och knävinklarna möjlig.

**Resultat:** Ingen signifikant skillnad mellan de olika utförandena hittades i kraftutveckling ($p = 0{,}25$) eller i koncentrisk och excentrisk hastighet ($p = 0{,}61$, $p = 0{,}16$). Däremot var rörelseomfånget i knäleden större då deltagarna inte använde lyftarbälte ($p = 0{,}03$), men ingen skillnad hittades i höftleden ($p = 0{,}70$).

**Konklusion:** Resultaten från den aktuella studien visar att lyftarbältet har liten eller ingen effekt på atletens förmåga att utveckla kraft, hastighet eller förbättra rörelseomfånget i en knäböj. Trots att en liten skillnad i knävinkeln upptäcktes krävs ytterligare studier på större populationer för att avgöra om den är av kliniskt värde.

# Table of content

# 1. Background

Weight lifting belts (WB) are becoming more and more common within resistance training. Elite athletes have been using this equipment for a long period of time but lately athletes on all levels have incorporated the WB into their training. A survey shows that 27 % of all gym members use WB, 90 % use it to prevent the upcoming of injuries and 22 % to better increase their performance (Renfro & Ebben, 2006). It was also found that the main reason for using the WB is to reduce the compression force on the lumbar spine as well as improve the athlete's performance, although the actual influence is not completely clear (Renfro & Ebben, 2006). Despite the increasing use of WB there exists few studies that examine their actual effect on performance, therefore further investigation about how WB is affecting the squat is of importance.

## 1.1 The squat

The squat exercise is a well-known exercise that can be performed in many different ways and it is used within most types of training and sports. There are different ways to perform a squat but the most common guidelines are to stand with the feet shoulder-width apart and slightly rotated outward while maintaining a good posture with natural back and chest up throughout the whole lift (Baechle & Earle, 2008). The back should be held in a fixed relatively straight position throughout the movement in order to reduce the compressive forces on the lumbar spine (Abdulrahman, 2003). During the downward phase the athlete should flex both the hips and the knees until the thighs are at least parallel to the floor or lower, while keeping the knees aligned over the feet and the trunk stable. When the athlete has reached the lowest point of their individual squat they should maintain the same posture during the upward phase while extending the hips and knees until the starting position is reached (Baechle & Earle, 2008).

The squat can be performed with or without an external load. When using an external load it can be placed in two different positions during the back squat, which in this study will be called the squat, either high-bar or low-bar. The high-bar position is with the bar precisely under the neck and the athlete uses a wider grip to get more support, and in the low-bar position the athlete has the bar across the shoulders and the trapezius (Baechle & Earle, 2008). With either bar position the squat will be performed in the same way, and the athlete is preferred to have a slightly bigger anterior tilt of the pelvis to keep a normal lordosis in the spine (Abdulrahman, 2003). As mentioned the squat can be performed in many different ways, which often is effected by the physical demands of the exercise and the human physiology.

### 1.1.1 Physiological aspects of the squats

When performing the squat there are three general categories to choose from, the partial squat, the half squat and the deep squat. The three squats put different amount of stress upon the involved joints and requires different amount of flexibility. The joints involved in the squats are the ankle-, knee- and hip joint (Schoenfeld, 2010) and the present study has its focus on the hip- and knee joint. The knee complex consists of a hinge joint with a possibly small axial rotation that connects the tibia to the femur and a gliding joint that makes it possible for the patella to slide over the femurs trochlear surfaces. To give support to the joint it is surrounded by ligaments and cartilage that makes it stable throughout movements. In contrast to the knee joint the hip joint is a ball-and-socket joint, which allows it to move freely in the three planes, the frontal-, sagittal and transversal plan, where movement occurs. The hip joint is the connection between the head of femur and the acetabulum of the os coxae (Schoenfeld, 2010). The muscles involved in movement of the knee- and hip joint are very similar. It is necessary to activate the quadriceps when extending the knee, and when flexion is made, the hamstrings are responsible for the action. The hamstrings along with gluteus maximus are primarily responsible for making the hip extension during the squat possible (Schoenfeld, 2010). During the squat the greatest flexion angles of the hip joint has been measured to 95 degrees (°) ± 26° and maximum knee flexion to 153° ± 10°, although the ROM of the hip- and knee joint is individual and some people might be able to reach greater angles. These angles can also vary depending on if the person for example is squatting with an external load or with the heels lifted up from the ground (Hemmerich, Brown, Smith, Marthandam, & Wyss, 2006).

Flexibility (also referred as range of motion) as well as stability in the lower extremity are two of the most important aspects when performing a squat (Kim, Kwon, Park, Jeon, & Weon, 2015). If the athlete lacks the required flexibility the risk of compensating with other structures to perform the squat will increase, which can lead to injuries. One example of this is the range of motion (ROM) of the hip. When ROM of the hip is limited the athletes often get a greater trunk flexion which increases the stress acting on the lumbar spine (Kim et al., 2015). In a study where the relationship of lower extremity strength and ROM in deep squats has been examined a gender difference was observed. The results from the study showed that women had a greater hip mobility compared to men (Kim et al., 2015). Another study has also demonstrated a significant gender difference in performing the squat when comparing the kinematics between men and women. The women demonstrated a greater hip adduction, flexion and external rotation than the male participants. These differences can partially be explained by intrinsic factors such as joint laxity, limb alignment such as the Q-angle and hormone levels (Zeller, McCrory, Kibler, & Uhl, 2003). For example, female sex hormones estrogen and progesterone together with relaxin helps to increase the joint and ligament laxity around the pelvis during pregnancy. Both estrogen and progesterone are controlling the menstrual cycle and might have an effect on the laxity even prior to or post a pregnancy (Harmon & Ireland, 2000; Marieb, Hoehn, & Hutchinson, 2014). Females also have a wider pelvis than males, which affects the alignment of the femur and its angle to tibia. The alignment of the femur will affect the position of the knee as well as the ankle and foot placement, and subsequently this can alter the muscle used during the squat (Zeller et al., 2003). To help stabilize the trunk and the lower extremity various appliances can be used, such as knee support or a WB.

## 1.2 Weight lifting belts

The WB is usually made out of leather and can be either wider in the back than in the front or the same width over the entire length. The WB is recommended when higher loads are to be lifted during exercises that put stress on the lower back, such as squats and deadlifts. For the purpose to reduce the risk of injuries, although a few studies have shown that it may have a negative effect on the abdominal muscles activity during the exercise (Baechle & Earle, 2008).

The shown effects by using WB are, as mentioned, inconclusive regarding its ability to induce the intra-abdominal pressure (IAP). The biomechanical effect of using the WB is that the abdominal muscles are forced towards the spine while tightening the belt, and also making the abdominal muscles contract. Both the WB and the contraction of the abdominal muscles are proven to increase the IAP (Abdulrahman, 2003). It has also been demonstrated that breath holding can be used to increase the IAP while performing different lifting exercises (Granata, Marras, & Davis, 1997). Further more the regulated breath (breath holding) in combination with the use of WB have been investigated in a previous study and the results showed an increase in IAP with up to 10 % (Kingma et al., 2006). There have also been indications that the WB and the increased IAP reduces the shear forces acting on the athlete's spine during the execution of a lift. The reduction of shear forces in the spine may contribute to reduced disc compression and unload the amount of stress put onto the lumbar spine while lifting (Abdulrahman, 2003).

A previous study has also shown that a WB can affect the athlete's performance in more than one way. One of the aspects is ROM, meaning the movement of the athlete while performing a squat including the angles in the hip- and knee joint. The study showed a tendency of improvements in ROM and a significant increase in the total distance traveled by the barbell while wearing a WB (Zink, Whiting, Vincent, & McLaine, 2001). The same study showed an increased vertical velocity while wearing a WB. These results have also been seen in another study where the impact of a WB was studied while an athlete performed several repetitions of squats (Lander, Hundley, & Simonton, 1992).

Another aspect that is of interest is the athlete's ability to develop power during the squat. Research has shown that there is a correlation between an athlete's one repetition maximum (1RM) in squat and jump height during a vertical jump (Augustsson, 2013). This correlation has later on been used as a foundation when making training plans for sports where jumping height is of importance, making the squat a central exercise for the athletes (Augustsson, 2013). On the other hand, when looking at the different exercises within resistance training, little is known about the power output when it comes to the squat. Most of the studies that have been done to determine the power output have focused on the deadlift (Renfro & Ebben, 2006). One of the studies investigated the power output in different starting positions of the deadlift and found a difference within the performance. The position where the most power was developed was with the barbell placed on the middle of the thigh, which might be due to the possibility to use more of quadriceps when there is a bigger flexion in the knee (Beckham et al., 2012). This starting position during the deadlift is similar to the one the lifter has during the concentric phase of a squat, when the athlete is returning to the starting position (Arvidsson, 2016). Therefore it is important to do further research of the squat to investigate if similar results can be found. To determine the power output during a squat the usage of measuring equipment is necessary, which will be described in the following paragraph.

## 1.3 Power measurements

To determine the power output (force x velocity) during resistance exercises different types of equipment such as force plates and a linear encoder can be used. The linear encoder, which was used in the present study, can measure power, velocity and displacement during both the concentric and eccentric phase of a lift. This is done with a shuttle connected to for example the barbell, and the shuttle itself is connected to an infrared sensor that register the mentioned variables (Bosquet, porta-Benache, & Blais, 2010). The force plates on the other hand measures the ground reaction forces (GRF) that are produced during the movement (Grimshaw, 2006).

Knowing the power output and velocity produced during an exercise can be of importance to properly see the progress made with a specific training plan. It can also be used as a tool for professional athletes to make sure that their training load and volume are set to the optimal level (Hatfield et al., 2006). When analyzing the velocity variable it is important to take the force-velocity relationship under consideration, which states that if velocity decrease the force will increase. The force produced is, among other physiological responses, related to the recruited motor units, their firing frequency as well as the activation of the muscles. All of these responses are necessary to gain muscle strength and hypertrophy. The velocity also has an impact on the power output during a squat, the higher the velocity is the greater power will be developed (Hatfield et al., 2006).

As mentioned above (paragraph 2.2 Weight lifting belts) little is known about the WB effect on power, velocity and ROM during a squat. Therefore further studies are needed in the area, which states that the current study is of importance to help generate more knowledge about the possible benefits of using a WB on an athlete's performance. This information can later on be of use for everybody dedicated to resistance training that includes squat exercises. Previous research has shown that the WB can have positive effects on power and velocity, and may also have an impact on the ROM due to the seen tendency to an increased knee ankle and total distance travelled by the barbell. Therefor the hypothesis of this study is that wearing a WB will have a positive impact on the performance during a squat, improve the velocity and power output as well as ROM.

# 2. Aim

The purpose of this study was to examine if weight lifting belts have an impact on well-trained med and women's ability to develop power, velocity or improve range of motion in a squat.

- Has the use of a weight lifting belt an influence on the well-trained men and women's ability to develop power and velocity in a squat?
- Does the weight lifting belt change the ROM in a squat for well-trained med and women?

# 3. Methods

## 3.1 Experimental design

The effects of a WB on the squat performance were examined with a quantitative experimental cross-sectional study. The study consisted of one day of testing for each participant and all data needed involving the lifts were documented at the same time. During the test day the subjects also participated in another study, which did not have an effect on the results due to it being executed after the present study.

## 3.2 Subjects

The study sample was recruited from Halmstad University. Information about the study was posted in the private group page for students at the Exercise Biomedicine program where the students could sign up to participate. A total of 18 people volunteered to participate, 15 via the mentioned post and another three volunteered after getting information after seeing the conduction of the tests. Three subjects had to be excluded from the study due to other commitments; the remaining 15 (ten men and five women) fulfilled the inclusion criteria. All subjects had different backgrounds within training but had good knowledge about the squat performance.

### 3.2.1 Inclusion and exclusion criteria

The inclusion criteria were that everybody had to be over 18 years of age and had been participating in resistance training including the squat for a minimum of two years, and also had knowledge of their 1RM. All participants had to be healthy which were defined as free from diseases and injuries in the lower extremity. If the subjects didn't fulfill the inclusion criteria or took some sort of medicine that could affect the study they were excluded. The subjects that had a history of back or knee pain that had required medical attention during six months prior to the study were also excluded (Warren & Appling, 2001).

## 3.3 Testing procedure

The study consisted of one day of tests for each participant (TP), which took place at two local gyms in Halmstad, and the TPs were divided into groups of two to three people. At the arrival to the gym where the tests were conducted each TP got weighed and notes of the TPs age, sex, height and self-reported 1RM were taken. Before the tests were conducted the TPs got information about the test procedure (Appendix 1) and had the opportunity to ask questions, and an informed consent (Appendix 2) was signed. Every squat were recorded with a video camera to make it possible to calculate the ROM during the squats, therefore the TPs got markers of white tape on three points on the left side of their body. The markers were placed at the lateral malleolus, the head of fibula and trochanter major (Figure 1 & 2) (Zink et al., 2001). During the test procedure the TPs were instructed to wear tight black clothes to make the markers more visible and they were allowed to choose any type of shoes that they preferred.

Figure 1 The picture shows how the markers were placed on the lateral malleolus, head of fibula and trochanter major.

Figure 2 The picture illustrates the visibility of the markers placed on the lateral malleolus, head of fibula and trochanter major while sitting in the end position of the squat.

The tests consisting of six repetitions of the squat divided into two sets started with the TPs doing a general warm-up of their choice for ten minutes, followed by a specific warm-up consisting of ten repetitions of squat at 50 % of their 1RM (Baechle & Earle, 2008). During the warm-up the researchers calculated each TP's external load that were used during the tests and prepared the equipment. The load was set at 75 % of each TP's 1RM (Lander et al., 1992). When the warm-up was executed the TPs got the instructions to perform the squats with their own technique with the requirement of a depth with their thighs at least parallel to the podium. The first group started with performing three squats without wearing a WB, and subsequently three squats with the WB were performed in the same way. All groups were randomly chosen to start either with or without a WB. The rest period between every set was three to five minutes with no rest between the repetitions and gave the TP time to recover between the squats (Baechle & Earle, 2008). To make sure the TPs got the proper amount of rest only one TP in every group were performing the squats while the others rested.

During the study two test leaders/researchers were present; one that was in charge of all the data that were collected and noted the results into the protocol, and another that helped changing the weight on the barbell and acted as a spotter while the subjects performed their squats.

### 3.3.1 Equipment

All squats were recorded from the sagittal plane with a video camera (Panasonic SDR-S26) at a distance of 3.5 meters from the TP at a height of 91 cm from the floor. The barbell had the linear encoder (MuscleLab, Egotest Technology AS, Langesund, Norway) attached to it with a shuttle; the power and velocity throughout all the squats were recorded. During all squats an Eleiko barbell (Eleiko, Halmstad) of 20 kilos were used and weight plates at a variety of 1.25 to 25 kilos (Eleiko, Halmstad). The weight belt that was used was an Eleiko Olympic weight lifting belt made out of leather, which was 10 cm wide in the back and 5 cm in the front.

## 3.4 Data collection

All data collected were noted in a test protocol. Apart form the background information about the subjects the data collected were; power measured in watt (W), eccentric and concentric velocity measured in meter per second (m/s) as well as videos of the movement to calculate the differences in ROM for the hip and knee during the different squat performances.

The power output and velocity were measured with a linear encoder provided by MuscleLab (MuscleLab V8.31) during the squats and the mean of every variable in every set of squats were calculated in Excel (Microsoft Excel for Mac 2011, version 14.4.6). The linear encoder that was used during the test procedure is considered to be valid equipment when collecting information about the power output and velocity of different tasks. The validity has been tested during a study where the researchers compared the estimated 1RM calculated by MuscleLab to the participant's actual 1RM. During the study it was noted that there was a high correlation between the actual 1RM and the estimated ($r = 0.93$), which proves the linear encoders accuracy (Bosquet et al., 2010). The equipment is also considered to have high testretest reliability, and it has been tested in a study where elite athletes had to perform countermovement jumps with an external load during two different test sessions. The results from the two different sessions had a significant and high correlation to each other ($r = 0.97$), which proves the reliability of the linear encoder (Hilmersson, Edvardsson, & Tornberg, 2015).

The recordings of the squats were analyzed in Dartfish (Dartfish classroom 5.5.10925.0) where the mean hip and knee angles in the lowest position of the squat were calculated. Dartfish is considered to be a valid and reliable method of measuring and tracking angels during mechanical lifting tasks such as the squat. The validity and reliability has been tested in a study where 15 women performed lifts of a crate from the floor up to a standing position. Two different examiners conducted the tests and analyzed the results in Dartfish, and later on a third examiner also analyzed the results to determine the inter-rater reliability. The study showed good validity when the results from tracking the angles of the hip and knee joint in Dartfish was compared to measurements made by a goniometer (Pearson $r \geq 0.95$), as well as good reliability when the different examiners conducted the test (ICC $\geq 0.91$) (Norris & Olson, 2011).

## 3.5 Ethical and social considerations

The study followed the four fundamental principles regarding human research stated in the declaration of Helsinki. The fundamental principles are; autonomy, beneficence, non-malfeasance and justice (F.d. Medicinska forskningsrådets nämnd för forskningsetik, 2003). The principles were included in the process of the study by having all subjects sign an informed consent (Appendix 1) were all the necessary information was included, as well as risks and benefits. In the informed consent they had to give their approval to attending the study and they were informed that they could discontinue their participation at any time, without affecting the process or their contact with the researchers.

All researchers that were present during the testing procedure and working with the data had professional secrecy. The collected data were saved on an USB and kept safe at Halmstad University. The subject were provided with a serial number to keep them anonymous and the personal data were handled according to the Personal Data Act (F.d. Medicinska forskningsrådets nämnd för forskningsetik, 2003).

The current study is out of importance to help generate more knowledge about the possible benefits of using a WB among athletes on all levels. Knowing how the WB affects the squat performance regarding power, velocity and ROM can be useful when following a specific training plan. The WB is known to increase the IAP and thereby reduce the shear forces acting on the spine while performing different resistance exercises such as the squat (Abdulrahman, 2003). Although little is known about the effects on aspects like the power and velocity and therefore further investigations are out of importance. The possible positive aspects of using a WB can motivate athletes to incorporate it as a tool and not only for preventing injuries.

## 3.6 Statistical analysis

The mean for all variables from the three squats during each set were calculated in Excel (Microsoft Excel for Mac 2011, version 14.4.6). Furthermore the statistical analysis was done in SPSS (IBM SPSS Statistics version 20) and the normality of the data was tested with Shapiro-Wilks test. All variables were normally distributed and therefore parametric statistics and a paired t-test were used to compare and analyze the collected variables. The significance level was set at $p < 0.05$ (Kingma et al., 2006).

# 4. Results

## 4.1 Subjects

The background data about the TPs (ten males and five females) are shown in Table 1. The female characteristics were (mean ± standard deviation (SD)); age 22.4 ± 0.8 years, weight 74.9 ± 6 kg, height 169.6 ± 5.3 cm and their 1RM 101.8 ± 15.4 kg. The characteristics for the male (mean ± SD) were; age 25.2 ± 2.5 years, weight 86.3 ± 10.4 kg, height 179.9 ± 7.2 cm and their 1RM were 161.5 ± 37.8 kg.

Table 1 The table describes the characteristics for the men and women that participated in the study.

| | **Male *(n[2] = 10)*** | **Female *(n = 5)*** | **All subjects *(n = 15)*** |
|---|---|---|---|
| **Age** | 25.2 ± 2.5[1] | 22.4 ± 0.8 | 24.3 ± 2.5 |
| **Height (cm)** | 179.9 ±7.2 | 169.6 ± 5.3 | 176.5 ± 8.2 |
| **Weight (kg)** | 86.3 ± 10.4 | 74.9 ± 6 | 82.5 ± 10.6 |
| **1RM (kg)** | 161.5 ± 37.8 | 101. 8 ± 15.4 | 141.6 ± 42.7 |

[1] Mean ± SD [2]Number of participants

## 4.2 Power

The results (mean ± SD, min and max) from the power measurements during the two different squats can be seen in Table 2. When comparing the two different performances (Figure 3) of the squat to each other no differences in power were found (p = 0.25). The mean differences were -53.6 W with a 95% confidence interval ranging from -148.7 to 41.5 W.

Table 2 The table shows the mean ± SD, min and max the results in power (Watt) with and without a weight lifting belt.

| | Power without WB[1] | Power with WB |
|---|---|---|
| **Min** | 480 | 481 |
| **Max** | 1747 | 1677 |
| **Mean ± SD** | 1023.6 ± 383 | 1077 ± 330.9 |

[1] Weight lifting belt

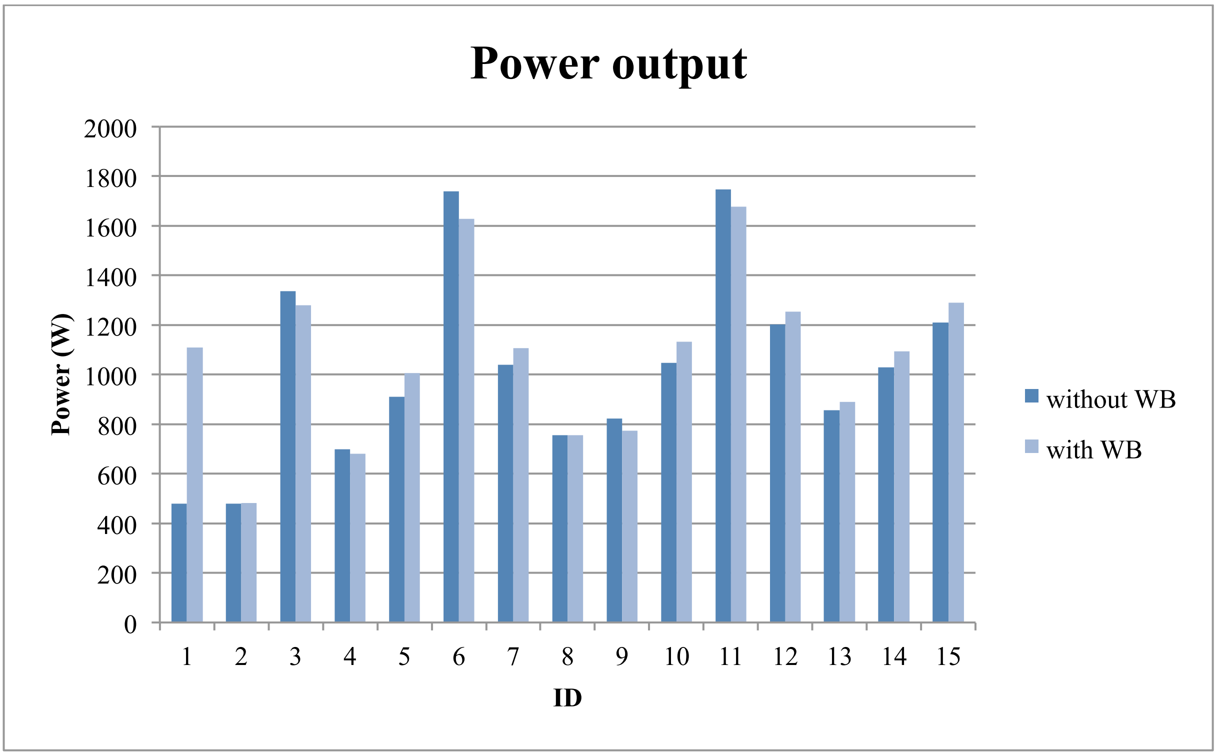


Figure 3 The figure shows the different power output for each participant with and without a weight lifting belt.

ID: Number of identification WB: Weight lifting belt W: Watt

## 4.3 Velocity

A comparison in velocity between the two different squat performances was made; both for the concentric (Figure 4) and eccentric phases (Figure 3) and the mean ± SD, min and max are presented in Table 4. The results showed that there were no differences between the two ($p = 0.61$ for the concentric phase and $p = 0.16$ for the eccentric phase). The mean differences for the concentric phase were – 0.01 m/s with a 95% confidence interval ranging from – 0.02 to 0.02 m/s, and for the eccentric phase the mean differences were 0.02 m/s with a 95% confidence interval ranging from – 0.01 to 0.04 m/s.

Table 3 The table describes the min, max, mean ± SD for the concentric and eccentric velocity (meter/second) during the squats with and without a weight lifting belt.

| | Velocity without WB[1] concentric | Velocity with WB concentric | Velocity without WB eccentric | Velocity with WB eccentric |
|---|---|---|---|---|
| **Min** | 0.40 | 0.40 | 0.35 | 0.39 |
| **Max** | 0.84 | 0.81 | 0.85 | 0.82 |
| **Mean ± SD** | 0.57 ± 0.13 | 0.65 ± 0.14 | 0.65 ± 0.14 | 0.63 ± 0.13 |

[1] Weight lifting belt

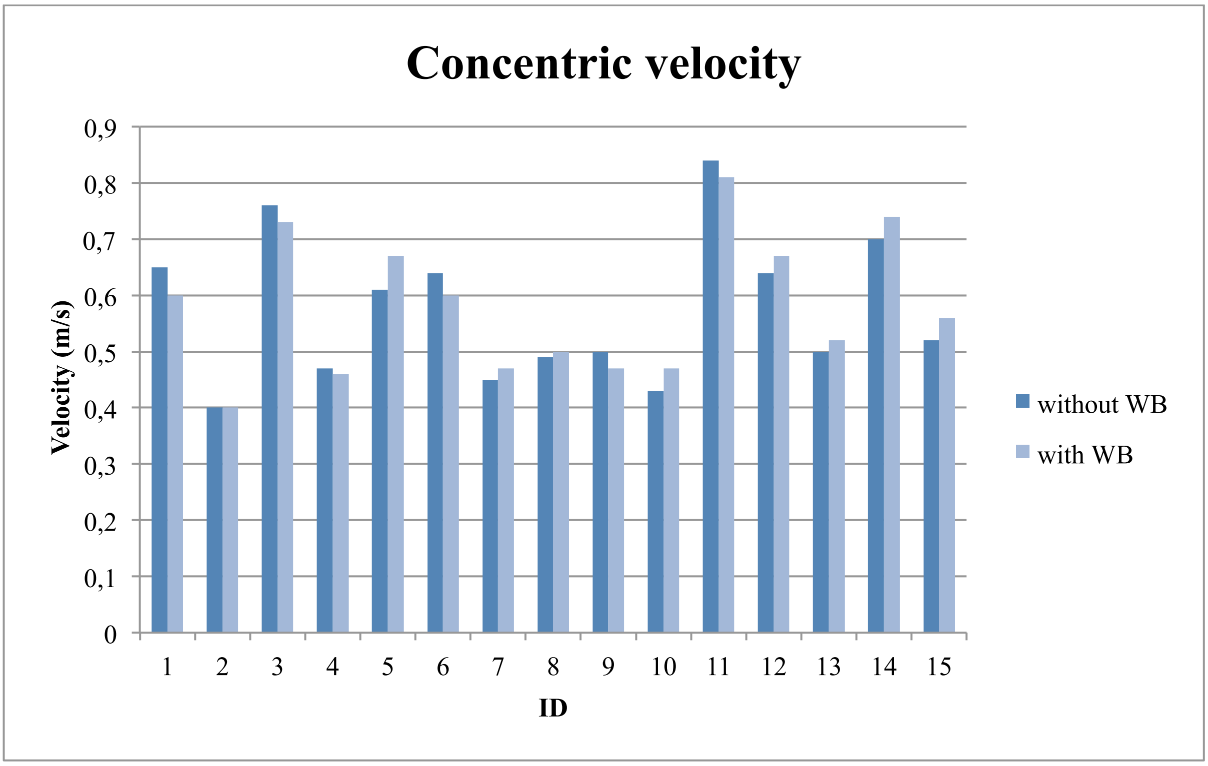


Figure 4 The chart illustrates the participants concentric velocity with and without wearing a weight lifting belt.

ID: Number of identification WB: Weight lifting belt m/s: meter/second

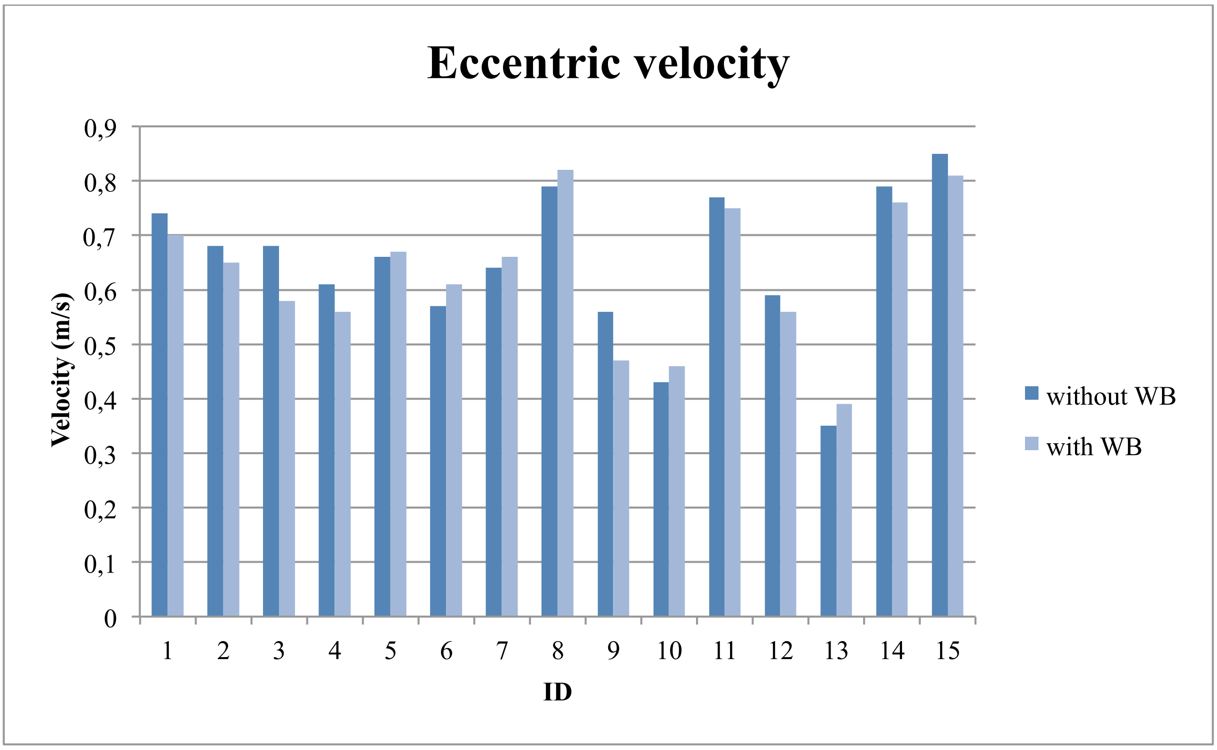


Figure 5 The figure illustrates the eccentric velocity developed by the participants with and without a weight lifting belt.

ID: Number of identification WB: Weight lifting belt m/s: meter/second

## 4.4 ROM

When looking at the different angles in the hip and knee (Table 4), there was no difference in the hip when using a WB or not (p = 0.68) (Figure 6). The mean differences between the degrees in the hip with and without a WB were -0.55° with a 95% confidence interval ranging from -2.27° to 3.37°. However when looking at the knee angles there was a difference when using a WB (p = 0.03). The mean differences for the knee angles were 1.97° with a 95% confidence interval ranging from 0.18° to 3.75°. This shows that the angles were larger when the TPs did not use a WB compared to using a WB (Figure 7).

Table 4 The table explains the different rang of motion in the hip and knee joint angles (min, max, mean ± SD) with and without the weight lifting belt.

| | ROM[1] hip without WB[2] | ROM hip with WB | ROM knee without WB | ROM knee with WB |
|---|---|---|---|---|
| **Min** | 96.1°[3] | 93.5° | 96° | 92.2° |
| **Max** | 133.1° | 133.7° | 133.3° | 130.8° |
| **Mean ± SD** | 109.9° ± 9.4° | 109.4° ± 10.5° | 115.9° ± 11° | 114° ± 11.9° |
| **P-value** | 0.68 | | 0.03 | |

[1] Range of motion [2] Weight lifting belt [3] ° = degrees

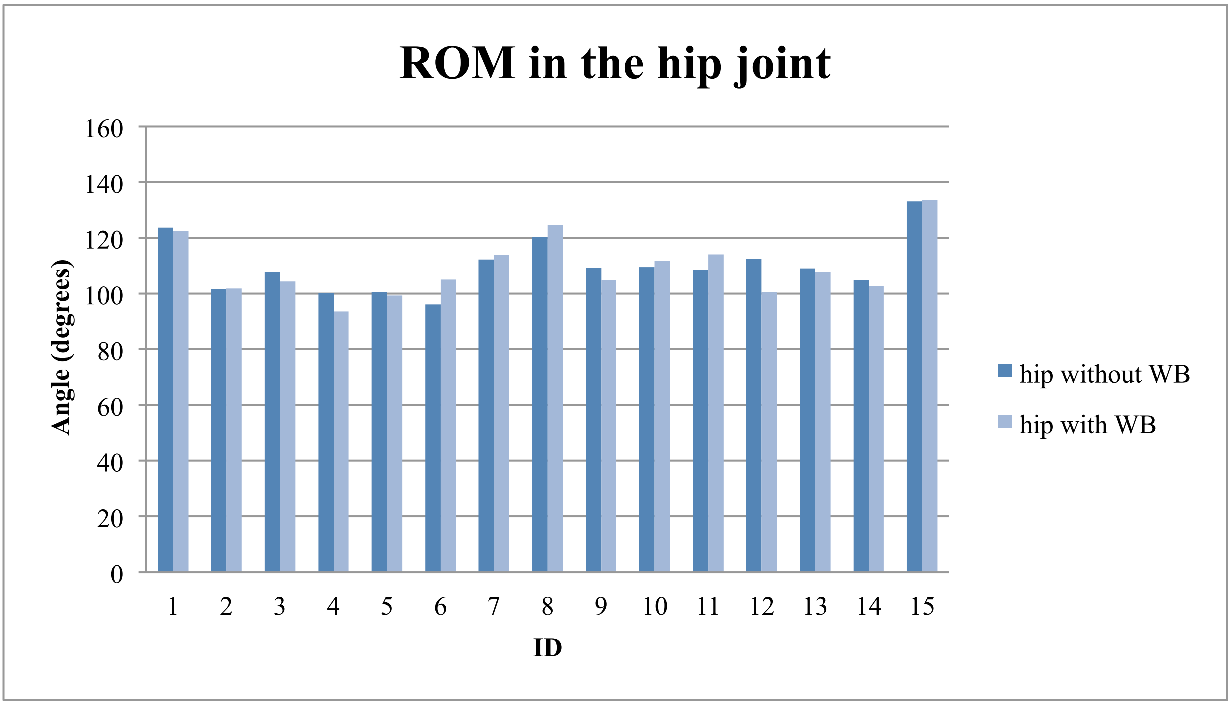


Figure 6 The figure illustrated the angular differences in the hip joint for the participants with and without a weight lifting belt.

ROM: Range of motion  ID: Number of identification  WB: weight lifting belt

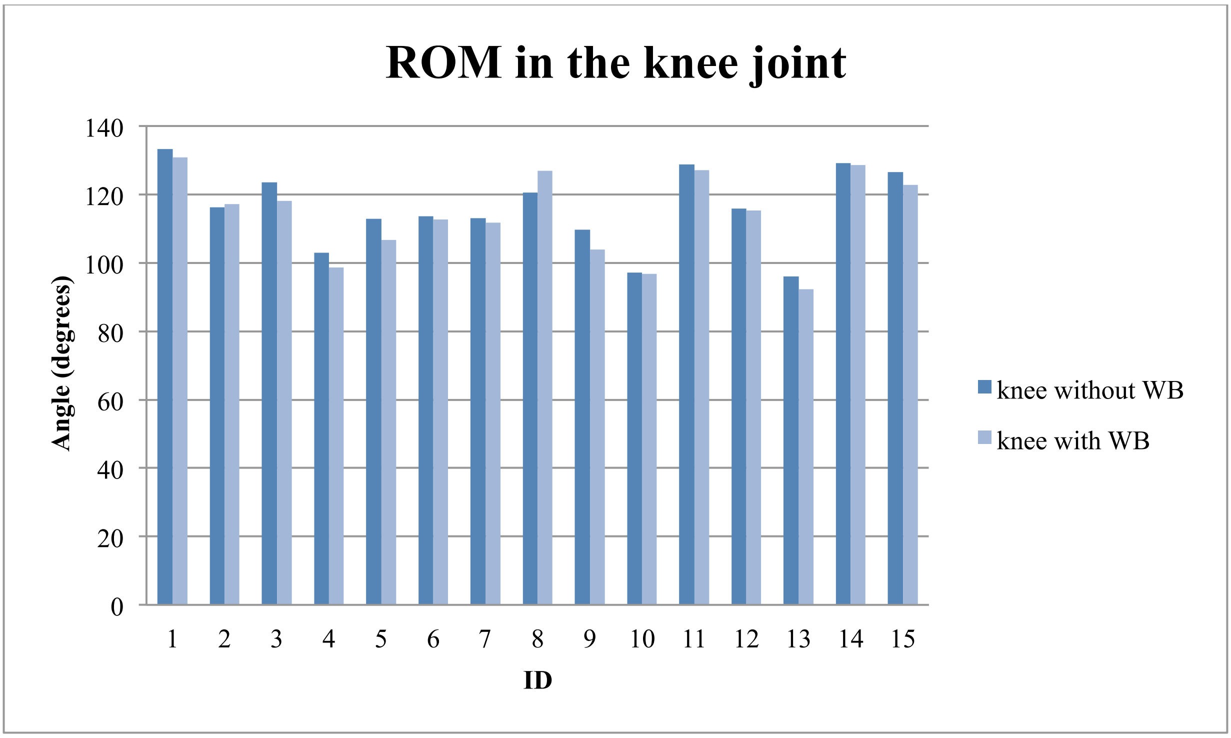


Figure 7 The chart illustrates the angular differences in the knee joint with and without a weight lifting belt.

ROM: Range of motion  ID: Number of identification  WB: weight lifting belt

# 5. Discussion

The result from this study shows that there was no difference in the variables when using a WB, apart from the ROM in the knee. When the TPs did not wear a WB they had a greater angle in the knee than when they wore the WB.

## 5.1 Results discussion

A previous study found that the power output increased in different starting position of the deadlift, and the greatest power was developed when starting with the barbell in the middle of the thigh while using a WB (Beckham et al., 2012). That position is similar to the concentric phase of the squat, although in the present study the power output were constant for the TPs regardless of the different performances of the squat. The results from the present study were reinforced by the results from a study where they tested the effect of two different types of WBs compared to not wearing a belt. The study showed that there was no significant difference between the two different WBs and not wearing a belt (Lander, Simonton, & Giacobbe, 1990). This shows that the WB does probably not affect the leg muscles, and therefore the power that is developed will not change. What would be interesting in this case, if the study would be redone, is to compare the muscle activation to the power developed to see if the theory is true. Similar investigations on the muscle activation has been done in two previous studies with different results (Lander et al., 1992; Zink et al., 2001), therefore it could be of interest to do further studies.

When analyzing the velocity from the different squats, there were no significant differences between the two. All TPs had almost exactly the same velocity during the eccentric and concentric phase with and without a WB. This result is opposite from what has been found in a previous study, where they saw that the athletes performed their squats faster while wearing a WB (Lander et al., 1990). The participants in that study reported that they were used to wearing a WB compared to the present study, where not all subject used a WB on a regular basis. In the previous study the participants reported that they felt safer while wearing a WB and the conclusion was therefore that they were able to perform their squats faster (Zink et al., 2001). The fact that the velocity did not change during the two sets of squats in the present study might therefore be because of the TPs being unfamiliar to the WB which made them not feel secure enough to perform the squats at a greater velocity. The unchanged velocity can also be one explanation to the results of the power output. Power is calculated by multiplying force and velocity, and if these variables are constant the power output will not change (Grimshaw, 2006). During the present study the force was consistent, and when analyzing the results no differences in velocity were found. Therefore one can assume that this explains that no differences were found in the power output.

Looking at the result and the difference that was found in the knee angles when the TPs wore a WB compared to when they did not, there was a clear significant difference ($p = 0.03$). The mean difference was 1.97° and this shows that the TPs had a larger angle in the lowest point of the squat when not wearing a WB. However it should be noted that although significant the difference between the measured angles were small, which questions the clinical value of the present findings. The present result also contradicts what has been found in a previous study, where the angle in the knee joint showed a small increase when the participants wore a WB Although worth mentioning is that these differences were not significant (Zink et al., 2001). In the present study only two of the TPs showed different results and their angle in the knee increased when wearing a WB. The result can have been affected by the fact that some of the TPs might not be used to wearing a WB while performing the squat. Or their anatomy might prevent them from reaching the lowest point while wearing a WB, thus reducing the ability to reach their full ROM. Similar aspects has been examined in a study where the influence of different WB on trunk motion, muscle activity and spine loading while lifting different boxes to an upright position has been investigated. In the study it was found that when wearing a WB made out of leather the subjects had a smaller trunk angle and a greater pelvic angle compared the angles when not wearing a WB (Granata et al., 1997). When analyzing the movement of the squat while wearing a WB the decreased angle in the knee joint might be because the WB forces the subjects trunk into a more upright position thus making it harder to reach a greater flexion in the knee, due to the higher requirements of flexibility in the athlete in this position.

## 5.2 Methods discussion

During the work process the planned sample group had to be changed for different reasons. Instead of having weight- and power lifters as subjects the sample consisted of well trained men and women with different backgrounds of training but with good knowledge of the squat performance. This may have affected the results in either direction. It is considered to be good because it made the group more heterogeneous than if it had consisted of only weight- and power lifters. The heterogeneous group makes the results more relevant in a larger perspective, although a homogeneous group might have gotten different results, but question is if they would be significant. Previous studies with homogeneous groups have shown a change in velocity while wearing a WB, but worth mentioning about the study is that only five males participated (Lander et al., 1992).

To further see if there in fact is a significant difference in the results and make them more useable is to redo the study on a bigger group, as well as making a comparison between men and women. Most previous studies consisted of men (Lander et al., 1992, 1990; Zink et al., 2001) therefore there is a lack of information in the literature that needs further studies. This could have been done in the present study if there would have been more subjects available. The present study only consisted of ten males and five females, which made the groups to small to make a valuable comparison when divided into gender. To divide the group into gender and make comparison within the groups could have had an impact on the outcome. Women tend to have greater joint laxity due to their specific sex hormones (Harmon & Ireland, 2000) as well as a wider pelvis, which make their movement patterns different and can make them more flexible (Zeller et al., 2003). For example, the wider pelvis affects the women to have a greater Q-angle. The Q-angle itself can affect how the hip and knee is able to move throughout the squat, for example women have been seen to reach greater hip flexion an external rotation (Zeller et al., 2003). If this actually makes a difference in the results or not need to be studied further, and be compared to the differences seen between males.

Another aspect that could have improved the accuracy of the results is that a 1RM test should have been performed prior to the study. This to make sure that the TP had the correct load during the test, and exclude bias of the 1RM being higher or lower than expected. This has been done in a previous study that found a tendency to an increase in ROM and a significant increase angular velocity when wearing a WB (Zink et al., 2001). Although this would have demanded more time from the TP due to an extra day of testing is required to perform the 1RM testing, which could effect the willingness to participate. Something that also is important to take under consideration is that not all TPs were used to wearing a WB. This could have affected the results and if they would have been able to try squatting with a WB beforehand the outcome might have been different. Similar to the participants in a previous study reported, the TPs in the present study might have felt more comfortable and thereby would be able to squat with a higher velocity (Zink et al., 2001).

The ROM that was seen during the different squat performance might also been affected by the TPs choice of shoes. A few of the TPs wore regular trainers while others had on weight lifting shoes. The weight lifting shoes has a built in heel, which can affect the athletes ROM. A study has demonstrated that a greater angle can be reached in the knee joint when the heels is lifted from the ground (Hemmerich et al., 2006), similar to the foot position in weight lifting shoes. Therefore the choice of shoes can have affected the results and the TPs that wore weight lifting shoes might not be able to reach the same ROM without them.

# 6. Conclusion

The result from the current study shows that when performing a squat the WB has little to no effect on power, velocity or ROM. Although a noticeable change in ROM of the knee joint were observed, further studies on larger populations are needed to determine if it is of clinical value.

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# 8. Appendices

## 8.1 Appendix 1

Info vid testtillfället

**Presentationen:**

Hej, ni har fått all information innan men vi vill gärna förtydliga hur detta kommer gå till och så får ni möjlighet att ställa frågor.

Dagens upplägg kommer vara att ni ska utföra 6 stycken knäböj fördelat på 2 set och dessa kommer ha en belastning på 75 % av ert 1RM. Alla knäböj ska utföras precis så som ni brukar förutom att ni kommer ha lyftarbälte under hälften av knäböjen. Innan vi börjar kommer ni vägas och mätas, och all information dokumenteras i ett Excell-ark. Ni kommer få ett löpnummer för att säkerställa er anonymitet, inga namn kommer vara nedskrivna förutom i det informerade samtycket.

Alla lyft kommer att filmas från sidan och därav kommer vi placera markeringar på er med vit tejp. Några frågor?

Uppvärmningen kommer ske genom att ni gör er vanliga uppvärmning och därefter kommer ni få utföra knäböj 10 repetitioner av knäböj på 50 % av ert 1RM.

**Procedur:**

Alternativ ett

- TP utan bälte, tre stycken
- TP med bälte, tre stycken

Alternativ två

- TP med bälte, tre stycken
- TP utan bälte, tre stycken

3-5 minuter vila mellan seten

Tack för att ni deltog och hör av er om ni har några frågor.

## 8.2 Appendix 2

# Informerat samtycke

*Bakgrund och syfte*

Användandet av lyftarbälte vid styrketräning i form av knäböj blir idag allt vanligare, både bland vanliga motionärer och elitidrottare. Främsta anledningarna till att det används är för att förebygga eventuella skador och för att förbättra prestationen. Trots att det blir allt vanligare är forskningen kring effekter och eventuella fördelarna med att använda lyftarbälte bristfällig. Därför är det av intresse att utföra denna studie för att öka kunskapen kring lyftarbältets påverkan.

Studiens syfte är att studera hur lyftarbälte samt valsalvamanöver, som är en andningsteknik där du andas ut med stängda luftvägar, påverkar kraftutvecklingen, hastigheten och rörelseomfånget i en knäböj. Det kommer ske 12 stycken knäböj på 75 % av en vikt du kan lyfta en gång och lyften kommer att delas in i fyra omgångar med tre lyft i varje med vila mellan. Alla lyft kommer filmas från sidan för vidare analys av ditt rörelseomfång.

*Förfrågan om deltagande*

Du har tillfrågats att delta i denna studie för att du aktivt tränar styrketräning och har utfört knäböj regelbundet i minst två år, samt har kännedom om ditt 1RM. Du ska inte deltaga i studien om du har haft någon skada på nedre extremitet det senaste halvåret som krävt läkarvård, intar några mediciner eller har någon sjukdom vid testtillfället.

*Tillvägagångssätt*

Du ska undvika alla former av hård träning inom 24 timmar före testerna. Du ska inte ha intagit en större måltid närmare än två timmar före testerna samt undvika någon form av nikotin och koffein i samband med testtillfället.

Testerna kommer ske vid ett testtillfälle. När du anländer till Halmstad Högskolas labb kommer du vägas och mätas samt noteringar av den vikt du maximalt kan lyfta i en knäböj, din ålder och kön. Därefter kommer markeringar placeras på olika kroppsdelar på höger eller vänster sida, vilket kräver att du som deltagare bär tajta svarta kläder. Du kommer få utföra en uppvärmning som förklaras på plats innan testen påbörjas. Efter uppvärmningen kommer du få utföra tre lyft i taget med vila mellan. Totalt kommer du utföra 12 lyft; tre utan bälte, tre med bälte, tre utan bälte med valsalvamanöver och tre med bälte och valsalvamanöver.

*Potentiella risker, obehag och fördelar*

Eftersom vi sökt dig som inte haft någon skada på nedre delen av kroppen eller ryggen ska det inte finnas några större risker för skador. Om det uppstår någon smärta vid testtillfället kommer testet avbrytas och detta kommer inte leda till några följder för dig som deltagare gällande studieprocessen. Efter avslutad studie kommer du få ta del av informationen om så önskas genom att kontakta de ansvariga forskarna för studien.

De fördelar som finns för dig som deltagare är att du får en fördjupad kunskap om hur ett lyftarbälte kan påverka dina lyft och även kring hur andningstekniken valsalvamanöver fungerar.

*Hanteringen av data*

Data som samlas in under studien hanteras enligt personuppgiftslagen (1998:204). De som ansvarar för att dina personuppgifter är Halmstad Högskola. Studien utförs av Amanda Engberg och Julia Björk under handledning av Åsa Andersson, Biomedicin, ETN, HH. Dina resultat kommer inte vara tillgängliga för obehöriga att ta del av.

*Hur tar du del av informationen om studien*

Resultatet av studien kan du som deltagare ta del av efter att studien är klar. Önskas muntlig presentation kommer detta vara tillgängligt.

*Frivillighet*

Ditt deltagande i studien är helt frivilligt och du har rätt till att avbryta studien när som helst utan att ange någon orsak. Om du väljer att hoppa av kommer detta inte påverka din tillgång till studiens resultat eller din kontakt med ansvariga och om du önskar kan insamlad data förstöras.

*Ansvariga för studien:*

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**Informerat samtycke**

- Jag bekräftar att jag fått skriftliga samt muntlig information om forskningsstudien samt att jag har fått möjlighet att ställa de frågor som jag ser nödvändiga för mitt deltagande.
- Jag ger mitt samtycke till att delta i studien och vet att mitt deltagande är helt frivilligt samt att jag utan anledning eller förklaring kan avsluta mitt deltagande och om så önskas kan insamlad data förstöras.
- Jag tillåter att mina personuppgifter registreras enligt den information jag tagit del av och att insamlad data om mig förvaras och hanteras elektroniskt av studieansvariga.
- Jag är medveten om att mitt deltagande i studien sker på helt egen risk.

……………………….. ……………………….. ………………………..

Datum Namnteckning Namnförtydligande

…………………………………………………………………

Födelsedatum

Undertecknad har gått igenom och förklarat studiens syfte för ovanstående forskningsperson samt erhållit forskningspersonens samtycke.

……………………….. ……………………….. ………………………..

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