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BACHELOR THESIS

The effect of a weight lifting belt and the use of valsalva maneuver on power output and velocity in a squat

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Bachelor Thesis in Exercise Biomedicine, 15 credits

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Abstract

Background: A squat is a common exercise that is used in many areas of strength training and for different purposes and the literature is inconclusive when it comes to whether the weight lifting belt (WB) affects performance and/or is injury-preventing. The use of breathing techniques is common during heavy lifting and therefore the practice of the breathing teqnice; valsalva maneuver (VM) may be of interest to study and if this along with the WB can provide some advantages in power output and velocity.

Aim: The specific aim of the study was to evaluate whether the velocity in the eccentric and the concentric phase of the squat, and the peak velocity in the concentric phases are affected in power output through the use of the VM when the subjects use or did not use a WB.

Method: Fifteen subjects (10 men and 5 women) volunteered freely to participate and did a total of 12 squats divided in four different sets with three repetitions each on 75% of their self-reported one repetition maximum (1RM). The first two sets were either with or without WB and the third and fourth sets were either with or without the practice of the VM. The three conditions (with WB, with WB + VM and VM only) were compared to each other and to the control group (without WB and VM) in terms of power output and velocity in the eccentric, concentric and peak velocity in the concentric phase of the squat.

Result: There was no significant difference in power output when comparing the four different test conditions. The velocity in the eccentric, concentric and peak velocity in the concentric phase did not have a significant difference between the different test conditions.

Conclusions: This study shows a different output compared to previous literature. The WB and the practice of VM did not affect the power output and velocity in a squat, alone or together.

Keywords: Linear encoder, power output, squat, strength training, valsalva maneuver, velocity, weight lifting belt

Bakgrund: Det finns många olikheter i litteraturen när det gäller huruvida tyngdlyftarbältet påverkar prestationen och/eller om det minskar skaderisken. En knäböj är en vanlig övning som används inom många områden av styrketräning och för olika ändamål. Användning av andningstekniker är vanligt vid tunga lyft och därför kan utförandet av andningstekniken; valsalvamanövern (VM) vara av intresse att studera och om det tillsammans med lyftbältet kan ge effekt på effektutveckling och hastighet i lyft.
Syfte: Syftet med studien var att utvärdera hastigheten i en knäböjs olika faser (excentriska, koncentriska och topphastigheten i den koncentriska fasen) och hur effektutvecklingen påverkas av lyftarbälte och valsalvamanövern.
Metod: Femton personer (10 män och 5 kvinnor) deltog frivilligt och utförde totalt 12 knäböj i fyra olika sets med tre repetitioner på 75 % av testpersonernas självrapporterade 1RM. De första två seten var utförda antingen med eller utan tyngdlyftarbälte och de tredje och fjärde seten var utförda antingen med eller utan utövande av VM. Dessa tre förhållanden (med lyftarbälte, med lyftarbälte + VM och VM endast) jämfördes med varandra och med kontrollgruppen (ingen VM och lyftarbälte) med avseende på effektutveckling och hastigheten i den excentriska, koncentriska och topphastighet i knäböjens koncentriska fas.
Resultat: Effektutvecklingen gav ingen signifikant skillnad i någon av de fyra olika förutsättningarna (med lyftarbälte, utan lyftarbälte, med bälte och valsalvamanövern och utan bälte och valsalvamanövern). Hastigheten i den excentriska, koncentriska och topphastigheten i den koncentriska fasen visade ingen signifikant skillnad mellan de fyra olika seten.
Konklusion: Studien visade ingen skillnad vilket kan jämföras med tidigare litteratur där en skillnad fanns. Lyftarbältet och utförandet av valsalva manövern påverkade inte effektutvecklingen och/eller hastigheten när en knäböj utfördes.

Nyckelord: Effektutveckling, hastighet, knäböj, linear encoder, lyftarbälte, styrketräning, valsalvamanövern

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1.0 Introduction

Could a weight lifting belt affect the power output and velocity in a squat and therefore be of great value, and could the practice of a breathing technique provide the same extra effect to resistance training athletes. This is the basis for the present study; the effect on power and velocity when a weight lifting belt is used and when the breathing technique, valsalva maneuver is practiced in a squat. Previous studies have investigated the muscle activation and the intra-abdominal pressure and, to some extent, the power and velocity and how this is affected in different lifts. Are these two tools, which are often used in resistance training, of any value when performance is in focus in terms of power. This gives this study the opportunity to contribute the knowledge within this field.

2.0 Background

To minimize the risk of injury and to maximize the performance are something many athletes strive for, not just the elite but even the common person that exercise for well-being. In almost any sport event the performance is in focus. If the risk of injury could be reduced and/or the potential for an increase in performance could be achieved by using a weight lifting belt (WB) or a breathing technique, could be of great value and something many athletes strive for (Blanchard, Smith, & Grenier, 2016). Ninety percent of the WB users are using the belt for the reduction of injury and twenty-two percent uses the WB with the aim to improve performance (Renfro & Ebben, 2006). The squat is used in many different areas and for different purposes as in rehab, prehab, hypertrophy training or to maximize strength. It has been shown that regular execution of the squat can improve the health and lifestyles and reduce the sport specific injuries in both children and elderly (Myer, Kusher, Brent, Schoenfeld, Hugentobler, Loyd & McGill, 2014).

2.1 Squat

The squat can be done in many ways and with or without different external weights. Air squats is when a person uses its own body weight (Beachle & Earle, 2008). Front squat is when the barbell is placed in front of the head on the front of m.deltoideus and back squat is when the barbell is placed behind the head on m.trapezius. The squat is often used primarily to train the muscles in the lower extremities such as: m.gluteus maximus, mm.hamstrings and mm.quadriceps. The placement of the barbell defines which kind of back squat is used, and in this study the squat is done with a high-bar position. In this squat variation the barbell is placed in the base of the neck on m.trapezius and the placement of the hands is slightly wider than shoulder width and the feet placement should be should with as well or wider. If the barbell is placed in the low-bar position the barbell is placed further down on the back of the athlete and the hands is placed slightly wider. The execution of any of the previous mentioned squats is divided in to two parts; the eccentric phase and the concentric phase. First the eccentric phase starts by standing straight followed by a flexion in the hip- and knee joint down to parallel to the floor or lower. After the eccentric phase are the amortization phase, which is the turning point from the eccentric to the concentric phase. The concentric phase starts when the person pushes back up by extension in the hip- and knee joint (Beachle et al., 2008). When a high-bar squat is performed, the force is evenly distributed between the hip and knee joint in comparison to the low-bar squat where there is more force on the hip-joint (Wretenberg, Feng, Arborelius, 1996).

2.2 Valsalva maneuver

The valsalva maneuver(VM) is a breathing technique and is often used in strength training and during lifts that is on the athletes one repetition maximum (1RM) or as close as 80% of their 1RM. Athletes performing different lifts that are close to their 1RM use a similar breathing technique even if they are unaware of it (Hackett, 2012). The muscles used when breathing is the diaphragm and the intercostals muscles and to some extent the obliques and these muscles are the same when performing the VM. This breathing technique is done by maximal exhaling with the glottis closed, which will create an intra-thoracic pressure (McArdle et al., 2014). There is fluid in the abdomen that during the contraction of the muscles and the diaphragm will create a fluid ball. Together with the contraction of the abdominal muscles and the use of VM the person will get a more stable posture and a better alignment in the vertebrae when performing heavy lifting and this can reduce the load on the vertebrae and can potentially reduce the risk for low back injury (Beachle et al., 2008; Hackett, 2012).

2.3 How the power and velocity works in the human body

Force is required to move an object and is calculated by taking the mass (kg) times acceleration (m/s2). When this is used on human movements, the mass is the weight of the body and the acceleration is the gravity, which is 9.81m/s2. The power is determined by the velocity times force. Velocity is calculated as the displacement (m) divided by time (s) (Grimshaw, 2006). Power and velocity within different lifts could be measured by different instruments and the Linear Encoder is one of these instruments. The Linear Encoder is an instrument used to measure vertical displacement over time and is often used to measure sport performance (Lindemann, Farahmand, Klenk, Blatzonis, & Becker, 2015). The string of the encoder is placed on a moving object, for example a barbell, and together with associated software can show force, displacement and velocity of the moving object (Moras, & Vázquez-Guerrero, 2015).

To create force and movement the human needs to make movements in the joint and this is done by the muscles pulling from the each side of the joint (Grimshaw, 2006). The human muscles consist of many muscle fibers and are structured with many components, and all of these components creates the muscle contraction. The smallest contractile unit is the sarcomere inside the muscle fiber. Inside the sarcomere are the myofibril, which consists of the two proteins; myosin and actin. These two components work together when there is a nerve impulse (action potential) from the nervous system through the nerve to release acetylcholine. Acetylcholine then connects to receptors in the muscle fiber and the depolarization causes the sarcoplasmic reticulum to release calcium and the sliding filament model can start. The myosin heads connect to the actin and pulls the actin closer to the M-line with is located in the middle of the sarcomere and this is called the sliding filament model. When the contraction begins, the adenosine triphosphate (ATP) is hydrolyzed to adenosine diphosphate (ADP) and an inorganic phosphate and the myosin head can attach to the binding sites on the actin and pulls the actin closer to the M-line. Then the ADP and inorganic phosphate is released and a new ATP is connected to the myosin and a new cross bridge can be made (McArdle et al., 2014). The human body and its muscles can create force and there are many factors contributing to how much force the muscles will produce. The neural control, which involves how many and how fast motor units that is recruited in a muscle contraction. The cross-sectional area of the muscle and its length are other factor which is involved in the muscles ability to create force. When a muscle reaches resting length the actin and myosin are next to each other and the number of cross-bridges are the most. Also, the joint angle and the velocity are two other factors contributing to the force a muscle can produce. When the velocity increases the power increase as well (Baechle et al., 2008). All of the previous mentioned factors are important to have in mind to get the adaptation of the training load (Hatfield et al., 2006). The muscle is divided into different muscle fibers with different characteristics and these are recruited at different occasions. When the occasion requires the athlete to rapidly accelerate the fast-twitched motor units (typ IIx) are the main muscle fibers used and the slow-twitch muscle fibers (typ I) is not used as much (Baechle et al., 2008). And the typ IIx fibers are important to produce high force and to gain as much training adaptation these fibers should be trained with near-maximum forces and at high velocities (Hatfield et al., 2006). The definition of strength is how much power a muscle can produce at a certain velocity (Baechle et al., 2008) and to gain power output in the muscles the athlete needs to do the lifts with a high velocity which is to prefer compared to lower velocities (Hatfield et al., 2006). Many sports require the athlete to be able to decrease or increase their own body weight or external weight and to do this the athlete needs to decrease or increase the velocity and this require force (Baechle et al., 2008).

The different phases in a squat are explained in *2.1 Squat*. A squat can be measured with a linear encoder which measures the different phases of the squat and its vertical displacement. The eccentric phase is the downward phase and then the concentric phase is the upward phase and they are measured in meters per second (m/s). The peak velocity in the concentric phase shows the highest measured m/s. As the velocity gets greater, the power becomes higher and this gives an indication on how the velocity is affected in a squat. The use of the stretch shortening cycle (SSC) in a squat, the countermovement (the eccentric phase) is where the energy is stored before the amortization phase (transition phase) and then when the concentric phase starts the stored energy in the eccentric phase is used and the athlete can push back up (McArdle et al., 2014). A study by McCarthy, Woon, Bolding, Roy & Hunter (2012) claims that to gain power the eccentric phase should be trained by breaking very quick before the concentric phase starts.

Our results regarding the force late in the eccentric phase of an SSC suggest a training strategy to focus on stopping or braking very quickly at the end of the eccentric phase to enhance force and power during the concentric phase

2.4 Previous literature

The specific muscle activation has been studied before and is mostly done on the back or abdominal muscles. The use of WB has little impact on muscle activation in m. erector spinae and the bigger abdominal muscles (Zink, Whiting, Vincent & McLaine. 2001; Lander, Simonton & Giacobbe, 1990 & Lee, Kang. 2002; Juliru, & Mcgill, 1999), but it has been shown that the use of a combination of both WB and VM at the same time can increase muscle activation which in turn can reduce injury risk on the lumbar spine and lower back pain (Blanchard et al., 2016). The literature is consistent when it comes to intra-abdominal pressure (IAP) and its ability to increase when the correct breathing technique is used and the literatur says it could have an impact on the stiffness of the vertebrae and reduce the risk of low-back pain and contributing to injury prevention (Harman, Bosenstein, Frykman, & Nigro, 1989; Juluru et al., 1999; Hackett, 2012; Blanchard et al., 2016; Baechle et al., 2008). The previous studies and litterature is inconclusive whether the WB and VM prevent low-back pain and injury or not. Many studies claim different effect in terms of muscle activation, force, IAP and velocity but all of them says that it needs to be more investigated to give an assured statement. Some of the possible effects are; reduced unwanted motion in the trunk (Karl-franzens-universit, & Mc, 2000), increased proprioception, restricted ROM and even a placebo effect (Blanchard et al., 2016).

The number of repetitions performed has also been studied and it has been shown that the use of WB increases the speed of all lifts but more in the last repetitions (Lander, Hundley & Simonton, 1992). All moving object is moved by force and the same comes for humans, the muscles must create force to move the body (Grimshaw, 2006). The human body is always producing force against the ground and it is called ground reaction force (GRF). The GRF indicates how much force a person can perform in a motion against to the ground, with or without an external weight. In one study, they investigated the GRF in deadlifts and how it is affected with or without WB and during exhalation or inhalation. The result of the study showed that wearing a WB and simultaneous inhale, reduced the force on the vertebrae by 10% (Kingma, Suwarganda, Bruijnen, Peters & va Dieën, 2006). The inhalation can resemble the execution of the VM, the only difference is that the VM is done by trying to push the air out through a closed glottis. Lifts that are close to the athletes 1RM or 1RM in a squat with the WB causes the athlete to keep the barbell closer to the knees and further away from the hip at the bottom position in the end of the eccentric phase. This indicates a larger torque in the hip and the lift is performed faster and with a larger power output (Zink et al., 2001). Because there is evidence that the velocity is the key to perform high power output and to gain and increase the peak power the training should be with higher velocities (Hatfield et al., 2006).

2.5 Rational

The purpose of this study was to investigate whether the usage of a WB and the VM could increase the performance through power output and velocity in a squat. The studies that have been presented before have mostly studied deadlifts with a lesser focus on power output. Most of the previous studies have focused on the muscle activation and how this change depending on weight and the use of the WB. The VM has been studied to some extent but mostly on muscle activation and intra-abdominal pressure. Therefore, this study was performed to see how the power output and the velocity in the lift changes with and without lifting WB and to see if the VM can give further positive effect on increased power and velocity. In turn this could possibly give the benefits of a lower load on the barbell with an increased power output. Because of the insufficient information on how the power output and velocity is affected by the WB and the VM this study, which could be of great interest to the athletes within this field, is done to minimize the knowledge gap. The hypothesis is that the WB can give positive effects and together with the VM give further benefits in power output and velocity.

2.6 Aim

The specific aim of the study was to evaluate whether power and velocity (eccentric, concentric and peak velocity concentric) in a squat is affected through the use of the valsalva maneuver when the subjects use or did not use weight lifting belt in young trained athletes.

2.6.1 Specific Questions

- Which effect do the weight lifting belt, weight lifting belt and valsalva maneuver or valsalva maneuver have on power output of the squat in young trained athletes.
- Which effect do the weight lifting belt, weight lifting belt and valsalva maneuver or valsalva maneuver have on velocity in the eccentric and concentric phase of the squat in young trained athletes.
- Which effect do the weight lifting belt, weight lifting belt and valsalva maneuver or valsalva maneuver have on peak velocity in the concentric phase of the squat in young trained athletes.

3.0 Methods

3.1 Study design

This study is a quantitative, experimental and cross-sectional study. The subjects participated at one occasion and at that occasion they performed squats with and without the use of a WB, with WB and VM and VM only. At the time of testing, the subjects were carefully supervised by the test leaders and followed standardized protocol. In addition to this study, there was another project ongoing which studied other variables with the same subjects.

3.2 Subjects

Ten males and five females volunteered as subjects for the study and signed a written informed consent before the study began. The majority of the subjects who participated came from Halmstad University and a local gym in Halmstad. The subjects received a request either through Facebook or got asked when they were at the gym and exercised if they would like to participate. A total of 18 people got asked to participate and some did not know their 1RM or just did not want to participate because their lack of time and a total of 15 people volunteered as subjects. The subjects inclusion criteria to participate were at least two years of resistance training and knowledge about their 1RM in a squat and therefore the 1RM is self-reported in this study. The subjects were excluded if they were sick during the test occasion or used any medication that could affect the test. They were also excluded if they had an injury in the lower extremities or back that required medical attention the past 6 months (Warren & Appling, 2001).

3.3 Experimental Setup

3.3.1 Procedure

All test subjects got tested at one occasion and this was done at Idrottscentrum, a local gym in Halmstad. They performed a total of 12 squats divided in four different sets with three repetitions each at 75% of their 1RM. When the subject came to the test occasion they got a thorough explanation of how the test will proceed and had time to ask questions. Before the test started they were weighed and measured and notes were taken about their gender and their self-reported 1RM in a squat. They then started their own warmup for about 10 minutes and after their own warm-up they performed ten squats with 50% of their 1RM (Beachle et al., 2008). The squat followed the international and national contest rules for powerlifting, which says that the top surface of the legs at the hip joint is lower than the top of the knees. The subjects participated in another study at the same test occasion where the ROM of the lift was studied, and therefor were no instructions given on how deep the squat should be, except parallel to the floor or lower.

The test started with the subjects performing three squats without pause or rest on a weight that was 75% of their 1RM either with or without WB followed by about three to five minutes (Beachle et al., 2008) rest before the next set and this continued for four sets. The weight (75%) was chosen because the subject would be able to do three reps without any problems. If the lift is to slow the encoder might not notice the movement and not give the values of the lift. The power output and velocity in their squat was calculated by using a Linear Encoder (MuscleLab, Ergotest Technology AS, Langesund, Norway) with the software Muscle lab (MuscleLab V8.31). Each of the subjects did three reps in four sets and the first two sets were without and with WB. When the two first sets were done, the test leaders gave instructions on how the VM should be done in the last two sets and these were also done with and without WB. The subjects got instructed to take a big breath in with as much air as possible and then try to push the air out through a closed glottis. The squats where the WB was used the subjects pulled the WB to a comfortable position and were told not to feel any pain or discomfort when using the WB. Some of the subject had experience with WB and did know how they wanted the WB to be placed. Some of the subject had never used a WB and the instructions were to tighten it as hard as possible without discomfort right below the ribs.

There were one to three subjects at each test occasion. To decrease sources of error every other group started with the WB and the other without WB. Eight subjects started with the belt and seven started without. The four different sets are explained in table 1.

Table 1. The setup in all of the four sets when the squat is performed in young trained athletes (N=15).

The first group	The second group
Without WB[1]	*With WB*
With WB	*Without WB*
Without WB + VM[2]	*With WB + VM*
With WB + VM	*Without WB + VM*

[1] Weight lifting belt

[2] Valsalva maneuver

The equipment used was a barbell (Eleiko, Halmstad) which weighs 20kg and together with associated weight plates, also from (Eleiko, Halmstad) assortment was used to reach the desired weight on the barbell. The WB used (Eleiko, Halmstad) followed the criteria with 5 cm in the front and 10cm in the back (Miyamoto, Linuma, Maeda, Wada & Shimizu, 1999). The length of the WB differed from person to person.

3.4 Data Collection

The collected data was age (years), gender, body weight (kg) and length (cm). Through the linear encoder (MuscleLab, Ergotest Technology AS, Langesund, Norway) the different squats gave the power output in watt (W) and the velocity (m/s) in the eccentric, concentric and the peak velocity (m/s) in the concentric phase of the squats. The Linear Encoder (MuscleLab, Ergotest Technology AS, Langesund, Norway) was used and has previously proven to be reliable when performing the squat and (Moras et al., 2015) to estimate 1RM in a bench-press based on the force – velocity relationship (Bosquet, Porta-Benache, & Blais, 2010). The Linear encoder was validity tested when athletes performed counter movement jumps (CMJ) and was shown to be reliable and valid. The CMJ has a similar movement as the squat except that the CMJ is a jump and therefore leaves the ground compared to the squat were the athlete never leaves the ground (Hilmersson, Edvardsson, & Tornberg, 2015).

3.5 Ethical and social considerations

This study follows the declaration of Helsinki. The declaration of Helsinki has the following fundamental principles when a study is performed on humans: The principle of autonomy, goodness, the principle not to damage and the justice principle. These principles are built into each other and have very similar content and they mean broadly a respect and integrity for of the subjects and prevent harm and all subject should be treated equally (F.d. Medicinska forskningsrådets nämnd för forskningsetik, 2003).

All the subjects got a written consent (appendix 1) and an oral presentation about the study and about the risks and discomfort that could occur during the study. All the subjects participated freely and could cancel their participation at any time of the study, which would not affect their contact with the test leaders. If they wished the already collected data could be removed. The collected data in this study followed Personal Data Act (1998:204) and no unauthorized person had access to the results of the study or any personal information about the subjects. The data that were collected during the study were saved on a USB stick and kept by the test leaders.

3.5.1 Social considerations

This study has the potential to provide the society with further information and knowledge about how the use of WBs and the VM can affect power output and velocity in the squat. The information is best suitable for resistance training athletes because the VM is often used when the athlete is close to their 1RM and the same goes for the WB. It could also be beneficial for other athletes whose sport require high power output and velocity to learn the potential benefits of using WB and the VM. The squat is used in many different areas as performance, rehabilitation and hypertrophy, and this study gives knowledge whether the WB and the VM provides positive effects on power output and velocity and if the WB alone can be used or if it is beneficial to use it together with VM.

3.6 Statistical analyses

The statistical analyses were done in SPSS (IBM SPSS Statistics, Version 20). The variables that occurred in the study were quantitative and fell under scale. To test if the data were normally distributed the Shapiro-Wilks test were used and it showed that the data were normally distributed. To further analyze the data, parametric statistics were used and the one-way ANOVA. All tables and figures were done in Windows Excel (Excel, 2016). The significance level was set at $p < 0.05$ (Kingma et al., 2006).

4.0 Results

The subjects' physical characteristics and their self- reported 1RM are showed in table 2. The males physical characteristics and 1RM were (mean ± SD) as following: age, 25.2 ± 2.5 years; height, 179.9 ± 7.2 cm; weight, 86.3 ± 10.4 kg; 1RM, 161.5 ± 37.8 kg. The females physical characteristics and 1RM were (mean ± SD) the following: age, 22.4 ± 0.8 years; height, 169.6 ± 5.3 cm; weight, 74.9 ± 6.0 kg; 1RM, 101.8 ± 15.5 kg.

Table 2. The subjects (N=15) physical characteristics and their self-reported 1RM[1] in the subjects squat.

Gender	*Male (N=10)*	*Female (N=5)*	*All (N=15)*
Age (years)	25.2[2] ± 2.5[3]	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 ± 6.0	82.5 ± 10.6
1RM (kg)	161. 5 ± 37.8	101.8 ± 15.5	106.3 ± 32.2

[1] 1 Repetition maximum

[2] Mean

[3] Standard deviation

4.1 Power

The power output between the different groups were as following and shown in figure 1: Without WB and no use of VM the power output in mean value of 1023.6±383 Watt (W); with WB and no use of VM had a mean value of 1077±330.9 W; without WB and the use of VM mean value were 994±309.6 W; with WB and the use of VM the mean value were 1060±327.1 W.

To analyze the difference between the groups the one-way ANOVA was used. It showed that there is no significant difference between the groups ($p = 0.91$) and therefore no further analyses were done to analyze and compare the different groups.

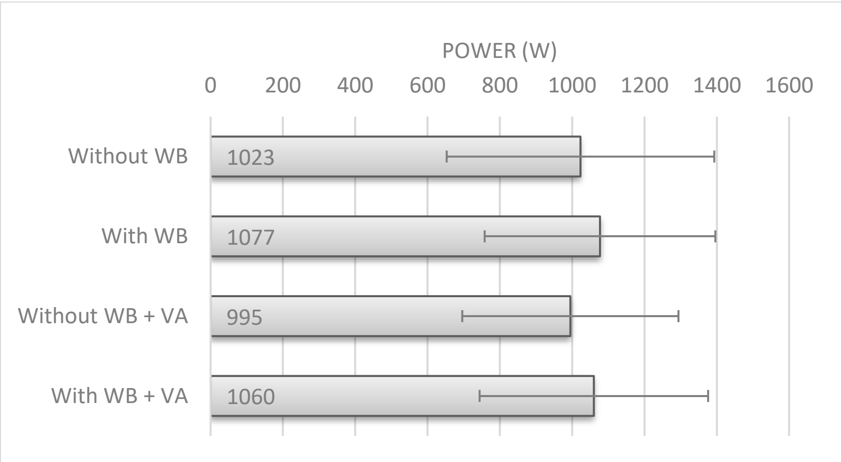

Figure 1. Shows the mean and the standard deviation in power output in a squat in all of the subjects (N=15). The four different conditions are; with WB[1], without WB, with WB and the use of VM[2] and with WB and the use of VM.

[1] *Weight lifting belt*

[2] *Valsalva maneuver*

With WB, the power was not higher than without WB. When the VM was practiced, the power output did not become significant higher when wearing the WB, the without.

4.2 Velocity

4.2.1 Velocity Eccentric

The velocity in the eccentric phase of the lift between the groups were as following and in figure 2: Without WB and no use of VM the mean value were 0.65±0.14 meters per secound (m/s); with WB and no use of VM the mean value were 0.63±0.13 m/s; without WB and the use of VM the mean value were 0.62±0.15 m/s; with WB and the use of VM the mean value were 0.63±0.15 m/s.

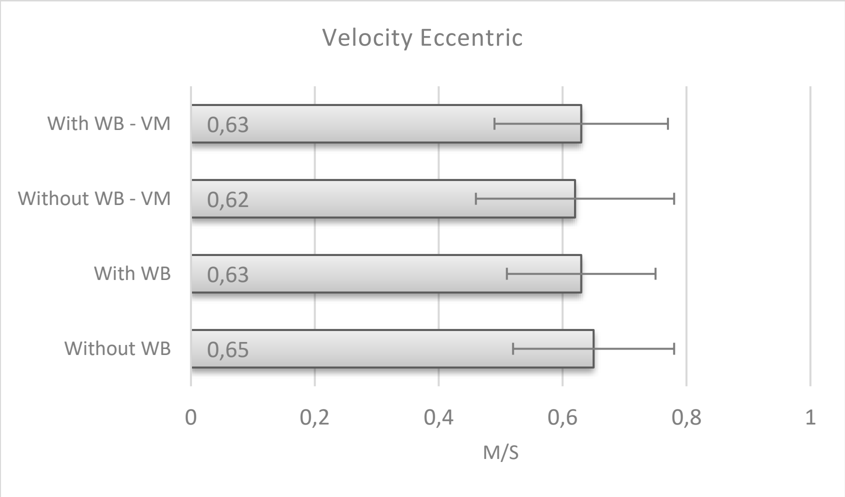

Figure 2. Shows the mean and the standard deviation on velocity in the eccentric phase in the four different conditions between all the subjects (N=15).

[1] *Weight lifting belt*

[2] *Valsalva maneuver*

There was no significant difference between the groups ($p = 0.96$) and therefore no further analyses were done to analyze and compare the different groups. The WB did not significantly affect the velocity in the eccentric phase and the same for VM. The VM together with the WB did not give a significant higher velocity.

4.2.2 Velocity Concentric

The velocity in the concentric phase of the lift between the groups were as following and in figure 3: Without WB and no use of VM the mean value were 0.57±0.13 m/s; with WB and no use of VM the mean value were 0.58 ± 0.12 m/s; without WB and the use of VM the mean value were 0.54±0.13 m/s; with WB and the use of VM the mean value were 0.57±0.13 m/s.

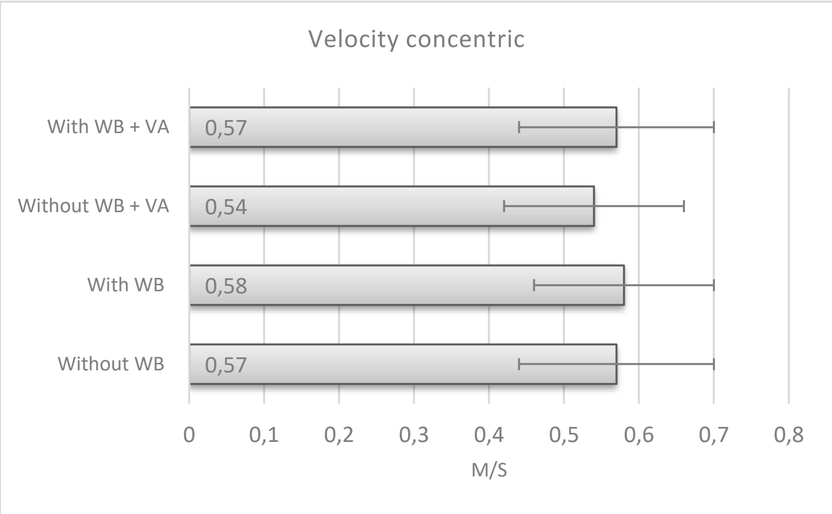

Figure 3. Shows the mean and the standard deviation on velocity in the concentric phase in the four different conditions between all the subjects (N=15).

[1] *Weight lifting belt*

[2] *Valsalva maneuver*

There was no significant difference between the groups (p = 0.85) and therefore no further analyses were done to analyze and compare the different groups. The WB did not significantly affect the velocity in the concentric phase and the same for VM. The VM together with the WB did not give significantly higher velocity.

4.2.3 Peak velocity in the concentric phase

The peak velocity in the concentric phase of the lift between the groups were as following and in figure 4: Without WB and no use of VM the mean value were 1.03±0.19 m/s; with WB and no use of VM mean value were 1.04±0.19 m/s; without WB and the use of VM the mean value were 1.0±0.19 m/s; with WB and the use of VM the mean value were 1.03±0.19 m/

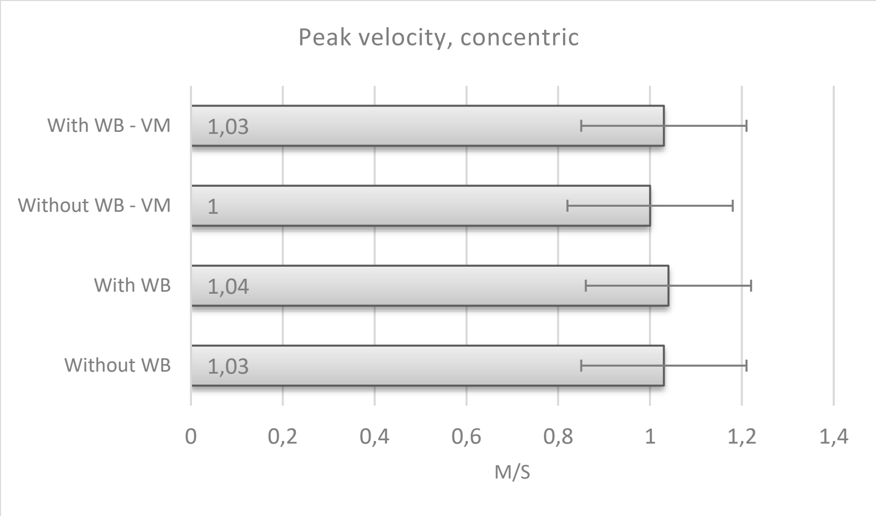

Figure 4. Shows the mean and the standard deviation on the peak velocity in the concentric phase in the four different conditions between all the subjects (N=15).

[1] *Weight lifting belt*

[2] *Valsalva maneuver*

There was no significant difference between the groups (p = 0.97) and therefore no further analyses were done to analyze and compare the different groups. The WB did not significantly affect the peak velocity in the concentric phase and the same for VM. The VM together with the WB did not give significantly higher velocity.

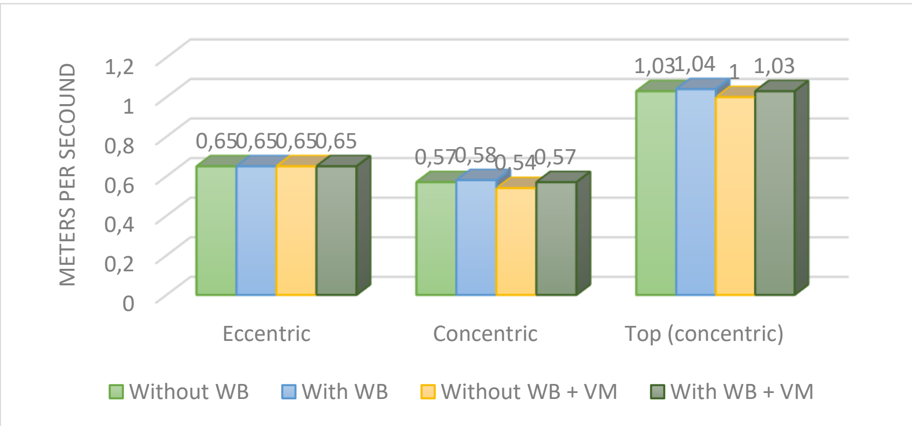

Figure 5. The mean values of the four different test conditions in the three different velocities.

[1] *Weight lifting belt*

[2] *Valsalva maneuver*

5.0 Discussion

The purpose of the study was to compare three different conditions (with WB, with WB and VM and VM only) to each other and to the control (without WB and not use the VM) in terms of power output and velocity in a squat. The main finding of this study showed no increase in power output when WB was worn compared to without WB. The same are applied when the participants used the VM, there were no increase in power output. The velocity in the eccentric and concentric phase of the squat did not increase. The peak velocity in the concentric phase was no exception, and did not increase in any of the three different conditions (with WB, with WB and VM and VM only) to each other and to the control group (without WB and not performing VM).

5.1 Power

The results show no significant effect on power output in any of the conditions. The WB did not affect the power and the VM did not give extra effect on the power output. This might be because there were no given instructions on how the squat should have been performed because there was another study that studied the range of motion on the same subjects. If they had got the instructions to do the squat as explosive as possible the effect might have been different. This study shows that there is no different if the athlete wears a WB compared to without WB on the power output and this does not agree with Zink et al. (2001) that claimed that there were a higher velocity and therefore a bigger power output when the WB was worn. When the subject practiced the VM the result showed no difference in power output between when the subjects when they wore WB or did not. The power determined by the velocity times force and the fact that the number of repetitions had been studied by Lander et al. (1992) and this showed that the use of WB increased the velocity of all the repetitions and specifically in the last repetitions can indicate that the power is increased as well. The power is not affected in any of the three conditions and this shows that there is no need to use the WB or the VM when performing a squat in power output, but further analyses need to be done on the injury-prevention when using WB and VM. The previous studies showed that the IAP is increased when VM is used and that this might have an injury-prevention effect and can give extra stability and together with WB be even more stable. Something that would be interesting to study is how the low-bar squat is performed because there is more force on the hip joint as Wretenberg et al. (1996) claimed and because of this the force is placed on the bigger muscles such as: m.glutes maximus and therefore may create more power.

5.2 Velocity

This study shows that there is no difference between the different phases of the squat in terms of velocity. This shows that the athlete did not do the concentric or eccentric phases any faster or slower with or without the WB and/or VM. Previous literature does not match the result of this study (Zink et al., 2001) as they claims that the repetition velocity increases with WB. And according to Lander et al. (1990) does the velocity of the lift increase. This study shows that in terms of velocity the WB and the VM have no effect and therefore is the use of WB and VM not a tool to use but more research need to be done on a more sport specific group of people, as weightlifters where the velocity is required to be high and therefore the power output of the lifts is of great value. To get training adaptations of a high power output the velocity needs to be high when the athletes are training (Hatfield et al., 2006). Further research needs to be done to see if there is specific breathing technique that could be used to increase the velocity and if there is any difference in the belt type and size. The fact that the eccentric and concentric phases of the lifts are almost the same in velocity in this study, the subjects might have used the SSC more if the eccentric phase had been done with a higher velocity. If the velocity increases it might has give a higher power output but needs to be more investigated. According to McCarthy et al. (2012) the eccentric phase should be fast and with a quick break to gain as much power in the concentric phase.

5.3 Valsalva maneuver & weight lifting belt together

The fact that this study shows no significant difference in the three different conditions in terms of power output and velocity could be due to the WB showed no increase in muscle activation in previous studies (Zink et al., 2001; Lander et al., 1990; Lee et al., 2002; Juluru et al., 1999). Because there is no increase in the muscle activation when only the WB were worn there is probably not more muscle fibers recruited. This could be the answer why there is no increase in power output and velocity. But when the WB were used at the same time performing the VM the muscle activation increased according to Blanchard et al. (2016), and this could show that the use of VM has a bigger effect on the recruitment of muscle fibers and this could mean a higher power output which is not showed in this study. The study by

Blanchard et al. (2016), studied the muscle activation and that it increased with both WB and VM but in the terms of stability of the spine and not performance.

The combination of WB and VM can possibly reduce the risk of injury on the lower back (Blanchard et al., 2016). When the deadlift was studied the results showed that when the athlete inhale and use WB the force was reduced on the vertebra by 10% (Kingma et al., 2006). The deadlift could be compared with the squat because both lifts are with a flexion in hip and knee joint and the main muscles that are trained is the same. The execution of an inhale (similar to VM) and wearing the WB shows reduction in force could the same occur in the squat.

5.4 Methodological discussion

The method of this study was well planned and followed the standardizations at every test occasion but some changes could have been done. The test result could be more reliable if 1RM tests were done a week before we tested the subjects power output and velocity on 75% of their estimated 1RM. Some of the subjects had recently tested their 1RM but some had tested it a while ago and could possibly have increased or decreased their 1RM. The previous studies by (Kingma et al., 2006; Zink et al., 2001), did their power output measurements with a force plate, this is something that could have been applied in this thesis but required more planning. In some of the participants they did their squat with a higher velocity and with more power can show that they have increased their 1RM as compared to others where they did their squats slower and with more effort. Otherwise the encoder is a reliable measuring instrument when measuring power and velocity in a lift (Moras et al., 2015).

All of the subjects got a written consent before the test occasion with some explanations how the test would procced and what to expect in addition to some instructions on what not to do before they arrived at the test occasion. This is something that the test leaders could not know if they followed and if they were telling the truth. This could have been tried to be avoided by reminding the subjects several days before the test occasion. There was another study that engaged the same subject at the same test occasion that studied the ROM of the squat and therefore were no instructions given to the subjects on how deep the squat should have been. This might have affected the effect on the SSC and in turn might have affected the power output and the velocity of the squat. The same for the “pause” that might occur at the bottom position in a squat, if this is to long the use of the energy in the eccentric phase disappears as heat and the concentric phase will not be as explosive. The study by McCarthy et al. (2012) the transition phase of the squat is important to be as short as possible to get a higher power output.

The fact that some of the subjects were used to wear WB and some were not, could have had a negative output on the study. The subject might think that the WB is an uncomfortable tool when performing the squat and have their minds set on how the WB felt instead of thinking about what they were performing; the squat. The study by Zink et al. (2001) the athletes said that they felt safer when using the belt but this is not showed in this study. When the VM was performed the experienced athletes that lift heavy did use almost the same breathing technique as the VM and therefor were there not a big different from the sets were the VM should not be used and when they were told to use it. This is something mentioned by Hackett (2012), that many athletes do a breathing technique when the weights get heavy without being aware of it. In this study, this could have been avoided if instructions to breathe out through the “sticking point” would have been given in the first two sets instead of no instructions at all. A study by Nachemson., Andersson. & Schultz., (1986) compared the VM with free breathing in terms of IAP. Nachemson et al., (1986) showed an increased in IAP when VM was used compared to free breathing and compared to this study where no instructions were given in the first two sets when the VM was not used. This might have influenced the output of this study but needs to be more investigated.

The subject came from different sports or with different information on how the squat should be done, this could influence how the squat is performed. The subjects came with different backgrounds as powerlifting, weightlifting, boxing, golf, crossfit or gym athletes. The weightlifters are used to do the squat as powerful as possible with a high velocity whereas the powerlifters are used to do heavier loads with a lower velocity (because of the loads) and the fact that there were no given instructions on how fast the squat should have been done this might have an impact on both power output and velocity in a squat.

6.0 Conclusion

Previous literature show increase in intra-abdominal pressure and muscle activation when both weight lifting belt and the practice of valsalva maneuver is used. The velocity is increased and therefore could imagine that the power output could be increased as well. This study shows otherwise, the power output and velocity did not increase in any of the three different test conditions (with WB, With WB + VM and Without WB + VM). This shows that the VM and the WB did not change the result of the study when a high power or velocity is desired in a squat, but needs to be more investigated because this is not consistent with earlier literature. I the future the VM should be monitored more careful and use subjects that are used to use WB to give a more reliable result. To test the subjects 1RM before and give them the opportunity to practice the VM beforehand.

7.0 References

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8.0 Appendix

Appendix 1

Informerat samtycke

HALMSTAD UNIVERSITY

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 är aktiv medlem i Halmstad TSK och har tränat tyngd- eller styrkelyft 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 är på helt egen risk.

…………………	……..……………………	..………………………..
Datum	Namnteckning	Namnförtydligande

………………………………………………………………

Födelsedatum

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

……………………	…..………………………..	………………………..
Datum	Namnteckning	Namnförtydligande

Appendix 2

		ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Load	105	60	94	79	83	173	139	75	96	158	113	107,5	97,5	72	143
Power(W)		*Without WB*	480	480	1337	698	910	1740	1040	755	822	1047	1747	1203	855	1030	1210
		With WB	1110	481	1280	681	1007	1627	1107	755	773	1133	1677	1253	891	1093	1290
		Without WB + VA	963	467	1190	666	910	1440	1017	698	774	907	1647	1207	775	1057	1203
		With WB + VA	1103	494	1370	616	970	1427	1220	764	776	1037	1717	1273	846	1087	1207
Velocity (m/s)	Without WB	*Concentric*	0,65	0,4	0,76	0,47	0,61	0,64	0,45	0,49	0,5	0,43	0,84	0,64	0,5	0,7	0,52
		Eccentric	0,74	0,68	0,68	0,61	0,66	0,57	0,64	0,79	0,56	0,43	0,77	0,59	0,35	0,79	0,85
		Maximum	1,24	0,85	1,25	0,85	1,16	1,16	0,82	0,98	0,83	0,85	1,44	0,98	1,08	1,09	0,94
	With WB	*Concentric*	0,6	0,4	0,73	0,46	0,67	0,6	0,47	0,5	0,47	0,47	0,81	0,67	0,52	0,74	0,56
		Eccentric	0,7	0,65	0,58	0,56	0,67	0,61	0,66	0,82	0,47	0,46	0,75	0,56	0,39	0,76	0,81
		Maximum	1,06	0,81	1,21	0,86	1,32	1,17	0,84	1,02	0,81	0,83	1,36	1,01	1,17	1,15	0,99
	Without WB + VA	*Concentric*	0,53	0,39	0,69	0,45	0,62	0,54	0,44	0,46	0,47	0,38	0,8	0,65	0,45	0,72	0,52
		Eccentric	0,6	0,55	0,72	0,6	0,56	0,48	0,66	0,82	0,46	0,45	0,81	0,66	0,28	0,83	0,81
		Maximum	0,94	0,84	1,16	0,86	1,26	1,06	0,79	0,99	0,78	0,74	1,4	1,08	1,05	1,14	1,04
	With WB + VA	*Concentric*	0,6	0,41	0,77	0,42	0,65	0,53	0,52	0,5	0,47	0,43	0,83	0,68	0,5	0,73	0,53
		Eccentric	0,7	0,67	0,59	0,58	0,61	0,47	0,65	0,83	0,52	0,48	0,79	0,68	0,31	0,86	0,65
		Maximum	0,97	0,84	1,27	0,86	1,28	1,03	0,88	1,03	0,8	0,79	1,41	1,06	1,07	1,15	1,02

Tabell 3. All of the subjects (N=15) test result in power and velocity in the four different sets.

[1] Weight lifting belt (WB)

[2] Valsalva Maneuver (VA)

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