

# MASTER THESIS



## A Comparison Between Foam Rolling and Dynamic Stretch on Throwing Velocity and Accuracy Among Male Handball Players

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Master Thesis in Exercise Science, 30 ECTS

Halmstad 2014-04-21

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2014-04-21

Master Thesis 30 credits in Sports and Exercise Science – Human Performance

Halmstad University

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## Acknowledgements

First of all I would like to thank my family and friends for all the support during both intervention and writing. A special thanks goes out to Lina Bergman, Carl Raask, Oscar Björk, Jacob Winqvist, Björn Frandsen, Henrik Årneby, Sebastian Edman, Andreas Holm and Lotten Ruff for the invaluable help during the interventions.

I would also like to thank Johan Petersson and Tommy Suoraniemi for all the help with logistics and scheduling. And last but not least my thesis advisor Anette von Porat for all the support, feedback and advice as well as my examiner Ann Bremander for her advice and concrete examination.

## Abstract

The monotonous and strenuous shoulder moving pattern during throwing may result in micro trauma and fibrous adhesions between the layers of fascia among athletes. In the last decade, self myofascial release (SMR) has gained good reputation as a way to treat these adhesions. However, there is limited data demonstrating the effects on upper body performance among athletes. **PURPOSE:** The purpose was to examine the effects from an acute bout of upper body SMR or from dynamic stretch (DS), on shoulder range of motion (ROM), throwing velocity and throwing accuracy. Also to examine correlations between shoulder ROM and throwing velocity/accuracy and between playing experience (PE) and changes in throwing velocity/accuracy and ROM. **METHODS:** 20 elite male handball players (age  $20 \pm 5$  years, weight  $84 \pm 9$  kg) were included in the study. The study had an experimental cross-over design in which participants first performed baseline measures. They also performed SMR and DS in two different trials. The trials were supervised and separated by 14 days. During SMR, the athletes performed a series of foam rolling exercises during two minutes for the muscles surrounding the shoulder joint. The same muscles were stretched for two minutes during the DS trial. Directly after foam rolling and DS, shoulder ROM, throwing velocity and throwing accuracy were measured using a gravity reference goniometer, radar gun and a high speed video camera. ANOVA with repeated measures and t-tests were used to analyze differences between and within groups. **RESULTS:** There were no statistically significant differences in either shoulder ROM, throwing velocity or throwing accuracy between the three trials. There was a moderate correlation between shoulder extension and mean accuracy ( $r = 0.62$ ;  $p = 0.004$ ) after DS. When dividing the group into high and low experienced players, among the players in the PE-low group, the most experienced players elicited the greatest increase in peak throwing velocity after DS ( $r = 0.58$ ;  $p = 0.10$ ). Change in peak accuracy showed moderate but conflicting correlations after SMR ( $r = -0.53$ ;  $p = 0.09$ ) and DS ( $r = 0.50$ ;  $p = 0.11$ ) for the players in the PE-high group, indicating a better result after SMR. **CONCLUSION:** An acute bout of upper body SMR does not affect ROM and does not improve throwing velocity or throwing accuracy compared to baseline or DS among elite male handball players. Nor could any correlation between ROM and throwing velocity or throwing accuracy be observed. The associations between PE and throwing performance was inconclusive. Further studies is needed to define if PE should be taken into consideration when using SMR or DS in order to improve throwing performance.

**KEYWORDS:** SMR, throwing velocity, handball, fascia, dynamic stretch, foam rolling

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## Introduction

As a handball player, it is crucial to throw the ball as fast as possible with good accuracy in order to score. A well-executed training program is crucial, whereby coaches and athletes all over the world are trying to refine and optimize training programs in order to increase the athletes' performance (Van den Tillaar, 2004). There is a wide spread use of Self Myofascial Release (SMR) among recreational gym members and professional athletes as a way to improve performance, increase range of motion (ROM) and improve recovery (Castiglione, 2008, Clark & Russell, 2009 & Boyle, 2009). During the last five years and especially the last two years, there has also been a growing interest within the scientific literature regarding the beneficial effects from SMR on the human body (Curran et al. 2008; Healey et al. 2014; Macdonald et al. 2013, 2014; Sullivan et al. 2013 & Okamoto et al. 2014).

Unexpectedly, there is yet no published research investigating the effects from SMR on athletes as far as we know. Neither is there any research investigating the effects of SMR on the upper body. Therefore, this study is investigating the effects on performance from an acute bout of SMR in comparison with an acute bout of dynamic stretch on elite handball players. If it proves to be beneficial it would be practically applicable and valuable to perform SMR both before and during game play. This study investigates the effects on ROM, throwing velocity and throwing accuracy.

## Background

Handball is an intermittent sport which put a lot of physical demands on the players' aerobic and anaerobic capacity (Póvoas et al. 2012). Players are moving rapidly in all direction across the field, jumping and throwing quickly whereby players need to have strength, agility and endurance to withstand the demands that is being put on them during both practice and game. The main key characteristics in elite handball are endurance, jumping ability, sprint performance and throwing velocity (Kruger et al. 2013). Ziv and Lidor (2009) conducted a review including 23 studies that examined the physical characteristics and physical attributes on both amateur and elite handball players. The results showed that elite handball players have higher fat-free mass and up to nine percent higher throwing velocity compared to amateur players. Elite handball players have more experience which is an important factor when it comes to designing training programs, performing physical tests and study design since novice players have not established an optimized throwing pattern and therefore may be more affected by changes in training programs, throwing instructions and any sort of change in joint mobility as a result of any kind of soft tissue treatment.

There is also a need for high levels of aerobic capacity rising towards 60 ml/kg/min when heart rates rise above 160 beats/min which occurs during sprinting and backwards movement from one court half to the other (Ziv and Lidor, 2009). During one season, each handball player performs at least 48.000 throwing motions with throwing speed approaching 130 km/h (Pieper, 1998). This repeated throwing puts great demands on the shoulder joint resulting in a functional instability, which in turn increases the risk for injuries (Gurinder, 2011 and Edouard, et al. 2013). There is, as described by Ziv and Lidor (2009), two possible strategies for scoring: 1) throw the ball as fast as possible without aiming in order to surprise the goal keeper, and 2) throw the ball as accurately as possible to keep the ball out of reach of the goal keeper. Today, most studies have focused towards throwing velocity but have not been looking at accuracy (Ziv and Lidor, 2009). There is as far as we know no study who has been investigating a way to increase throwing velocity and accuracy at the same time.

Coaches and scientists have earlier made different attempts in constructing specific training programs (TP) in order to increase the players throwing velocity, resulting in a two to seven percent increase (Van den Tillaar, 2004). However, no conclusions could be drawn but only advice could be given. For example: (1) the specific TP needs to be sustained during five weeks

with at least three training sessions per week and (2) the TP needs to be individually constructed based on individual parameters such as playing experience (PE) (Van den Tillaar, 2004). But there is no acute short term solution for increasing throwing velocity despite the plausible benefits from an increased throwing velocity.

To be able to maximize the athletes throwing velocity without increasing the risk of injuries, there is a need for balance between mobility, muscular balance and dynamic stability around the glenohumeral joint (Borsa et al. 2008). Mobility is needed in order to reach maximum rotation so that velocity can be transferred to the ball, but at the same time, there is a need for stability in order keep the humeral head in the glenoid socket and stabilize the joint. This is known as the “throwers paradox” where the relationship between mobility and stability needs to be maintained in order to reduce the risk of injuries (Braun et al. 2009). Kinematic analysis of handball throwing in a standing position shows that internal shoulder rotation angular velocity is an important contributor to throwing velocity (Van den Tillaar and Ettema, 2004; Ettema, 2007 & Wagner and Müller E, 2008). However, conflicting findings shows that peak torque of internal and external rotation is not related with ball velocity (Zapartidis, 2007).

The normal ROM around the shoulder among handball players is not clearly investigated, there is however a well-researched area among baseball pitchers which are doing a similar shoulder moving pattern during throws. It is common that baseball pitchers have increased humeral head retroversion in relation to increased humeral external rotation together with a reduced internal rotation in the dominant shoulder (Heber et al. 2002; Osbahr et al. 2002 & Reagan et al. 2002). Pieper (1998) discussed the fact that the increased humeral retroversion might act as a protection mechanism for the anterior capsulabral complex, since the retroversion allows more external rotation of the shoulder without putting excessive strain on the joint complex (Pieper, 1998). It does however seem as the players overall rotational arc (maximal internal rotation to maximal external rotation) is the same between the dominant and non-dominant shoulder. They also have a similar proprioceptive sensation in the dominant shoulder compared to the non-dominant despite changes in internal and external ROM (Safran et al. 2001).

The throwing motion during overhead throwing is very quick and the muscles are sequentially activated to a total period of time up to 120 milliseconds in the kinematic chain during an overarm throw. Thereby it is possible to increase the throwing velocity by increasing the



velocity of the initial movement in the kinematic chain (Grezios et al. 2006). The equation of the distal joint throwing velocity is described as following by Grezios et al (2006):

$$V_{end} = V_{Anf} + \sum V_{Gel/Di I} \quad (\text{Equation 1})$$

$V_{Anf}$  is the absolute speed of the first joint and  $\sum V_{Gel/Di I}$  is the relative speed of the following joint in relation to the proximal joint. Since the muscles are sequentially activated, an increased velocity of the proximal movement would lead to an increased throwing velocity. During the first 50 milliseconds of the throw, the stretch shortening-cycle (SSC) is apparent (Grezios et al. 2006). A passive muscle does not exhibit elastic characters and must be pre-activated in order to maximize the effect from the SSC. An increased pre-activation enables the muscles to store more elastic energy and increase the amount of SSC (Grezios et al. 2006) which in turn could lead to an increased throwing velocity.

Since internal rotation is important for throwing velocity, it is important to emphasize and maintain a good ROM for shoulder internal rotation among handball players. The cause for the loss of internal rotation among handball players is a multifactorial matter where a number of different factors affect the ROM. Reactive scarring of the contracture of the posterior shoulder capsule with a resulting immobility of the posterior shoulder could be one reason (Borsa et al. 2008). The reactive scarring forms over time when multiple micro traumas with resulting scars in the connective tissue occurs, thereby creating adhesions between layers of connective tissue. Another explanation for the overall changes in ROM is the involvement of the fascia surrounding the muscles and connecting the joints to each other. Stiffness of the fascia as a result of monotonous movement patterns with resulting micro trauma. This micro trauma may lead to an inflammatory response which in turn leads to fascia scar tissue with resulting adhesions between the fascia and muscle. These adhesions are one possible explanation for changes in ROM and muscular dysfunction (Cantu and Grodin, 2001 & Curran et al. 2008).

Fascia is more or less inseparable from all structures in the body and acts as a connecting structure linking body tissues to each other in order to enhance function and stability in the body. A more recent approach to the area of mobility and its effect on athletic performance is the fascia as a major player where the fascia acts as a tissue memory, adapting to all the movements in the body (Paoletti, 2006). This “cellular memory” is being described by Paoletti (2006) as something that is being derived from the embryonic growth and that this “cellular memory” acts as a tissue memory that registers any deformation which they undergo and

corrects the deformations. The ability to correct deformations is however sooner or later exceeded if the structure deformation is too extreme, whereby a progressive pathology with continual changes in the structure occurs. These continual changes are shown to induce a fibrous adhesion between the different layers of fascia, preventing adjacent dense layer of tissue to glide past one another which in turn prevents normal muscle mechanics (i.e. decrease strength, endurance and ROM) (Curran et al. 2008 & Graham et al. 2013).

Other authors have found the same properties for the fascia and states that the fascia is able to adapt fiber arrangement, density and length according to local demands (Findley, 2009).

Within the fascia, there are a large number of mechanoreceptors, which means that the fascia plays a large role in nociception and proprioception (Yahia, 1992 & Van der Wal, 2009). Majority of the input to these mechanoreceptors arrive from the interstitial receptors that are directly connected to the autonomic nervous system (ANS). Thereby, stimulation of the intra fascial mechanoreceptors changes the input to the ANS resulting in a changed tonus regulation of the motor units connected to the affected tissue. The result is a more relaxed and pliable tissue, leading to a larger mobility (Schleip, 2003).

## Dynamic Stretch

Dynamic stretching (DS) is a mobility drill that involves a controlled movement through the active ROM for a joint (Fletcher, 2010). Research has showed that an acute bout of low-volume DS results in a significant decrease in maximal isometric peak force for pectoralis major and triceps brachii. However, no significant changes in average amplitude of surface EMG, time to maximal isometric force or rate of force production were found (Leone et al. 2012). Overall, literature indicates that shorter durations of DS does not inhibit muscular performance compared to static stretching and is often recommended during warm-up since the movements used are similar to movements that occur during sports (Torres et al. 2008 & Behm and Chaouachi, 2011).

## Self Myofascial Release

Self Myofascial Release (SMR) is a modern technique that has been developed from Myofascial Release therapy (MFR) which was a manual-therapy technique developed by Barnes (1997) to reduce fibrous adhesion between the layers of fascia (Barnes, 1997). The main difference between SMR and MFR is that instead of a therapist that provides manual therapy, subjects practicing SMR use their own body mass on a foam roller and/or a dense ball in order to isolate specific areas and treat soft tissue restrictions (Curran et al. 2008 & Castiglione, 2010). Thereby

the term “Self Myofascial Release” is applied to techniques that use tools such as foam rollers, tennis balls and other rollers with varying shapes and hardness. The tool is used in order to elongate muscle fibers and fascia while at the same time comprise the area and create an ischemic compression just like acupressure or massage. Thereby increase soft tissue temperature and restore muscle length-tension relationship prior to a workout (Clark and Russell, 2009). The exact mechanism of how this work is not clearly investigated. One hypothesis is that the ischemic compression would loosen up the possible adhesions between layers of fascia and thereby restore soft tissue mobility. Another possible hypothesis was first described by Klinger et al. (2004) which showed in vitro that the stiffness of the fascia is partly due to its water content and when the fascia is comprised, the water is being extruded from the tissue and thereby making the tissue more pliable (Klinger et al. 2004). A more recent study confirmed this results and showed that water returned to the tissue within a few hours in a higher concentration than before the water efflux, resulting in a stiffer tissue as a result of the “super compensation” of fluid (Schleip et al. 2012). The period between when the water is being extruded and prior to its refilling are described by Schleip et al. (2012) as a “window of opportunity” for increased mobility/flexibility.

SMR seems to become more frequently used as a warm up-, rehabilitation- and/or mobility technique to help promote soft-tissue extensibility, increase ROM and promote muscle function. Layman’s literature supports that SMR is commonly used in training facilities by ordinary training facility members but also by coaches and athletes. It is used both before and after training in order to reduce any possible dysfunctions resulting from micro trauma and thereby be able to increase the athletes training volume (Castiglione, 2008, Boyle, 2009 & Clark and Russell, 2009). There have as far as I know, been six peer reviewed articles investigating the effects of foam rolling before and after exercise / performance test (Curran et al. 2008; Healey et al. 2014; Macdonald et al. 2013, 2014; Okamoto et al. 2014 & Sullivan et al. 2013). Curran et al. (2008) showed that myofascial rollers made of harder material was more beneficial compared to softer, in order to optimize muscle function (Curran et al. 2008). Two articles found that an acute bout of SMR increased lower body ROM without a subsequent decrease in muscle activation or force (MacDonald et al. 2013 & Sullivan et al. 2013). One article found that foam rolling prior to exercise was beneficial in improving dynamic movement, muscle activation, ROM and reduced muscle soreness in comparison to a control group (MacDonald et al. 2014). Another article found no difference between foam rolling and planking on athletic performance. However, the post-exercise fatigue was significantly reduced after foam rolling

compared to planking. This reduced feeling of fatigue could in turn augment continuous performance enhancements (Healey et al. 2014). Okamoto et al. (2014) investigated the effect of SMR on vascular endothelial function and arterial stiffness and found that one bout of SMR reduced arterial stiffness and improved vascular endothelial function compared to a control group (Okamoto et al. 2014). These findings support the layman's literature and the peer-reviewed studies report consistent findings that SMR may increase one or more physiological parameters that may augment athletic performance. However, there is a lacking consistency in methods and materials that has been used in the existing articles investigating different aspects of SMR. Even though the earlier findings support the fact that SMR increases performance parameters in one way or another, there is a various amounts of conclusions and explanations for why this happens. The inconsistency regarding methods and materials used is thought to be one reason for the diverse conclusions among studies.

There is a growing interest for SMR and its possible benefits on human performance and mobility. However, none of the published studies have been performed on athletes and most of the published studies are aiming towards effects on the lower extremities. Empirical evidence and literature investigating the effect of SRM for the upper body is lacking. Therefore, the purpose of this study was to examine and evaluate if an acute bout of SMR or DS could have an effect on ROM, throwing velocity and/or accuracy among elite male handball players.

## Study Questions

- 1) Will an acute bout of SMR affect throwing velocity and/or accuracy compared to baseline values?
- 2) Will an acute bout of DS affect throwing velocity and/or accuracy compared to baseline values?
- 3) Is there any significant difference between SMR and DS on throwing velocity and/or accuracy?
- 4) Will the SMR-treatment be as effective as DS in order to increase shoulder ROM in the shoulder joint?
- 5) Is there a correlation between shoulder ROM and throwing velocity and/or accuracy?
- 6) Is PE correlated to changes in shoulder ROM, throwing velocity and/or accuracy from SMR or DS?

## Methods

### Subjects

A total of 37 subjects who were handball athletes volunteered for the study. The players were at the moment playing in the Swedish handball elite series and Champions League. The participants filled in a questionnaire (Appendix 1) regarding injury history and basic anthropometric data (Table 1) before participation. They were included if they were uninjured in their throwing arm during the last six months prior to study start and were able to participate in all trials. They were excluded if they had any former experience of upper body SMR. Two subjects were excluded from the study because of injury and 15 subjects were excluded because of inability to participate in all trials (Figure 1).

Subjects were instructed to refrain from alcohol and heavy exercise 24 hours before the test and keep their regular sleeping pattern. They were also instructed to maintain their regular caffeine and nicotine intake and not change it during the study period. A total of 20 healthy male participants (age  $20 \pm 5$  years, weight  $84 \pm 9$  kg) met inclusion and exclusion criteria.

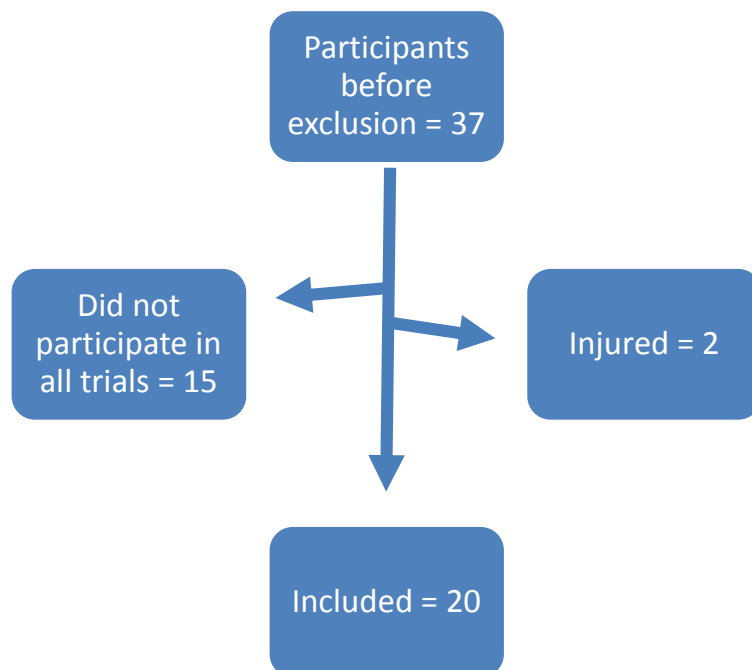


FIGURE 1. Flowchart describing the exclusion process

TABLE 1. Descriptive statistics of participants (n = 20)

	<b>Mean <math>\pm</math> SD<sup>2</sup></b>	<b>Min</b>	<b>Max</b>
Age (years)	20 $\pm$ 5	16	32
Weight (kg)	84.1 $\pm$ 8.8	69	96
Length (m)	1.90 $\pm$ 0.06	1.77	2.02
BMI <sup>1</sup> (kg / m <sup>2</sup> )	23.3 $\pm$ 2.1	19.9	26.2
Experience (years)	12 $\pm$ 4	6	20
Training frequency (hour/week)	11 $\pm$ 4	6	20

<sup>1</sup>BMI – Body Mass Index; <sup>2</sup>SD = Standard Deviation

## Testing Procedures

In an experimental, cross-over design, the experiment was carried out during the athletes' regular scheduled training and consisted of three measurement occasions. One baseline measurement trial and two experimental trials (DS and SMR) were performed. All subjects were split after the baseline trial into either start with the DS-trial or the SMR-trial without any specific order. All trials occurred in the afternoon at the same time separated by fourteen days with at least 24h of rest from any type of heavy exercise prior to each testing occasion in order to minimize shoulder fatigue as a confounding factor (Carpenter et al. 1998).

During all trials, measurement of active ROM throughout sagittal shoulder flexion and extension, and internal- and external shoulder rotation in 90° abduction were measured with a gravity-reference goniometer, (RR Parir, Bålsta, Sweden (Myrin)). Prior to each measurement, all subjects performed a general warm-up consisting of easy jogging and football playing for approximately ten minutes. Thereafter they were asked to lie down in a supine position on a bench with their dominant arm hanging outside the bench, making it able to move freely during measurements. Two examiners performed the measurements where one examiner was in charge of stabilization of the shoulder by applying a posterior-directed force against the subject's clavicle with the heel of the hand, preventing scapula from moving. This method has previously been shown to increase the reliability during ROM-measurement of internal- and external rotation of the shoulder (Awan et al. 2002). The other examiner measured active ROM during sagittal shoulder flexion, extension and thereafter, internal- and external shoulder rotation. Subjects were instructed to perform a full active shoulder flexion starting in a neutral position.

Measurements were taken when subjects had reached their maximal active ROM. Thereafter, they performed a full active shoulder extension starting in a neutral position. Here as well, the measurement was taken when the subjects reached their maximal active ROM. They were told to keep their elbow fully extended during both shoulder extension and flexion. Subjects were then instructed to have their shoulder in 90° abduction and the elbow in 90° flexion when they performed a maximal active internal rotation followed by active external rotation. All measurements were performed in a supine position and the readings were taken during the first attempt in order to avoid influences on ROM from repeated testing. The Myrin goniometer was attached with Velcro straps on a rubber cloth to the subjects forearm directly below processus styloideus radii. Myrin goniometer is an inclinometer that has been previously used in a randomized controlled study (Ryans et al. 2005) and has also been shown to be reliable and show good agreement to a three-dimensional ultrasound motion device (Zebris) during measurement of cervical ROM (Malmström et al. 2003).

Directly after the ROM measurements, subjects performed three seven meter throws with a standard International Handball Federation (IHF) Size 3 handball for men (weight ~ 450gr, circumference 59 centimeters) from penalty throw line towards a standard team handball goal (3 x 2 meter). Subjects were told to be in contact with the ground with their front foot during throwing; they were also told to use handball glue during all throws as during game play. Maximal ball velocity ( $V_0$ ) was measured using a radar gun (Bushnell Velocity Radar Gun, Bushnell Outdoor Products <sup>TM</sup>®, Overland Park, Kansas, USA) (Caliskan and Akkoyunlu, 2011 & Cerrah et al. 2011). The radar gun was placed behind the goal aiming at the center of a circular target with 66.5 centimeter in diameter placed in the goal about 1.5 meter above ground (Figure 2). This is a previously used set up that has been shown to be both valid and reliable (Finnoff et al. 2002 & Skoufas et al. 2003). Subjects were instructed to hit the center of the circle without emphasizing accuracy in order to avoid influencing their throwing speed (Van Den Tillaar and Ettema, 2003; Garcia et al. 2013). Throwing accuracy was measured with a high speed video camera recording at 240 frames per second (fps), (Canon IXUS 220 HS, Canon Svenska AB, Solna, Sweden) placed one meter behind the center of the circle. The placement where the ball passed through the circle was measured at the moment when the ball struck the net. The data was analyzed with Dartfish video analysis software (Dartfish®) to identify the deviations of throws with respect to the center of the circle.

Throwing speed and accuracy were measured during three subsequent throws, after which mean and peak throwing velocity were calculated. If the ball struck the net further away than 55

centimeter from the center of the circular target, subjects were allowed another throw until they had three approved throws. All three throws were used to calculate mean accuracy, and the best hit was used to estimate peak accuracy.



FIGURE 2. Throwing accuracy and velocity setup

## Self Myofascial Release

All subjects performed both experimental trials separated by fourteen days in a crossover design.

The type of SMR that was used was foam rolling. During the SMR-trial, subjects were first instructed in how to use the equipment for the posterior shoulder capsule, m.latissimus dorsi, m.teres major/minor, m.pectoralis major/minor, m.infraspinatus, m.m.rhomboideus major/minor and the thoracic spine. Thereafter they performed four different foam rolling exercises for 30 seconds / exercise (two minutes total). The equipment used was a 330 millimeter long foam roller made of a hollowed polyvinyl chloride (PVC) pipe (four millimeter wall thickness) with 110 millimeter in diameter surrounded by a 15 millimeter thick layer of Ethylene-vinyl acetate (EVA) foam (THE GRID, Trigger point Performance Therapy, Texas, USA). During the first exercise targeting the muscles crossing the armpit (m.latissimus dorsi and m.teres major/minor), subjects were instructed to place their body on the side on the foam roller. Their throwing arm was outstretched overhead with the hand behind the neck and their other hand put on the hip (Figure 3). They were then starting at the proximal aspect of humerus and started to roll down the lateral side of the thorax in a speed of about two centimeters / second before turning back and returning towards the proximal part of humerus.





FIGURE 3. Starting position during the first exercise. The upper leg was used to push the body forward on the foam roller.

During the second exercise, subjects were instructed to keep their body position as during the first exercise but started to lean their body ventrally until the foam roller put pressure on the anterior part of the armpit. The change in body position was performed in order to increase the pressure on m.teres major. Subjects foam rolled from the proximal aspect of humerus toward the center of the armpit, movement during this technique was minimal. During the third exercise, subjects put their back on the foam roller with their hand crossed over their chest. They elevated and kept their hips from the ground and put as much of their body weight as possible on the foam roller and started to roll back and forth from the neck down towards midway between neck and sacrum. During the fourth exercise, subjects lay supine on the foam roller with the foam roller positioned along the spine with the center of the foam roller between the scapulae. Subjects held their hips from the ground and positioned as much of their body weight as possible on the foam roller. Thereafter, they put their arms out at the sides and started to roll from side to side. During this exercise, the foam roller gently rolled over scapula and m.m.rhomboideus. Subjects were told to put as much of their bodyweight as possible on the foam roller during all exercises, however pressure was self-adjusted by using hands and feet to offset weight as required. Subjects were instructed to keep a steady pace and quickly turn back to the initial position in one fluid motion. The treatment was supervised by an examiner to ensure proper execution. ROM, throwing accuracy and throwing velocity was measured as during baseline directly after the SMR.

## Dynamic Stretching

The DS group performed the supervised DS for 30 seconds / exercise (two minutes total) for the same muscles as treated during SMR. They performed Sleeper stretch, Phelps stretch, overhead backward arm swings and window washers in that order (Appendix 2). These DS exercises were used to stretch the following muscles of the upper body: m.latissimus dorsi, m.pectoralis major/minor, m.m.rhomboideus major/minor, m.deltoideus and m.teres major/minor. After the DS session, the same ROM-measurements and throwing procedure as during the baseline test were performed.

All subjects were told not to use SMR at home during the study period. They were also told to avoid any extra stretching except for that normally performed during training.

## Ethical and Social Considerations

Prior to participation, subjects were verbally informed of all procedures in the study, and if willing to participate, read and signed a written informed consent form (Appendix 3) according to the Helsinki declaration. There was also time for questions during the verbal information. All personal data was handled according to the Swedish Personal Data Act (PUL§10) and the result is presented on group level, meaning that none of the results is possible to derive to a certain person.

The findings from this study will help us by giving more information about the possible effects from SMR in comparison with DS both frequently used in training programs for athletes. It will also aid to the health for the population, where an extended knowledge regarding warm up would help both trainers and physiotherapists to affect and formulate more efficient training programs for the general population.

## Statistical Analyses

A power analysis was performed before study start to estimate the sample size. The result from the analysis showed that with the alpha level set at  $p \leq 0.05$  for statistical significance, and a premise that a five to ten degree change in ROM would be similar to the one presented in other comparable studies, there needed to be at least ten subjects included in this study for a power value of 80 %. Data was collected using a Microsoft Excel 2010 spread sheet and is expressed as mean  $\pm$  standard deviation (SD). Statistical analyses were performed using Statistica software (IBM SPSS ver.20, Chicago, IL, USA). All data were normally distributed determined

by Shapiro-Wilks which could not show a significant difference between groups. A two-way analysis of variance (ANOVA) with repeated measures was performed on all dependent variables. A student t-test was used to analyze changes within the group. The alpha level was set at  $p \leq 0.05$  for statistical significance. Pearson product correlation was used to determine any relationship between dependent variables (Vincent and Weir, 2012). The correlation was determined as moderate when  $r = 0.5 - 0.8$  and large when  $r > 0.8$  (Cohen, 1988).

## Results

### Throwing Velocity

There was no significant difference in peak throwing velocity ( $p = 0.74$ ) or mean throwing velocity ( $p = 0.75$ ) between the three trials (Table 2, Figure 4).

TABLE 2. Comparison of throwing velocity among participants ( $n=20$ ) between trials. Values presented as mean  $\pm$  SD

Variable	Baseline (km/h)	DS <sup>1</sup> (km/h)	SMR <sup>2</sup> (km/h)	p-value
Peak Velocity	84.80 $\pm$ 8.32	84.55 $\pm$ 7.54	85.15 $\pm$ 7.76	0.74
Mean Velocity	82.17 $\pm$ 8.13	82.00 $\pm$ 7.68	82.52 $\pm$ 8.02	0.75

<sup>1</sup>DS = Dynamic Stretch, <sup>2</sup>SMR = Self Myofascial Release

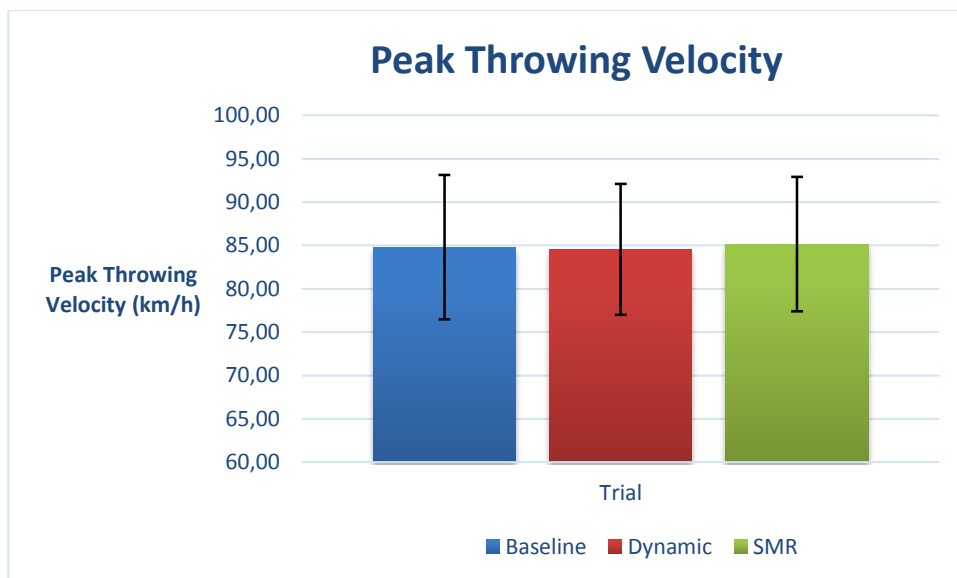


FIGURE 4. Peak throwing velocity for all participants ( $n=20$ ) during baseline, dynamic stretch and SMR. Values are presented as means for all participants. Error bars show the standard deviation.

### Throwing Accuracy

There was no significant difference in peak throwing accuracy ( $p = 0.81$ ) or mean throwing accuracy ( $p = 0.69$ ) between the three trials (Table 3, Figure 5). An increased value shows that the handball struck the net further away from the center of the target, thereby indicating a decreased accuracy.

TABLE 3. Comparison of throwing accuracy for all participants (n=20) between the three trials. Values are presented as mean  $\pm$  SD and show the distance from the center of the target

Variable	Baseline (cm)	DS <sup>1</sup> (cm)	SMR <sup>2</sup> (cm)	p-value
Peak Accuracy	20.70 $\pm$ 12.19	21.20 $\pm$ 13.71	19.10 $\pm$ 9.29	0.81
Mean Accuracy	32.72 $\pm$ 11.16	35.30 $\pm$ 10.64	33.35 $\pm$ 8.19	0.69

<sup>1</sup>DS = Dynamic Stretch, <sup>2</sup>SMR = Self Myofascial Release

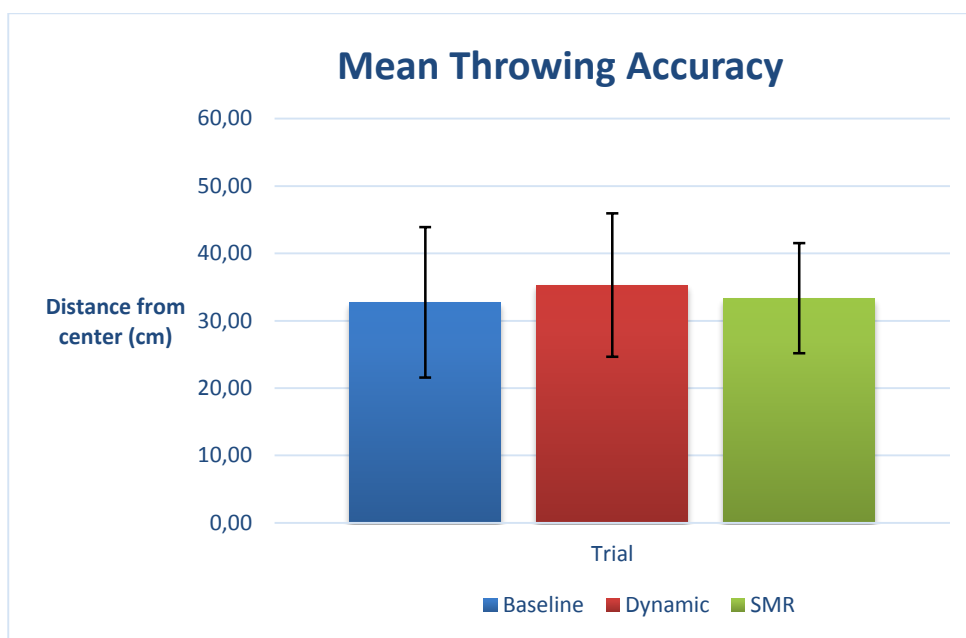


FIGURE 5. Mean throwing accuracy (distance from center of target) during baseline, dynamic stretch and SMR. Values are presented as means for all participants. Error bars shows the standard deviation.

## Shoulder Joint ROM

There was no significant difference between the three trials for either flexion ( $p = 0.11$ ), extension ( $p = 0.13$ ), internal rotation ( $p = 0.51$ ) or external rotation ( $p = 0.13$ ) (Table 4) between all participants.

TABLE 4. Comparison of active Range of Motion (degrees) for all participants (n=20) between trials. Values presented as mean  $\pm$  SD

Variable	Baseline	DS <sup>1</sup>	SMR <sup>2</sup>	p-value
Flexion	189 $\pm$ 10.46	183 $\pm$ 13.09	185 $\pm$ 9.44	0.11
Extension	31 $\pm$ 9.59	29 $\pm$ 10.03	35 $\pm$ 13.25	0.13
In-Rot <sup>3</sup>	37 $\pm$ 15.85	36 $\pm$ 9.95	34 $\pm$ 10.04	0.51
Ex-Rot <sup>4</sup>	104 $\pm$ 10.44	106 $\pm$ 10.50	109 $\pm$ 10.00	0.13

<sup>1</sup>DS = Dynamic Stretch, SMR = <sup>2</sup>Self Myofascial Release, <sup>3</sup>In-Rot = Internal Rotation; <sup>4</sup>Ex-Rot = External Rotation

## Correlation between ROM and Throwing Velocity/Accuracy

Shoulder extension and mean throwing accuracy measured after DS showed a moderate correlation ( $r = 0.618$ ;  $p = < 0.00$ ) indicating that players with greater shoulder extension had a lower mean accuracy than players with a more limited shoulder extension after DS. Otherwise there were no moderate or high correlations between any ROM-values and throwing accuracy or throwing velocity during baseline, DS or SMR (Table 5, Table 6).

TABLE 5. Correlation (r) between Range of Motion (degrees) and Throwing Accuracy / Velocity after Dynamic Stretch (DS) for all participants (n=20)

ROM	Peak Velocity r	p	Mean Velocity r	p	Peak Accuracy r	p	Mean Accuracy r	p
Flexion	0.078	0.74	0.081	0.74	0.155	0.514	0.223	0.34
Extension	-0.260	0.27	-0.249	0.29	0.381	0.098	0.618*	0.00
In-rot	-0.245	0.30	-0.216	0.36	-0.314	0.177	-0.152	0.52
Ex-rot	0.179	0.45	0.140	0.56	0.194	0.413	0.087	0.72

*In-rot = Internal Rotation, Ex-rot = External Rotation. \* = Moderate Correlation*

TABLE 6. Correlation (r) between Range of Motion (degrees) and Throwing Accuracy / Velocity after Self Myofascial Release (SMR) for all participants (n=20)

ROM	Peak Velocity r	p	Mean Velocity r	p	Peak Accuracy r	p	Mean Accuracy r	p
Flexion	-0.029	0.90	-0.040	0.87	0.297	0.20	0.459	0.04
Extension	-0.155	0.51	-0.208	0.38	0.276	0.24	0.297	0.20
In-rot	-0.004	0.99	-0.032	0.89	-0.154	0.52	-0.242	0.30
Ex-rot	-0.222	0.35	-0.292	0.21	-0.034	0.89	0.196	0.41

*In-rot = Internal Rotation, Ex-rot = External Rotation*

## Playing Experience and the Outcome of SMR and DS

### Velocity

The subjects were divided into two groups by the median of PE where nine players were categorized as low experience players with 6-9 years of PE (PE-low). Eleven players were categorized as high experience players with 11-20 years of PE (PE-high).

During baseline, there was a nine percent higher throwing velocity among the players in the PE-high group compared to the players in the PE-low group ( $87.55 \pm 8.70$  vs.  $81.44 \pm 6.84$  km/h;  $p = < 0.00$ )

A correlation between PE and the change in velocity was calculated. The difference between trials was calculated by comparing the experimental values to the baseline values (experimental

value – baseline value). A positive correlation shows that the more PE the players have, the more will the throwing velocity increase due to the treatment.

There was no correlation between PE and the change in peak throwing velocity during SMR ( $r = 0.22$ ;  $p = 0.36$ ) or DS ( $r = 0.28$ ;  $p = 0.23$ ) for the all subjects ( $n = 20$ ). Neither was there any correlation regarding PE and changes in mean throwing velocity during SMR ( $r = 0.09$ ,  $p = 0.70$ ) or DS ( $r = 0.135$ ,  $p = 0.57$ ) for all twenty subjects.

There was a moderate correlation between PE-low and change in peak throwing velocity after DS ( $r = 0.58$ ;  $p = 0.10$ ) indicating that among the PE-low players, the most experienced players were the ones who did elicit the greatest increase in peak throwing velocity after DS. Otherwise, there was no correlation between changes in peak or mean throwing velocity from either DS or SMR among PE-low and PE-high players (Figure 6, Figure 7).

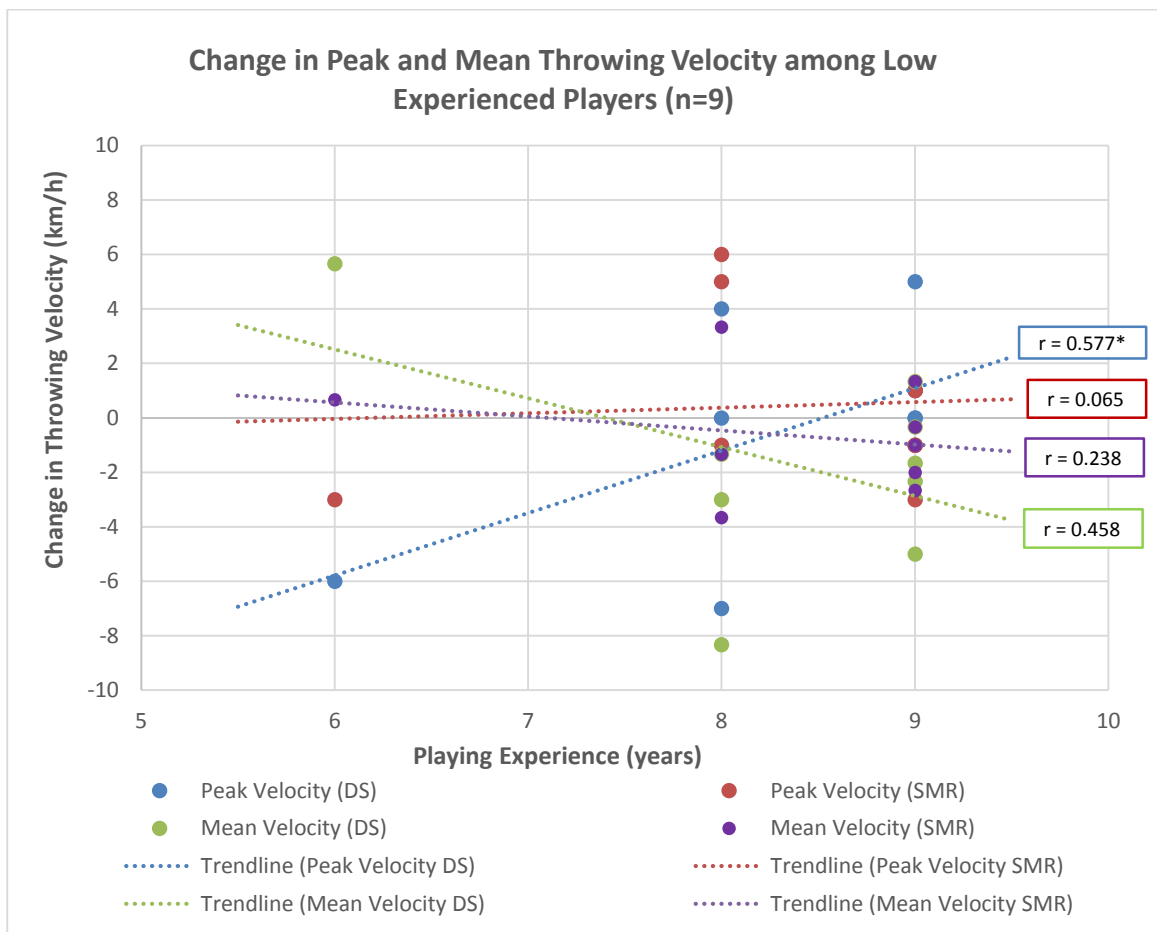


FIGURE 6. Relationship between PE and change in throwing velocity after SMR and DS among low experienced players (6-9 years of experience,  $n=9$ ). \* = Moderate correlation.

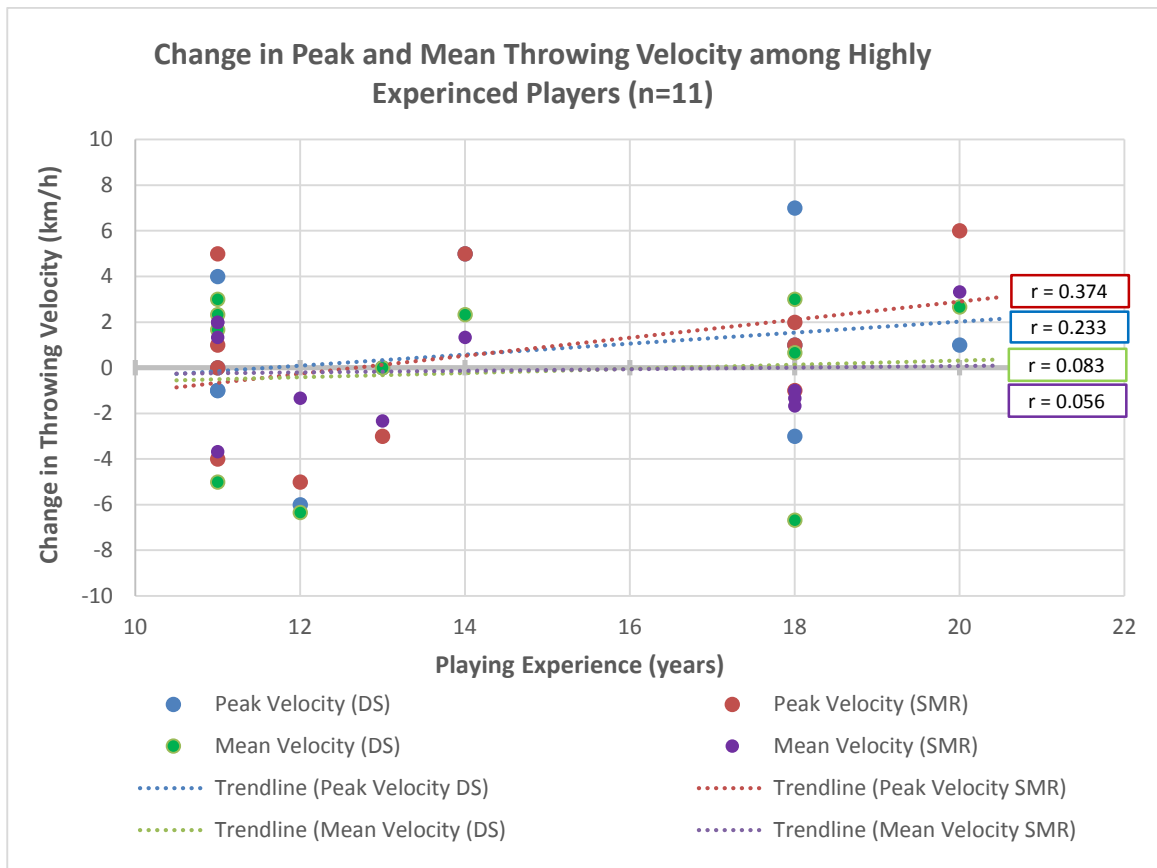


FIGURE 7. Relationship between PE and change in throwing velocity after SMR and DS among highly experienced players (11-20 years of experience, n=11).

## Accuracy

A correlation was calculated between PE and the change in accuracy calculated as the difference between baseline values and experimental values. A positive correlation shows that the more PE the players have, the more will the throwing accuracy decrease due to the treatment. A negative correlation indicates that the more PE the players have, the more will the throwing accuracy increase due to the treatment.

No correlation was found between PE and changes in peak accuracy during SMR ( $r = -0.463$ ,  $p = 0.04$ ) or DS ( $r = 0.393$ ,  $p = 0.09$ ) for all twenty subjects. Nor could any correlation between PE and the change in mean accuracy be found for all subjects during SMR ( $r = 0.141$ ,  $p = 0.55$ ) or DS ( $r = 0.435$ ,  $p = 0.06$ ).

The subjects were divided into two groups here as well. They were divided by low (6-9 years,  $n = 9$ , PE-low) or high (11-20 years,  $n = 11$ , PE-high) PE. There was a moderate negative correlation between PE-high and change in peak accuracy ( $r = -0.530$ ;  $p = 0.09$ ) during SMR indicating that the less experienced the players were, the more did their accuracy decrease due



to the SMR. There was also a moderate correlation between PE-high and change in peak accuracy ( $r = 0.501$ ;  $p = 0.12$ ) during DS, indicating that the less experienced the players were, the more did their accuracy increase due to the DS. No correlation could be found between PE and any changes in throwing accuracy among players in the PE-low group.

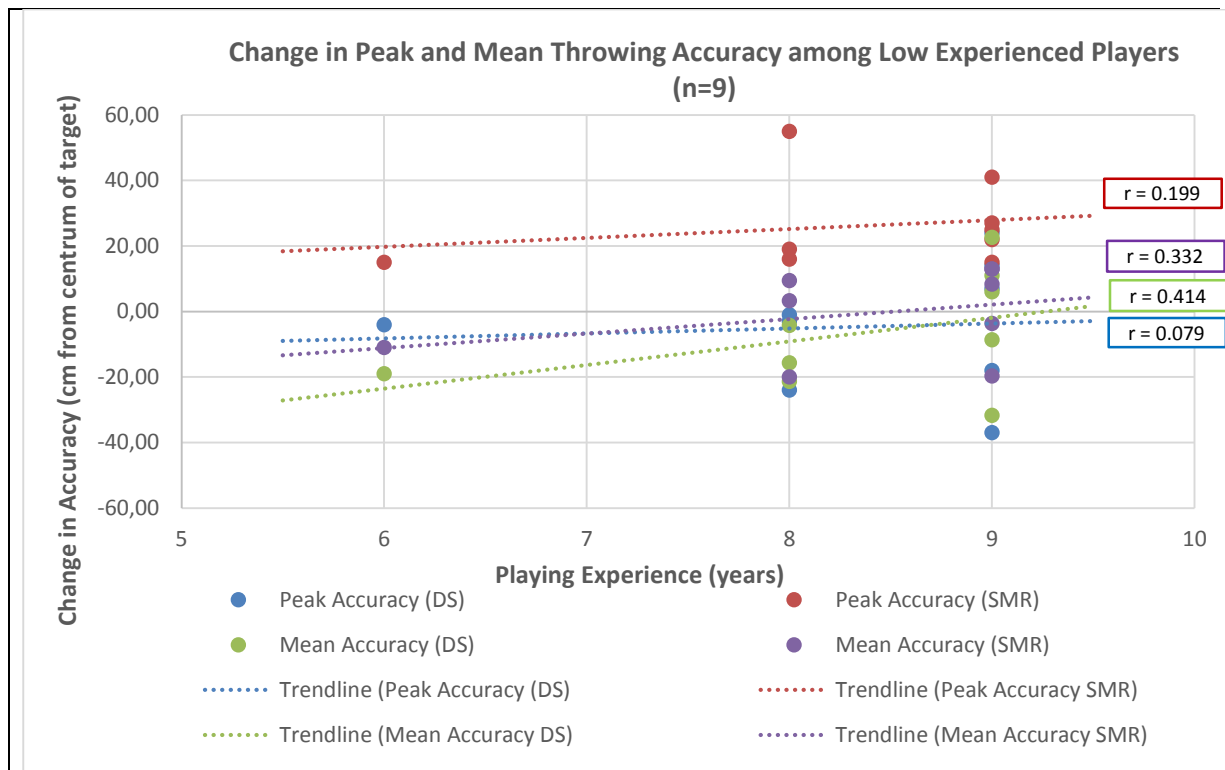


FIGURE 8. Relationship between PE and change in accuracy after SMR and DS among low experienced players (6-9 years of experience,  $n=9$ ). A positive value means that the handball struck the net further away compared to baseline and thereby accuracy decreased.

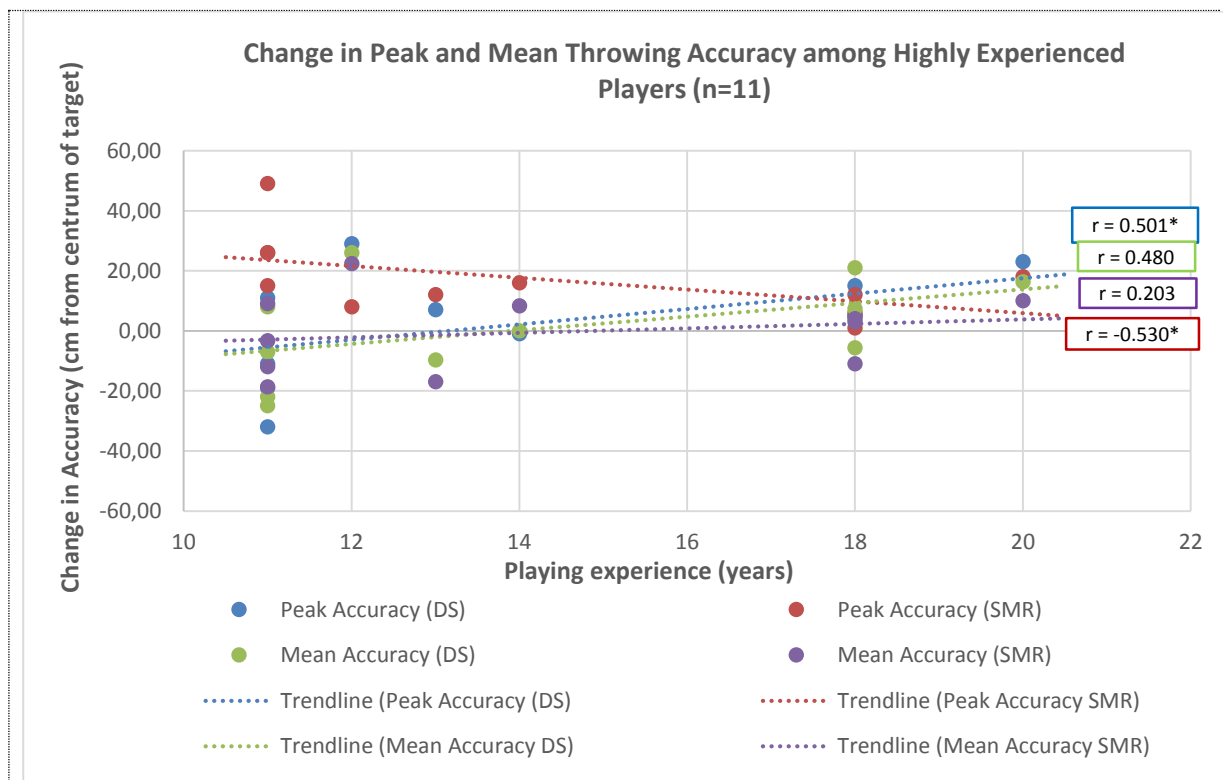


FIGURE 9. Relationship between PE and change in accuracy after SMR and DS among highly experienced players (11-20 years of experience, n=11). A positive value means that the handball struck the net further away compared to baseline and thereby accuracy decreased. \* = Moderate correlation.

## Discussion

To our knowledge, this is the first study to examine the effects of SMR on athletes. It is also, as far as we know the first study to examine the effects of SMR on the upper body and compare the results to a similar session of DS. The results show that two minutes of SMR or DS for the involved muscles during overhead throwing have no significant effect on throwing velocity or throwing accuracy compared to baseline values for all participants. The results also shows that the active shoulder ROM after an acute bout of SMR or DS does not differ significantly compared to baseline values among the elite handball players in this study. Even though the shoulder ROM does not differ between trials, there was a moderate correlation between shoulder extension and mean accuracy after DS, indicating that the greater shoulder extension, results in a decreased mean accuracy after DS. These results are not causal but might indicate that trying to increase the players shoulder extension with mobility exercises such as DS could be counterproductive and lead up to a reduced accuracy among elite handball players. Stratifying the sample based on PE gave inconclusive results.

Healey et al. (2014) used 30 seconds of SMR / muscle group for the lower limb and back and found no significant improvements in the performed athletic tests. Neither could MacDonald et al. (2013) find any significant differences in any neuromuscular performance measurements (muscle force, rate of force development and muscle activation) post 2, 1-minute trials of SMR for quadriceps. Sullivan et al. (2013) found no difference in MVC between SMR and the control group. However, twitch force decreased 7.1 – 10.5 % from pre- to post-SMR. MacDonald et al. (2014) measured vertical jump height and maximal voluntary contractile force which did not change while rate of force development and twitch force did both decrease by 23 % and 14 % 24 hour post SMR.

Throwing velocity or accuracy did not change for the subjects in this study which goes in line with the small or nonexistent differences in muscle contractile properties seen in earlier studies. The studies performed on DS and muscular performance by Torres et al. (2008) and Behm and Chaouachi, (2011) both shows that shorter durations of DS does not inhibit muscular performance. However, Leone et al. (2012) found that DS decrease maximal isometric peak force for pectoralis major and triceps brachii but does not affect the rate of force production which is more interesting during a dynamic movement. These results from earlier studies are in line with the results for throwing velocity and throwing accuracy between baseline and DS in

this study. No other studies have compared SMR to DS regarding athletic performance properties. This study is the first to investigate this and the results shows that there is no difference in throwing performance between SMR and DS.

The results in ROM for the subjects in this study is not directly comparable to results achieved in other studies because of differences in training experience between subjects and the time used during SMR. Sullivan et al. (2013) performed a five second SMR-session and a ten second SMR-session for the hamstring which increased hamstring and lower back ROM by 4.3 % and 6.6 % as measured by a sit and reach test. MacDonald et al. (2013) achieved a 12.7 % (10.6 degrees) improvement in passive knee joint ROM compared to baseline two minutes post 2, 1-minute trials of SMR for quadriceps. MacDonald et al. (2014) did not measure ROM directly after SMR. However, they did not achieve a significant difference in passive ROM for the quadriceps and hamstrings 24 hour post five SMR exercises performed for two minutes each. The measured differences are small but it seems as if a longer duration of SMR is more beneficial in order to increase ROM directly after SMR and that the improvements in ROM decreases by time.

There was a moderate correlation between shoulder extension and mean throwing accuracy measured after DS but no other correlations could be found. The difference in ROM between the trials shows that their overall rotational arc (internal rotation to external rotation) remains about the same during all trials (Baseline, 142°; DS, 142° & SMR, 143°). Earlier studies have investigated the correlation between external rotation and throwing velocity and found that there usually is a correlation between an increased external rotation and increased throwing velocity. There was however no difference in any measured ROM for the subjects, thereby, there was neither any correlation between external rotation and throwing velocity as shown by Van den Tillaar and Etterna (2004, 2007) & Wagner and Müller E (2008). There is a possibility that the overall rotational arc is a more important contributor to throwing velocity compared to internal- or external rotation only. Further studies is needed to confirm this hypothesis.

The group was divided by PE to investigate if there were any major differences in the measured throwing parameters between low vs. high PE. There was a nine percent higher throwing velocity among the experienced players during baseline which is in line with the results by Ziv and Lidor (2009). The most experienced players in the PE-low group were the ones who did elicit the greatest increase in peak throwing velocity after DS. The correlation was only moderate and the results may be affected by many other factors such as individual ROM,

previous injuries, training program and shoulder strength which should be taken into account. Unfortunately the group in this study was too small to stratify for all these variables whereby no certain results could be withdrawn.

In the PE-low group, you could hypothesize that it would be more beneficial for athletes with more PE to perform DS rather than SMR according to the correlation between PE and change in peak throwing velocity for these players. The correlations was however not significant whereby no certain recommendations can be made. No correlations could be found between PE and throwing accuracy during DS or SMR for PE-low. Further studies with larger sample groups is needed to draw any certain conclusions, due to the small sample size in this study.

There was no moderate or high correlations between PE and the change in throwing velocity for the PE-high group. There is a possibility that the more experienced players have got more adhesions between the muscles and the surrounding layers of fascia preventing normal shoulder functioning. Partly since the more experienced players most likely have performed more throws with higher throwing velocity than the less experienced players, resulting in higher degrees of soft tissue restrictions and that these restrictions needs a longer duration of SMR and/or higher mechanical pressure in order to loosen up.

Interestingly, there was a moderate correlation between PE-high and the change in peak accuracy during DS indicating that DS will decrease the player's accuracy the more experienced the players are. However, there was an opposite moderate correlation during SMR which shows that peak accuracy seems to decrease with SMR the less experienced the players are. The results are inconclusive but if these data can be reproduced it seems as if SMR might be more beneficial for the most experienced players when it comes to improving peak accuracy for subjects with a PE of 10 years or more.

Overall, there was no major differences during either SMR or DS for all participants and stratifying the sample based on PE gave interesting but inconclusive results showing that the more experienced players in both groups decreased their mean and peak accuracy during both DS and SMR compared to the less experienced players, except for peak accuracy during SMR which increased among the more experienced players in the high PE group. In an attempt to summarize the inconclusive result it seems as if an acute bout of SMR or DS decreases accuracy and might therefore be counterproductive for experienced handball players. However, the more

experienced players in both the PE-low group and PE-high group did increase their peak throwing velocity the most which might be more beneficial for the players. However, you should remember that the correlations that are found are only moderate and the results depending on PE are somewhat inconclusive.

Neither ROM, throwing velocity or accuracy differed significantly between SMR and DS. However, it would be interesting to record muscle activation with surface electromyography (sEMG) to see if the activation of the stabilizing muscles surrounding the shoulder joint increased. Grezios et al. (2006) stated that in order to maximize the effect from SSC, the muscle must be pre-activated. Although the throwing velocity did not increase, the overall stability around the shoulder joint might have increased and thereby leading to a reduced risk of injuries as discussed by Gurinder (2011) & Edouard et al. (2013). Further studies measuring muscle activation with EMG around the shoulder joint is needed in order to control for this.

## Method Discussion

The overhead throwing motion involves a lot of muscles which is sequentially activated in order to maximize throwing velocity. At the same time, a lot of muscles around the scapula work synergistically to the agonist and antagonist muscles during an overhead throwing motion. This complexity makes it difficult to perform the myofascial release with a foam roller on a single muscle. There is probably more beneficial to use a smaller tool such as a tennis ball to reach and affect each muscle individually.

One possible explanation for the effects in muscle-length tension that has been observed earlier could be the increased soft tissue temperature (Clark and Russell, 2009). In order to exclude the increased soft tissue temperature as a confounding factor in this study, the DS group was used as a control group since the DS would increase soft tissue temperature in a similar way as SMR (Behm and Chaouachi, 2011). However, SMR and DS do affect the soft tissue in different ways and the two types of soft tissue mobility exercises are not directly comparable.

The abnormal crosslink and scar tissue formation within the fascia surrounding the shoulder joint are most likely to be found among elite handball players as a result from repeated strenuous movement. SMR works mechanically by applying a direct pressure towards soft tissue. The hypothesis is that this applied direct pressure would be enough to shear out the scar tissue and abnormal crosslinks and reduce fibrous adhesion between the layers of fascia. Whether the

fascia becomes more pliable as a result of changed tonus regulation, proposed by Schleip (2003) and/or due to the extruded water after the compression showed by Klinger et al. (2004) and Schleip et al. (2012) is yet to be determined. However, the duration of mechanical stress application from this treatment may have been too short in order to elicit any significant changes despite a sufficient pressure according to earlier studies where it has been calculated that mechanical stress forces ranging from 24-115kg would be high enough to cause a more pliable tissue (Threlkeld, 1992).

Subjects in this study were instructed to put as much of their bodyweight as possible on the foam roller leaving nothing but hands and feet in the ground to offset weight. The mechanical stress application was only applied for 30 seconds / exercise but the mean bodyweight of 85 kg should have been high enough to create a sufficient mechanical force in order to induce a more pliable tissue. However, the foam roller in this study was not as rigid as the one used by Curran et al. (2008), leading to a decrease in pressure since the contact area increases when the roller deforms under the participants bodyweight.

The theory described by Schleip et al. (2012) propose that the fascia acts as a sponge with a “window of opportunity” for increased mobility/flexibility during the time where the water is being extruded during SMR and before its refilling is interesting. The result from this study did not show any increases in ROM. That is maybe because we did use SMR as a tool to see if it would increase ROM directly after the treatment. But according to the theory proposed by Schleip and colleagues (2012), it would be necessary to use some kind of mobility drill directly after the SMR-session in order to obtain any increase in mobility. This is of interest during further studies that are recommended to use SMR and stretch in combination.

Another potential limitation in this study was the inability to control pressure exerted on the foam roller. A pressure carpet like the Tekscan system used by Curran et al. (2008) would have been beneficial in order to control for individual pressure variances between subjects.

We did however use a numeric pain rating scale (NRS) as a tool to see if the subjects perceived pain were similar for the group. NRS is the preferred subjective pain scale for assessing pain intensity among adults (Hjermstad et al. 2011) and earlier studies have used the NRS-scale as a test to test measurement tool to control for perceived pain based on muscle soreness (MacDonald et al. 2013). You could hypothesize that the athletes’ similar training schedules and training programs would put a similar strain on their bodies. This similarity should in return result in a similar muscular stiffness and fascial adhesions among the players and thereby a

similar pain rating within the group for each exercise as long as they put an equal pressure on the foam roller. The NRS-scale was in this case used to see if the players used an equivalent soft tissue pressure. However, the results from the NRS-scale was scattered and no conclusion could be drawn from the NRS-score. The NRS-scale is still just a subjective tool and individual variances in how the subjects perceive pain, individual soft tissue stiffness and amount of pressure put on the foam roller could explain the outcome variance. The results from the NRS showed that there was a wide variety of pain ratings (Range (0-10), m.latissimus dorsi 3-9, m.teres major/minor 2-9, thorax 0-7, m.m.rhomboideus 1-5) among the players. In order to control for any perceptual bias, only subjects who had no prior experience with SMR for the upper body were recruited. However, there is a possibility that the players' subjective perception of pain could have altered how they performed.

During measurements of ROM, a gravity reference inclinometer (Myrin) was used, this measurement device have been used previously and have been shown to have good intra- and interrater reliability, but only for cervical ROM (Malmström et al. 2003). There seems to be a difference in reliability depending on which joint that is being measured. Gajdosik and Bohannon (1987) discussed the fact that "reliability of measuring ROM is specific to the action measured and to regional structure and function" (Gajdosik and Bohannon, 1987). The shoulder joint is a multidirectional ball and socket joint with a large ROM-span. Even though the measurement procedure was standardized, there is a possibility that the reliability of the shoulder joint measurements are much lower compared to cervical range of motion, which in turn results in a larger measurement error. It was difficult to read the exact value from the goniometer during ROM-testing so there is a possibility that a  $\sim 5^\circ$  error margin was present during all measurements which would explain the difference in ROM between trials. Malmström et al. (2003) showed that the Myrin measurement device has got an error margin of 3.6% to 7.6% for intratester reliability. Thus, since shoulder ROM for the different measurements varied between 29 degrees during extension up towards 189 degrees during flexion, then 3.6% to 7.6% error would equal about 1-2 degrees during extension and as much as 7-14 degrees during flexion.

Instructions to the players could have been an affecting factor, but since the participants were highly experienced players they were categorized as expert throwers and their accuracy would not have been affected by the instructions to throw as fast as possible according to earlier studies (Van den Tillaar and Ettema, 2003, 2006).



The time of 30 seconds of both SMR and DS was chosen since the aim was to see if an acute and short term session of SMR would lead to any performance enhancements. It is of interest to have a time efficient treatment that could be used shortly before game and / or during half-time. Earlier studies have used between five seconds and two minutes of SMR on each muscle without any increase in muscle activation, there has however been significant increases in ROM (Healey et al. 2014; MacDonald et al. 2013 & Sullivan et al. 2013). An increased ROM would most likely be beneficial for handball players in order to increase throwing velocity. However, there were no significant differences in ROM among these subjects. DS still remains as the recommended and preferred specialized warm up before throwing since it does not require any equipment in comparison to SMR. This was however the first study investigating the effects of SMR on experienced athletes and further studies is needed to draw any certain conclusions regarding its efficiency during upper body performance on athletes

## Conclusion

Based on the result of this study we conclude that an acute bout of upper body SMR does not affect ROM and does not improve throwing velocity or throwing accuracy compared to baseline or DS among elite male handball players. Neither could any correlation between ROM and throwing velocity or throwing accuracy be observed. Further research is needed to prove if there are any differences in the outcome from SMR and DS among players with varying PE since no certain recommendations can be withdrawn from the data in this study.

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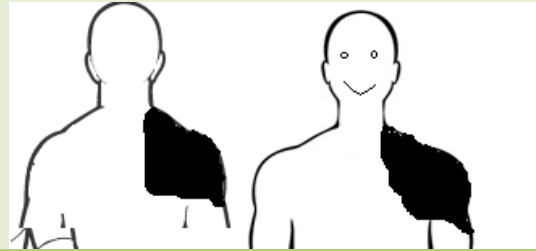
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## Till dig som är aktiv handbollsspelare

Fråga	
1	<ul style="list-style-type: none"><li>▪ <u>Kön</u><ul style="list-style-type: none"><li>○ Man</li><li>○ Kvinna</li></ul></li></ul>
	<ul style="list-style-type: none"><li>▪ <u>Vikt</u> _____kg      <u>Längd</u> _____cm</li></ul>
2	<ul style="list-style-type: none"><li>▪ <u>Vilket år är du född?</u> 19 _____</li></ul>
3	<ul style="list-style-type: none"><li>▪ <u>Vilken spelarposition har du?</u> _____</li></ul>
4	<ul style="list-style-type: none"><li>▪ <u>Hur länge har du spelat/tränat handboll?</u> _____år</li></ul>
5	<ul style="list-style-type: none"><li>▪ <u>Hur många timmar tränade du handboll under en vecka under perioden januari – juni?</u> _____Stycken</li></ul>
6	<p><i>Definition: Med skada avses smärta och/eller funktionsnedsättning som uppkommit i samband med träning/match och därefter omöjliggjort fortsatt idrottsutövande under minst 4 dagar</i></p> <ul style="list-style-type: none"><li>▪ <u>Har du under de senaste 6 månaderna varit skadad i den axel/skuldra (se bild) som du använder för att kasta?</u><ul style="list-style-type: none"><li>○ Ja</li></ul></li></ul>

☐ Nej



7

▪ Om du svarade ja på fråga 6, vilken typ av skada var det? Kryssa i ett eller flera alternativ som stämmer in på dig.

- ☐ Överbelastningsskada
- ☐ Luxation (axeln ur led)
- ☐ Fraktur
- ☐ Inklämningssyndrom (Impingement)
- ☐ Annat, beskriv: \_\_\_\_\_

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8

▪ Har du tidigare använt eller använder du SMR/Foamrolling?

- ☐ Ja
- ☐ Nej

*Härmed intygar jag att de svar jag lämnat är sanningsenliga. Jag godkänner att de uppgifter jag lämnat får användas i studien:*

Datum

Namn-teckning

Namn-förtydligande

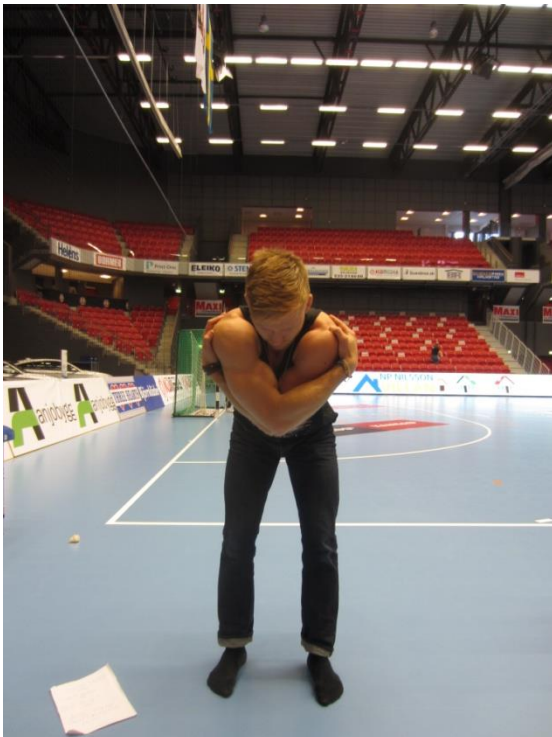
Appendix 2 – Pictures showing the four dynamic stretching exercises

Sleeper stretch

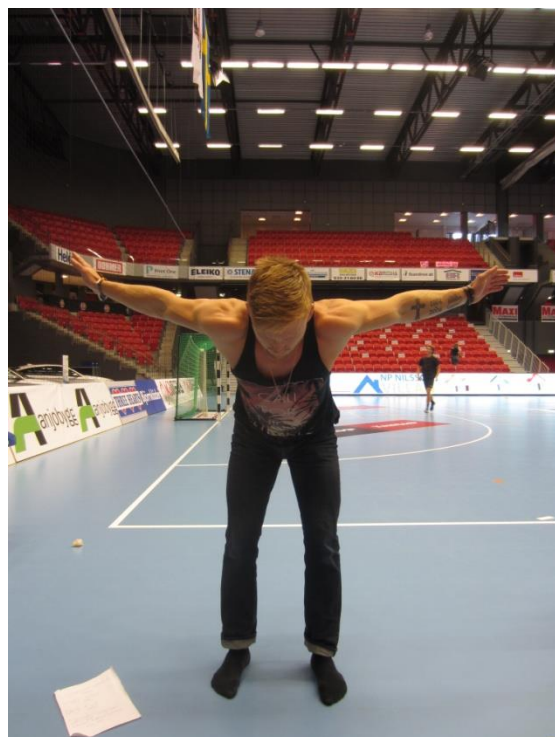


Phelps stretch

Start

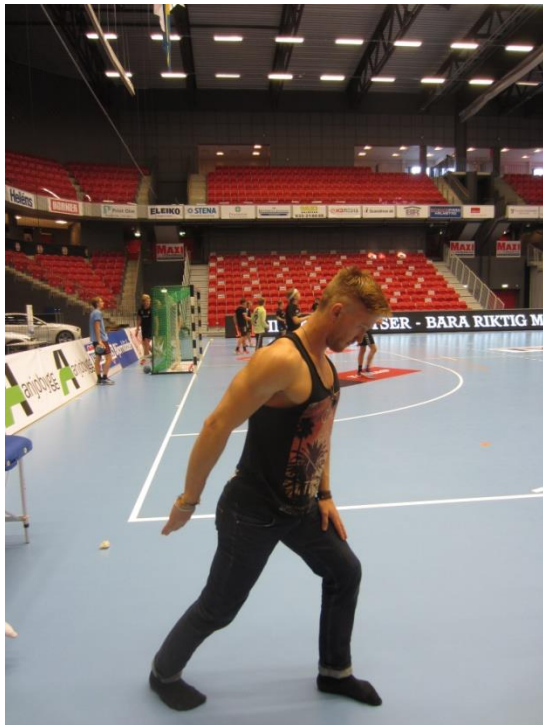


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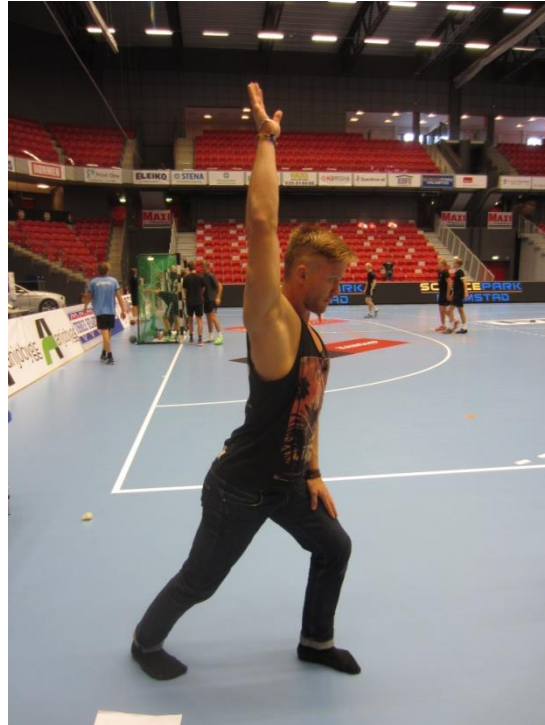


## Overhead backward arm swings

Start

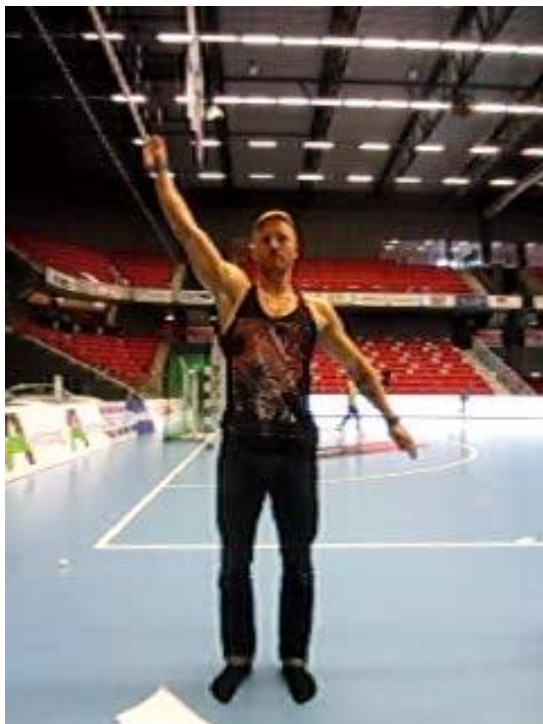


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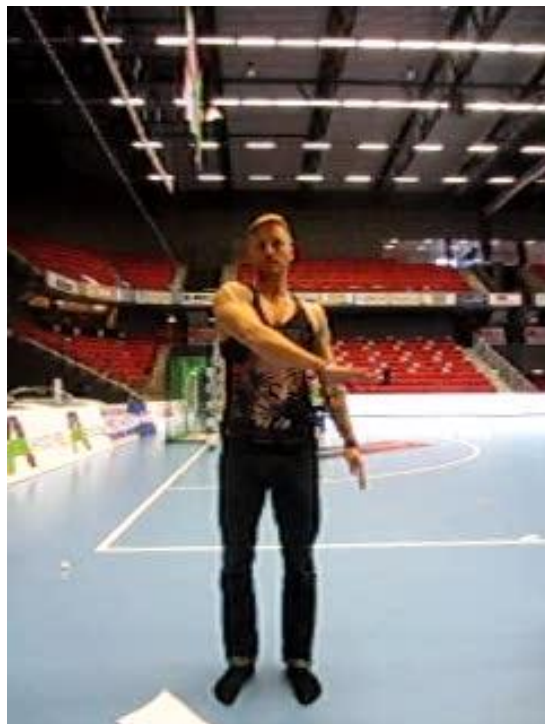


## Window washers

Start



Finish



## **Informerat samtycke för dig som testperson i studien –**

“A Comparison Between Foam Rolling and Dynamic Stretch on Throwing Velocity and Accuracy Among Male Handball Players?”

### **Bakgrund & Syfte**

Mitt namn är Tommy Ivarsson, jag studerar Biomedicin – inriktning fysisk träning på magisternivå på Högskolan i Halmstad (HH) och denna studie görs som min D-uppsats under utbildningen.

Handbollsspelare på elitnivå bör vara kapabla till att utföra kastörelser med hög hastighet och bra pricksäkerhet för att prestera. Styrka, explosivitet och rörlighet är nyckelfaktorer när det gäller prestationen hos spelarna. För att kunna uppnå maximal kasthastighet behövs bra rörlighet ihop med en välbalanserad muskulatur kring axelleden. Stram muskulatur kan förhindra spelaren från att utföra explosiva kast med god siktesförmåga. Tyvärr är skador i axelpartiet vanligt förekommande, främst på grund av kastörelsen som utförs vid spel men även på grund utav dålig muskelstabilitet och rörlighet. Self Myofascial Release (SMR) är en teknik för att på kort tid och på egen hand med självvald belastning mjuka upp muskler och fascia i syfte att öka rörligheten. Den ökade rörligheten i berörd muskulatur kan därmed ge möjlighet till snabbare och eventuellt mer pricksäkra skott. Detta är dock inte studerat tidigare och ett behov av detta finns därför.

### **Förfrågan om deltagande**

Du som läser detta är tillfrågad om du vill delta i studien då du spelar handboll på elitnivå inom Drott HK i Halmstad.

### **Hur går studien till?**

Du kommer under tre tillfällen att värma upp enligt era rutiner. Vid tillfälle nummer ett kommer kasthastighet och pricksäkerhet testas utan SMR eller stretching, under andra tillfället kommer samma procedur utföras fast med SMR-behandling kring axelpartiet innan testet och vid tredje tillfället kommer du utföra dynamisk stretching kring axelpartiet. Du kommer även att få fylla i ett frågeformulär med frågor om din ålder, vikt, kön, skadehistorik etc.

Det hela beräknas ta ungefär 30 minuter där 10 minuter är uppvärmning, 5-6 minuter är stretching/SMR, 10 minuter information + kastande och därefter ett par minuter för att fylla i formuläret som delas ut. Alla tester och mätningar kommer att utföras under ordinarie schemalagd träningstid i Halmstad Arena idrottshall.

### **Risker**

SMR-behandlingen kan upplevas som smärtsam men då du själv väljer belastningen och tryck som du lägger på musklerna så kommer du kunna reglera smärtupplevelsen.

### **Fördelar**

En ökad kunskap inom området är viktigt för både spelare och tränare i syfte att optimera träningsresultaten och effektiviteten under träning. Om SMR-behandlingen visar sig ha en positiv effekt på kasthastighet samt pricksäkerhet kommer det vara en tidseffektiv metod för att öka dessa parametrar inför träning och match.

**Hantering av data och sekretess**

Data från undersökningstillfället kommer att hanteras enligt personuppgiftslagen § 10 och förvaras skilt från personuppgifter. Inga utomstående har tillgång till datan och resultaten redovisas som medelvärden på gruppnivå, utan möjlighet att identifiera individer. Du har rätt att få ta del av undersökningsresultaten om det önskas. Huvudman för projektet är Högskolan i Halmstad.

**Frivillighet**

Du kan när som helst avbryta ditt deltagande och har då rätt att begära att all insamlad data som kan härröras till dig personligen ska förstöras. Om du under studiens gång vill ändra ditt samtycke gällande insamlad data är du välkommen att kontakta ansvarig person för studien.

**Information om studiens resultat**

Resultaten ifrån studien kommer att presenteras i en magisteruppsats på HH. Du är välkommen att själv komma till presentationen, du kan även få arbetet skickat till dig när det är färdigt om så önskas. Kontakta mig då enligt nedan.

*Med vänliga hälsningar*

Tommy Ivarsson

**Ansvariga**

Forskningshuvudman – Högskolan i Halmstad

Handledare – Anette von Porat, Leg. Sjukgymnast, Doktor i Medicinsk Vetenskap, Idrottsskadecentrum i Helsingborg, Telefon 070-7982116.

Ansvarig för genomförande och analys av studien:

- Tommy Ivarsson
- Telefon – 0735341781
- E-post – tomiva09@student.hh.se

## **SAMTYCKE TILL DELTAGANDE I FORSKNINGSTUDIE**

*Nedan ger du ditt samtycke till att delta i den studie där jag utvärderar effekterna från en SMR-behandling på kasthastighet och pricksäkerhet. Läs igenom detta noggrant och ge ditt medgivande genom att skriva under med din namnteckning längst ned.*

### **Medgivande**

- Jag har tagit del av informationen kring studien och är medveten om hur den kommer att gå till och den tid den tar i anspråk.
- Jag har fått tillfälle att få mina frågor angående studien besvarade innan den påbörjas och vet vem jag ska vända mig till med frågor.
- Jag deltar i denna studie helt frivilligt och har blivit informerad om varför jag har blivit tillfrågad och vad syftet med deltagandet är.
- Jag är medveten om att jag när som helst under studiens gång kan avbryta mitt deltagande utan att behöva förklara varför.
- Jag ger mitt medgivande till Högskolan i Halmstad att lagra och bearbeta den information som är insamlad under studiens gång.

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*Deltagarens namnteckning*

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*Ort & Datum (ÅÅMMDD)*

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*Namnförtydligande*

## **Tack för ditt deltagande!**

Tommy Ivarsson, Högskolan Halmstad & Anette von Porat, Idrottsskadecentrum i Helsingborg.





Human performance and the way in which it can be affected is truly interesting. I will continue to use the scientific process together with the experience and knowledge that I've gathered and use it in order to help athletes increase their performance, step by step.



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