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DOES A PRE EVENT UPPER LIMB MASSAGE EFFECT SPEED, AGILTIY AND COUNTERMOVEMENT JUMP PERFORMANCE IN FEMALE FIELD HOCKEY PLAYERS

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Abstract

Background- Massage is frequently utilized with a sport science setting however there is little evidence that supports its effectiveness (Goodwin, 2007). Field hockey is a commonly played sport however there is a sparse amount of data that provides information on physiology and time motion analysis which are essential in order to develop valid and effective training sessions (Hawley & Burke, 1998) and areas such as sports massage.

Aim- No previous research has identified the effect of an upper limb massage of speed, agility and countermovement jump in female field hockey players.

Participants- Eleven female participants from the 1st and 2nd squads at University of Wales Institute, Cardiff (UWIC) participated in this study.

Design- A randomised cross over design was implemented. Participants were not provided with their performance data in order to eradicate any systematic bias.

Methods- All participants took part in three interventions of dynamic warm up only (DWUO), massage only (MO) and dynamic warm up and massage (DWUAM) before completing three field tests of 30m sprint; countermovement jump (with arms) and pro agility. Each participant completed three trials of each test and testing took place across a three day period.

Results- Data was analysed using SPSS (Chicago, IL, USA) and statistical difference was reported as $p<0.05$. No significant difference was found between all interventions of DWUO, MO and DWUAM across the 30m sprint, countermovement jump or pro agility. Split times recorded also showed no significant difference between intervention group ($p>0.05$)

Conclusion- Massage cannot be advertised as beneficial to enhance performance and that a greater amount of time should be spent on the warm up prior to a game or race. Greater emphasis should be placed on sprinting technique by coaches in training sessions with a view to increase movement efficiency in team sports performers.

Key Words- Massage, upper, limb, pre performance, sprint, countermovement jump, pro agility, tapotement, vibrations

CHAPTER I:

INTRODUCTION

1.0. <u>Introduction</u>

Team sports are characterized by high intensity bouts of energy which include sprinting, cruising, combined with low intensity activity (i.e. walking, jogging) or passive recovery (i.e. standing). Within such movement patterns, many team sports require participants to produce near or maximal sprints of a short duration combined with multiple accelerations, decelerations, turning ability and directional change consistently throughout a match duration (70- 90 minutes) The mean distance and duration of sprints of field team sports is recorded to be between 10-20m and 2-3 seconds with a variance of between 20-60 sprints across a distance of 700-1000m per match (Bishop *et al.*, 2001; Bishop *et al*, 2003; Spencer, 2005).

Despite being a commonly played sport, there has been very little research and thus knowledge surrounding field hockey in comparison to other team sports such as football and rugby union. However, without an understanding of sporting demands, valid and effective training sessions cannot be developed (Hawley & Burke, 1998) in order to expand knowledge of field hockey and progress areas in an applied sports science settings such as sports massage.

Field hockey has been described as continuous and therefore more demanding on the body's aerobic system however involves frequent interchanges with the anaerobic system in order to produce quick bursts of movement, correlating to approximately 1000 changes in activity throughout the course of a game (Reilly & Borrie, 1992; Lothian & Farrally, 1992). Time motion analysis research on female field hockey is scarce and unreliable due to progressions in rules, equipment and playing surface which consequently have heavily influenced the physiological demands of the game (Macloed *et al.*, 2007; Boddington *et al*., 2002). These rule changes include the use of continuous substitutions, the abolition of the offside rule and the use of water based playing surfaces (MacLoed *et al*., 2007 p 2). The progression in equipment in term of stick developments has ensured the same muscular input produces a greater control of the ball and a greater impact and velocity of shot on contact with the ball (Reilly & Borrie, 1992). The most recent research by Spencer *et al.,* (2004) identified sprint duration lasted 1.8 seconds with a frequency of 30 sprints per game with average recovery period of 140 seconds between sprint activities for all players.

There is a lack of relative massage research and an even smaller sample still that relates to field hockey. Massage is claimed to have both calming and stimulating properties and is often used in a pre, intermediate or post event setting, despite a lack of empirical evidence that shows it as a performance enhancement mechanism (Goodwin *et al*., 2007, p 1028). Massage should be tailored to meet individual needs for specific goals (King, 1993). For the purpose of the study, stimulatory methods need to be incorporated within the massage protocol in order to achieve optimal performance potential across testing in countermovement jump, 30m sprint and pro agility tests. Tapotement is a percussive massage technique that is applied to the body vigorously (Goats, 1994 p 150). The purpose of tapotement is to vibrate tissues, trigger cutaneous reflexes and cause vasodilatation, which can also stimulate muscle contractility (Goats, 1994 p 150). Vibrations, on the other hand, are a massage technique which is generally used to encourage circulation, facilitate muscle relaxation and stimulate nerve endings (King, 1993). It is also considered to decrease muscle tone (Callaghan, 1993) however, when applied vigorously is thought to increase muscle tone which justifies its use as a method for enhancing performance.

On the whole there is no specific consensus on the technique, application, intensity, or duration of massage application prior to training or competition in order to achieve optimum performance potential (King, 1993; Paine, 2000, Weerapong *et al*., 2005; Goodwin, 2007) which could suggest the inconclusive results apparent of previous research. This study is going to look at the effect of a stimulatory upper limb massage with a view that speed, agility and countermovement jump performance will improve. Speed can be calculated by stride frequency X stride length. By increasing either or both components it can be expected that a greater speed can be generated (Brown & Ferrigno, 2005). Increased arm drive is the desired effect of the pre performance massage. Although the upper limb is not the main contributor of speed, it is however required to maintain body alignment via vigorous and co-ordinated arm movements as well as influencing balance and arm drive (Mann, 1983; Chapman, 2008; Brown & Ferrigno, 2005). This is thought to be particularly important during the acceleration phase which is relevant to field hockey in terms of sprinting distance. It has been suggested that a vigorous arm drive will assist forward drive in sprinting (Lockie *et al.,* 2003). Bhowmick & Bhattacharyya (1988) found that the horizontal acceleration of the arm swing helps to increase stride length and regulate leg movement, while the upward motion of the arm swing assisted with an enhanced leg drive. This justifies common belief that the muscles of the upper limb, in particular the shoulder flexors and extensors require strength training for much the same reasons as lower limb muscles (Chapman, 2008 p125).

Similarly, the upper limb has been proven to increase jump height through the use of arm swing (Lees *et al.*, 2004; Harman *et al.*, 1990). However, in field hockey, sport specific variables such as dribbling with the ball, running in a bent over position (even when not directly involved in play), carrying a hockey stick (approximately 600-750 grams) and the arm and shoulder exercise from using the hockey stick are all known to increase energy expenditure and hinder sprinting mechanics (Reilly & Seaton, 1990; Lothian & Farrally, 1992; Reilly & Borrie, 1992). Despite this, if the upper limb is more stimulated prior performance by increasing the frequency component of speed, this will potentially assist improvements on the stride frequency component of speed, with a view to increase overall performance. From this, it can be hypothesised that the effect of an upper limb massage will effectively increase jump height, sprint times and pro agility times in female field hockey players.

CHAPTER II:

LITERATURE REVIEW

2.0. Literature review

2.1. Time motion analysis

Many studies have investigated the distance, duration and frequency of the common movement patterns in field based teams over the last few decades (Spencer *et al*., 2005). Time motion analysis is important as without such information, the requirements of a sport in terms of physiological and movement demands cannot be quantified (Spencer *et al.*, 2005).

Spencer *et al*., (2005) recommended that movement patterns should be distinctly coded into activities of standing, walking, jogging, striding and sprinting in order to make meaningful comparisons between studies. This methodology is fairly constant in recent time motion analysis studies in field hockey which is beneficial as they are under the rules of the modern game (Boddington *et al.*, 2002; Spencer *et al.*, 2004; Spencer *et al.,* 2005; Macloed *et al.*, 2007). From this a variety of results have emerged between variables such as sprint duration, sprint frequency and recovery between sprints in previous time motion analysis studies on field hockey. The first study conducted by Lothian & Farrally (1994) found sprint duration lasted 3.1 seconds at a frequency of 75 times over a 70 minute match with an average recovery time of 56 seconds between sprint activities. Research under modern rules portrays a different collection of findings. Spencer *et al.,* (2004) showed sprint duration lasted 1.8 seconds with a frequency of 30 sprints per game with average recovery period of 140 seconds between sprint activities for all players. However, 25% of the recovery periods recorded was less than 21 seconds duration (Spencer *et al.*, 2004). The most likely explanation of this is the influence of playing surface and the elimination of the offside rule. These changes were initiated to promote fast-paced, continuous play and have significantly decreased recovery periods for every player except the goalkeeper (Murtaugh, 2001 p 201).

The most recent field hockey study by MacLeod *et al.,* (2007) showed that the amount of time spent in low intensity activity (classified as standing motionless, walking and jogging) was 92.1 ± 7.4% in comparison to high intensity bouts (classified as cruising, sprinting and lunging) which was 7.9 ± 1.2% during three games of women's English National League standard field hockey . This differs to a study by Boddington *et al*., (2002) who found that 97% of match time was spent in low intensity activity compared to 3% of high intensity activity, similarly observed across a 3 game duration in female field hockey players as identified by MacLoed *et al.,* (2007). However, MacLoed *et al.,* (2007) incorporated a lunging motion category within their classifications of high intensity activity which may have resulted in the differentiation of results. Although lunging is a common movement pattern in field hockey, this variable is not apparent in previous time motion analysis studies concerning field hockey. These findings vary greatly from data collected by Lothian & Farrally (1994) who reported 78% of low intensity activity during observation from 12 female players who also competed at national league standard. This alone indicates the change in the nature of the game over time due to several rule, equipment and playing surface progressions, for example, the abolition of the offside rule and the introduction of synthetic surfaces, which has consequently changed the physical demands of the game (Boddington *et al*., 2002; MacLoed *et al.*, 2007). Due to such developments, early research relating to field hockey could be classified as unreliable as it has not been played under modern rules. Generally, limited research has highlighted field hockey in terms of time motion analysis and physiology which could be foreseen as the foundation for developing other support science areas such as specific training programs or the implementation of massage therapy, of which there are minimal studies.

2.2. Sports Massage

There is a lack of relative massage research and an even smaller sample still that relates to field hockey. Massage is claimed to have both relaxing and stimulating properties and is often used in a pre, intermediate or post event setting, despite a lack of empirical evidence that shows it as a performance enhancement mechanism (Goodwin *et al*., 2007, p 1028). To date, there is a sparse amount of research regarding the effects and efficiency of using massage to aid performance**.** Pre event massage aims to physically and mentally prepare an individual for upcoming activity (Benjamin & Lamp, 2005). It is physiologically proposed to benefit performance by increasing circulation and therefore providing a greater oxygen supply to a given area, as well as reducing muscular tension and increasing range of motion

(Benjamin & Lamp, 2005; King, 1993). The first study to investigate the effects of pre event massage on performance was undertaken by Wiktorsson- Moller *et al*., (1983). They aimed to promote relaxation among the muscle groups however massage showed to decreased muscular strength in the lower extremity when examined using isokinetic measures. Despite this, a sample of eight males was used and the massage techniques used were unidentified therefore the results can not necessarily be deemed reliable. Similarly, Barlow *et al*., (2004) found that a hamstring group massage did not significantly increase performance of the sit and reach test of eleven active males using effleurage and petrissage techniques. However, it was noted that participants with original low scores (<15 cm) from the original sit and reach testing had a greater reach following the massage intervention which suggests that massage had a beneficial effect on performance for participants with low flexibility levels. This is in agreement with the most recent study by Arabaci (2008), who found that 10 minutes lower limb Swedish massage positively influenced sit and reach test performance in 24 active males however, had an adverse effect on vertical jump, speed and reaction time. As the sample size was larger, these results are suggested to be more reliable.

For the purpose of the study, stimulatory methods need to be incorporated within the massage protocol in order to achieve optimal performance potential. Tapotement and vibration techniques, which are commonly implemented into pre performance massage protocols, are designed to create a stimulatory effect and enhance an athlete's state of readiness (Cash, 1996; Benjamin & Lamp, 2005) rather than encourage reduction in muscular tension or increase range of motion. Tapotement can be defined as a percussive massage technique that is applied to the body vigorously (Goats, 1994 p 150). The purpose of tapotement is to vibrate tissues, trigger cutaneous reflexes and cause vasodilatation, which can also stimulate muscle contractility (Goats 1994 p 150). This justifies its wide use as a performance preparation method. Vibrations on the other hand, are a massage technique which is generally used to increase venous and lymphatic circulation, facilitate muscle relaxation, stimulate nerve endings and decrease muscle tone (Callaghan, 1993; King, 1993). However, in a pre performance setting it can be used vigorously to create a stimulatory effect (Cash, 1996) for target muscle groups prior to competition.

McKechnie *et al.,* (2007) investigated the effects of tapotement and petrissage techniques on plantar flexor and ankle joint power and flexibility levels in nineteen male participants. With tapotement, they found no significant results in power measures however suggested that massage increased flexibility in the plantar flexors without having an influence on power output. This suggests a positive effect as a result of petrissage and tapotement techniques. There is a lack of studies that have utilised the use of manual vibratory techniques within a massage protocol. Most studies have used mechanical means of vibratory stimulation (Issurin & Tenebaum, 1999; Cafarelli *et al*., 1990; Cohrane & Stannard, 2005). Issurin & Tenebaum (1999) and Cafraelli *et al.,* (1990) found no significant difference of vibrations being effective however Cochrane & Stannard (2005) found vibration training significantly increased a counter movement jump height with arm swing in a sample of eighteen elite female hockey players. However, as the mode of application in not manual massage, it can not be suggested the same results will emerge and therefore, shall not be explored further.

There have been a few studies that have investigated the effects of pre performance massage specifically to warm up, sprinting and jump performance. These have been indentified and discussed further in the relevant sections.

2.3. Warm Up

More recently sports massage has been incorporated to be a part of a well structured warm up. A warm up is considered to be a necessity for optimum performance (Bishop, 2003) and could be suggested to be the minimum preparation method for any pre performance activity. Despite this, there is little scientific evidence to support the effectiveness of a warm up and as a result, warm up procedures are usually based on the trial and error experience of the athlete or coach rather than scientific study (Bishop, 2003 p 484). Goodwin (2002) evaluated the comparison between a massage protocol (consisting of effleurage and tapotement techniques) and sub maximal exercise as warm up procedures for enhancing vertical jump performance. He concluded that massage may have a detrimental effect on explosive performance outcome in comparison to an active warm up protocol however derived that the effects of massage was not attributable to temperature changes whereas an active warm up may have been. This is in agreement with Bishop (2003) who suggested that an active warm up has the potential to improve short term (<10 seconds) performance as a result of increased muscle temperature which encourages effects such as decreased muscle and joint stiffness and increased transmission rate of nerve impulses (Bishop, 2003).

A very high intensity warm up can be detrimental to performance as high energy phosphates can deplete at a faster rate, leaving an insufficient amount of time for energy to regenerate before the start of a game or competition which could result in the early onset of fatigue (Bishop, 2003). Structurally, the warm up should be sport specific to movements and demands that are representative of the particular sport ands can be manipulated in terms of intensity, duration and recovery period in order to achieve the desired physiological and performance factors (Bishop, 2003). These factors have been highlighted in the testing protocol.

2.4. Physiology: Energy Systems and Energy Expenditure

Reilly & Borrie (1992) described field as continuous and therefore more demanding on the body's aerobic system. However the anaerobic system is frequently utilized in order to produce regular and quick bursts of movement (Reilly & Borrie, 1992). This is cohesive with recent time motion analysis studies that show field hockey as a predominantly low intensity activity (MacLoed *et al*., 2007; Boddington *et al*., 2002).

The mean distance and duration of sprints of field team sports is recorded to be between 10-20m and 2-3 seconds with a variance of between 20-60 sprints across a distance of 700-1000m per match (Spencer *et al*., 2005). Maximal sprint exercise requires a high adenosine tri phosphate (ATP) turnover rate. The intramuscular ATP storage is only able to sustain muscular activity for duration of 1-2 seconds; therefore ATP must continuously be regenerated in order for exercise to continue (Bishop *et al*., 2003 p 199). As the mean sprint duration is 1.8-3.1 seconds in field hockey, this is supportive of suggestions that anaerobic glycolysis will be utilised as the predominant energy source activated during 2-3 second sprints in team sports and more specifically, field hockey (Lothian & Farrally, 1990; Spencer *et al.*, 2004; Spencer *et al.*, 2005).

Repeated sprint ability (RSA) is a common aspect of team sports and is used to describe successive sprints which are performed with minimal recovery in between (Spencer *et al*., 2005, p 1026). Because the body is able to replenish approximately 85 to 90% of ATP and Creatine Phosphate (CP) stores for every minute's rest (Clark *et al*., 2008), and remove by products of anaerobic glycolysis before the start of the next sprint, if a 2-3 second sprint of between a 10-20m distance occurred every minute during a game the likelihood of performance decreasing is unlikely (Spencer *et al*., 2005 p 1031).

Previous studies investigating RSA have focused on the frequency and duration of sprinting; however few have identified the actual activity pattern of the movement which was what Macloed *et al.,* (2007) primarily addressed. From their findings, it was noted after a sprint was completed, a significant decrease of cruising and increase in walking was apparent in the second half of the game of field hockey in comparison to the first half. MacLoed *et al.,* (2007) identified a high to low intensity workload shift which effectively hinders game situations where players are regularly required to exert maximal or high intensity efforts repeatedly.

As there are approximately 1000 changes in motion occurring every three seconds during a field hockey match (MacLoed *et al*., 2007), even if a small additional energy cost was required to change an activity, this may influence total energy expenditure (Lothian & Farrally, 1992 p 222). Reilly & Seaton (1990) investigated the energy cost of dribbling a hockey ball on a treadmill. They found that dribbling the ball increased the energy expenditure between 15-16 KJ/min above the energy cost of the running speed (8 & 10 km.h-1) in seven male hockey players. As players fatigue, their movements may become more inefficient so an energy cost which was apparent at the beginning of the match may underestimate the energy cost towards the end of the match (Lothian & Farrally, 1992 p 222).

General and sport specific variables such as accelerating, decelerating, changing direction continuously, dribbling with the ball, running in a bent over position (even when not directly involved in play), carrying a hockey stick (approximately 600-750 grams (Lothian & Farrally, 1992 p 224)) and the arm and shoulder exercise in using the hockey stick (Reilly and Borrie, 1992, p 13) are all contributors to additional energy expenditure during a game (Reilly & Borrie, 1992, p 13).

During sprinting, it has been suggested that a vigorous arm drive will assist forward drive (Lockie *et al.,* 2003). Bhowmick & Bhattacharyya (1988) found that the horizontal acceleration of the arm swing helps to increase stride length and regulate leg movement, while the vertical element of the arm swing enhances leg drive. Similarly, Chapman (2008, p 125) stated that muscles of the upper limb, in particular the shoulder flexors and extensors require strength training for much the same reasons as lower limb muscles with a view to increase upper limb acceleration and increased ground reaction force during sprint starts. Although this would appear more relevant for sprinters, in team sports such as field hockey, athletes are constantly in motion and therefore need to develop an efficient running technique for making the transition from a low intensity activity, for example, walking or jogging, to a maximal sprint (Dintiman & Ward, 2003). However, due to the nature of the game, factors such as carrying the stick and running in a bent over position consequently reduce running efficiency and hinder sprint mechanics (Lothian & Farrally, 1992; Reilly & Borrie, 1992), as well as increasing energy expenditure.

From this it can be derived that by making movements more efficient during game play this would effectively save energy and enable athletes to increase or sustain performance for longer periods of time. Pre performance massage is though to assist the muscles to work for longer and become more efficient (King, 1993, p 23) justifying it use as a pre event benefactor. As the arm and shoulder are commonly used in field hockey (Reilly & Borrie, 1992), if elements such as correct running technique and increased utilization of the arms were implemented into game play, it could be suggested that field hockey players could potentially increase performance rate. As massage has proposed benefits to increase muscle efficiency, application to the upper limb is a key area to consider in a pre event environment for improving performance.

2.5. Counter-movement jump

Although jumping would not appear to be a frequent characteristic of the game of field hockey, the counter movement jump is often used as an indicator of lower body power in field testing (Canavan & Vescovi, 2004; Vescovi & McGuigan, 2007). As increased arm drive is the desired aim of massage, the countermovement jump using an arm swing will be required to determine whether the effect of arm drive on leg drive is influenced by massage during the upward phase of the jumping movement. Lees *et al.,* (2004) determined that arm swing increased maximal jump height in twenty adult males. Participants jumped higher (0.086 m) in an arm swing intervention compared to the no-arm swing intervention and this was due to increased height (28%) and velocity (72%) of the centre of mass during take-off. The increased height was thought to be because of additional energy exerted from the shoulder, elbow and hip joints (Lees *et al.,* 2004). This is supported by results found by Harman *et al*., (1990) who found that countermovement jump and arm swing significantly increased jump height ($p < 0.05$), peak vertical reaction force and peak positive power during take off in a sample of 18 males. When examining the effects of massage on recovery and jump performance, Mancinelli *et al.,* (2005) found a thigh massage comprised of effleurage, petrissage and vibration techniques, significantly ($p<0.05$) increased vertical displacement and perceived recovery in 11 female basketball and volleyball players who received the massage intervention. This differs to results obtained by Arabaci (2008) who found that a pre event lower limb massage had a significant ($p<0.05$) detrimental effect on vertical jump performance in a sample of 24 active males. The fact that Mancinelli *et al.,* (2008) used a specific sporting population which involves jumping within the sport as well as females could pose questions that massage could affect gender and sport specific samples versus the general population in different ways, beneficial or not. Despite this, if the upper limb which is already proven to increase jump height through the arm swing (Lees *et al.*, 2004; Harman *et al.*, 1990) is more stimulated then it can be hypothesised that the effect of an upper limb massage will effectively increase jump height.

2.6. Agility and Speed

The ability to sprint repeatedly and change direction while sprinting is a determinant of sports performance in field sports (Sheppard & Young, 2006). Agility can be defined as ‘‘a rapid whole-body movement with change of velocity or direction in response to a stimulus’’ (Sheppard & Young, 2006 p 922). More specifically, agility has been shown to be an important aspect in the game of field hockey (Keogh *et al*., 2003) with a reported 11.6% of a game spent moving other than a forward direction, for example, backwards and laterally (Lothian & Farrally, 1994). Team sports performers typically begin a sprint whilst already in motion (Vescovi & McGuigan, 2007) which consequently involves a vigorous arm action to assist the transition of changing direction (Dintiman & Ward, 2003). Keogh *et al*., (2003) executed a battery of field tests in order to evaluate and help improve talent identification specifically to female field hockey players. Using the Illinois agility test for agility performance measure, participants executed the test with and without the ball. Times were reported to be slower when carrying the ball which could attribute why energy expenditure is increased as result of carrying a hockey ball (Reilly & Seaton, 1990) as players are required to carry the ball for a longer period of time whilst executing high intensity movements. It was also reported that as standard of play increases, so does an athlete’s level of agility (Keogh *et al*., 2003).

In a study by Mann (1983) the kinetic analysis of sprinting was evaluated. The author used a force plate positioned at 10m over a 40m distance in order to measure the force application of a stride in the muscles about the ankle, knee, hip, shoulder and elbow joints whilst at maximal sprinting speed. As this study is looking into the effects of upper limb massage on performance, the concern here relates to the data obtained from the shoulder and elbow. Mann (1983) found that the shoulder was greater in moment in comparison to the elbow, but was still low in comparison to the knee, ankle or hip. Although movement for the whole upper limb requires large moments from the shoulder (Holzbaur *et al*., 2007), the lack of large dominant muscles present at the shoulder or elbow is at variance with prevalent coaching belief in utilizing the arms to maximum capabilities (Mann, 1981, p 328). This suggests that if muscles surrounding the shoulder and elbow joints were greater conditioned, they could be utilized for greater force production during sprinting performance.

Goodwin *et al.,* (2007) was the first study to investigate the effects of pre performance lower limb massage specifically on sprinting performance. Prior the warm up, effleurage, petrissage and tapotement techniques were incorporated within the massage protocol with a view to create a stimulatory effect. Goodwin *et al*., (2007) determined that any significant effect of pre performance massage will disperse over in response to an active warm up. The actual results depicted no significant effect of a rapid stimulatory fifteen minute lower limb massage on 30m sprint performance however; the results indicated a slight trend that a massage intervention slowed sprinting performance time. From this Goodwin *et al*., (2007) suggested that any potential negative effects of massage are not carried over through an active warm up and that because no positive effects were identified, massage should not be included as an important part of the warm up process. However the lower limb was applied with massage therefore it could be suggested that different results may emerge as a result of an upper limb massage.

2.7. Rationale

This study is going to look at whether a three minute pre performance stimulatory massage of the upper limb will improve speed, agility and countermovement jump performance in female field hockey players. Speed can be calculated by stride frequency X stride length. By increasing either or both components it can be expected that a greater speed can be generated (Brown & Ferrigno, 2005). Increased arm drive is the desired effect of the pre performance massage. As upper limb musculature is attributable to providing a counteracting effect to the lower limb in terms of angular momentum and the maintenance of body alignment via vigorous and co-ordinated arm movements (Chapman, 2008; Brown & Ferrigno, 2005), it can be hypothesised that by stimulating the upper limb to increase arm frequency, this will assist improvements on stride frequency component of speed, which has been shown to be a greater determinant of early acceleration in field sports athletes more so than stride length (Murphy *et al.*, 2003).

The upper limb is not the major contributor of speed; however it does influence balance, alignment and arm drive (Mann, 1983; Chapman, 2008; Brown & Ferrigno, 2005). Co-ordinated arm movements are necessary to keep the body in proper alignment during sprinting, in particular during the initial acceleration phase (Brown & Ferrigno, 2005), which is relevant to field hockey in terms of sprinting distance and duration. As stated by Chapman (2008), the shoulder flexors and extensors need to predominantly be conditioned in order to increase force production in sprinters. This therefore needs to be targeted within the massage protocol in view of enhancing arm drive.

There are several methodological issues with regard to previous massage studies that potentially influenced the outcome of the research. These include poorly described massage protocols, whether the aim of the massage is for stimulatory or relaxation purposes, appropriate control groups, low subject numbers and limited performance measures which consequently suggests that any previous massage research regarding increased performance is inconclusive (Goodwin *et al*., 2007; Weerapong *et al.*, 2005; McNair & Stanley, 1996). On the whole there is no specific consensus on the type, style, application, duration, intensity, number of strokes applied or time of application prior to training or competition (Arabaci, 2008 p 549**)** which could suggest the inconclusive results apparent of massage studies. The use of vigorous vibration and tapotement techniques are often used pre event with a view to create a stimulatory effect (Cash, 1996). This shall therefore be incorporated into the methodology of the study.

CHAPTER III:

METHOD

3.0. Method

3.1. Participants

Twelve female participants from the 1st and 2nd team hockey squads at UWIC participated in this study. The mean height, weight and age of the participants were 163.92 ± 4.66 cm, 62.48 ± 4.02 kg and 19.75 ± 1.29 years respectively. Participants trained and played competitive games twice weekly.

Each participant provided signed informed consent to participate in this study. The research question was approved by the ethics committee at University of Wales Institute, Cardiff (UWIC) and data remained anonymous throughout. All athletes were free from injury at the beginning of the study and were notified that they could withdraw at any time from the study without giving a reason.

3.2. Procedures

Height and weight was recorded using a stadiometer (Holtain fixed stadiometer Holtain Ltd, Crosswell, Wales) and digital weighing scales (SECA- Model 770 Vogel & Halke, Hamburg, Germany) once at the beginning of the study. All participants were assigned in a group as part of a randomised cross over design. Groups were staggered across three hourly time slots between 10am-1pm and remained in these groups throughout the study. This was to ensure the same time of day was standardised for participants within each group. Groups were not informed of what intervention they would be taking part in until arrival at each testing session. All groups completed a pulse raiser warm up before participating in the given intervention for that particular testing day. These consisted of a dynamic warm up only (DWUO), massage only (MO) or dynamic warm up and massage (DWUAM) intervention. All participants were exposed to all three interventions across three non consecutive testing days and the pulse raiser activity remained constant to minimise injury potential. See Table.1. for the intervention order off all groups across the testing period.

Table.1. *Intervention order of groups*

	Day 1	Day 2	Day 3
Group 1(10 -11am)	DWUO	MO	DWUAM
Group 2(11-12pm)	DWUAM	DWUO	MO
Group 3(12-1 pm)	MO	DWUAM	DWUO

Following the intervention participants were required to complete three different field tests with three trials at each test to calculate a mean score for analysis. The tests used were a 30m linear sprint (Goodwin *et al.*, 2007) recorded at 5, 10, and 30m respectively, countermovement jump with arms (Cochrane & Stannard, 2005; Harmer *et al.*, 1990) and pro agility test (Harman *et al.*, 2000) The countermovement jump was executed using arms to see whether a stimulatory upper limb massage enhanced the effects of arm drive on leg drive during the upward phase. The pro agility drill as illustrated in Figure.1 is an example of a planned agility test as participants are aware of the exact movement pattern required before test completion (Oliver & Meyers, 2009). This is used to assess multidirectional speed, agility and body control (Reiman & Manske) which is suggestive of the sporting demands of field hockey.

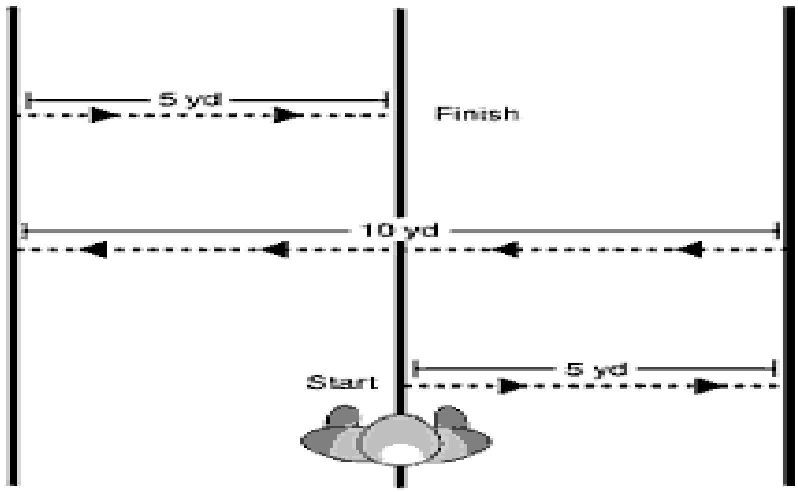

Figure.1. *Pro agility test (Reiman & Maske, 2009). Arrows indicate sprint direction*

Participants were not informed of their performance data to help eradicate any systematic bias that may have occurred during testing. Recovery was instructed to be active with a designated area. Running and jogging were given as examples as active recovery to participants however no set movements, time or intensity was set. All participants were required to carry a stick during the execution of tests as this is known to impact running efficiency and energy expenditure in field hockey players (Lothian & Farrally, 1992, Reilly & Seaton, 1990), enhancing specificity. Participants rotated round the three testing stations which were executed in order of 30m sprint, countermovement jump with arms and pro agility. This remained constant across the entire testing period. Data was collected by using SmartJump and SmartSpeed (Fusion Sport, Brisbane, Australia). This method of data collection has been validated (Oliver & Meyers, 2009; Deutsch & Woo, 2006). Testing was held within an indoor facility with a view to control weather, temperature and surface variables.

3.3. Dynamic warm up protocol

3.3.1. Intensity

Short term performance appears to be dependent on the state of muscular temperature and availability of energy (Bishop, 2003). It is thought a moderate intensity warm up is likely to improve short term performance (<10 seconds) as opposed to warm ups that are too high or low in intensity (Bishop, 2003) Therefore, participants were required to undergo a warm up of moderate intensity in order to substantially increase muscle temperature however, not deplete large amounts of energy supplies.

3.3.2. Duration

Muscle temperature is thought to increase during 3-5 minutes of exercise and plateau after 10-20 minutes (Saltin *et al*., 1968). Therefore, by executing an active warm up protocol that comprises of dynamic stretching and warm up at a moderate intensity for approximately 10 minutes, the desired effects of maximising muscle temperature with minimal depletion of energy supplies are achieved. See Appendix C for the warm up protocol and Appendix D for explanation of exercises prescribed.

3.4. Massage

As part of the rationale for this study, the upper limb will be massaged to look into how speed, agility and countermovement jump performance is impacted. This is in differentiation to previous massage studies which have mostly investigated lower limb massage only (Goodwin, 2002; Goodwin *et al.*, 2007; Arabaci, 2008). Massage was performed and timed by 5 qualified and insured sports massage practitioners studying at UWIC. The massage protocol applied is demonstrated in Table.2. See Appendix E for explanations of hand skills. One person massaged one person at any given time. As groups were staggered into three time slots throughout the day, and there was no more than four people in one group, massage practitioners had plenty of recovery prior the next massage to avoid fatigue. One person timed the massaged and instructed the practitioners when to change body part or technique. Goodwin *et al.,* (2007 p1030) stated that any negative effects of massage do not seem to carry over through an active warm up. In order to differentiate this, the warm up protocols were executed first, followed by the massage intervention to ensure the immediate effects of massage were accounted for during performance.

3.5. Statistical analysis

All statistical analysis was undertaken using SPSS Version 17 (SPSS Inc. Chicago, IL, USA). The level of statistical significance was set at $P<0.05$

Table.2. *Massage protocol*

Body Part	Body Position	Massage Technique	Muscles targeted	Time (sec)
Left Shoulder	Prone	Slapping	Shoulder extensors	15
Left arm	Prone	Cupping	Arm flexors	15
Left arm	Prone	Vibrations	Whole limb	15
Right shoulder	Prone	Slapping	Shoulder extensors	15
Right arm	Prone	Cupping	Arm Flexors	15
Right arm	Prone	Vibrations	Whole Limb	15
Left Chest	Supine	Hacking	Shoulder Flexors	15
Left arm	Supine	Cupping	Arm Extensors	15
Left arm	Supine	Vibrations	Whole Limb	15
Right Chest	Supine	Hacking	Shoulder Flexors	15
Right arm	Supine	Cupping	Arm Extensors	15
Right arm	Supine	Vibrations	Whole Limb	15

CHAPTER IV:

RESULTS

4.0. Results

4.1. Participants

All statistical analysis was undertaken using SPSS Version 17 (SPSS Inc. Chicago, IL, USA). A repeated measures analysis of variance (ANOVA) was used for between group comparisons and a Bonferroni post hoc analysis was implemented to enable a comparison of means to deviate suitable descriptive statistics for analysis between dynamic warm up only (DWUO), massage only (MO) and dynamic warm up and massage (DWUAM) intervention groups. The level of statistical significance was set at $P<0.05$ and data was reported as mean ± standard deviation (SD). Eleven female participants of the original twelve completed this study due to injury. Only completed data sets were used for analysis (*n=11*). Table.3. illustrates the subject characteristics (Mean ± SD) for all participants.

Table.3. *Subject Characteristics (Mean ± SD)*

Height (cm)	Weight (kg)	Age (years)
163.92 ± 4.66	62.48 ± 4.02	19.75 ± 1.29

4.2. Countermovement jump

Figure.2. suggests that the massage only intervention had a detrimental effect on mean height (cm) however there was no significant difference recorded for the countermovement jump between intervention groups ($p = 0.077$).

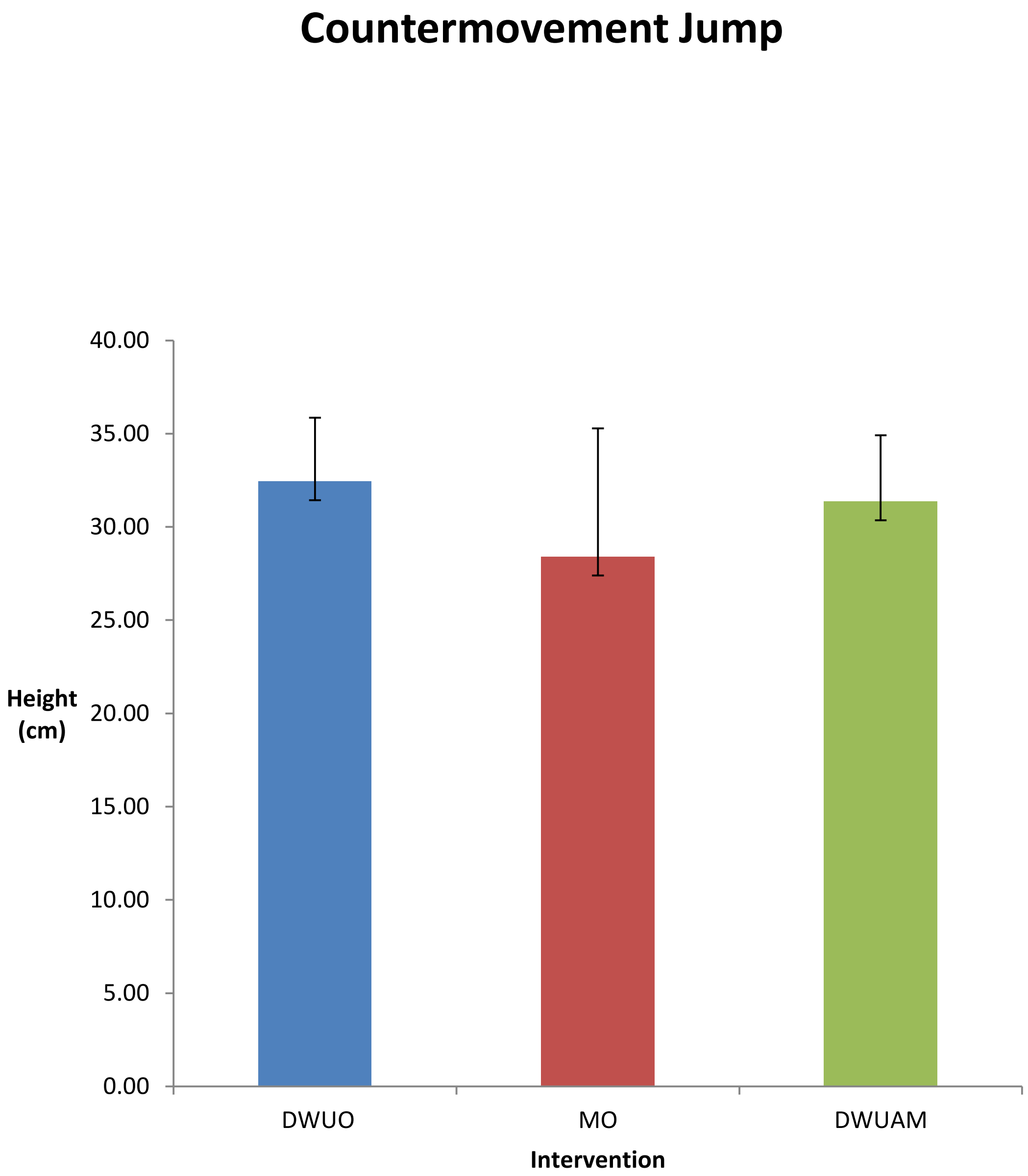

Figure.2. *Countermovement Jump Height. Data reported as Mean ± SD. Mauchly's Spheicrity assumed was violated (P<0.05) and so the Greenhouse Geisser significance value (p <0.05) was alternately used (O'Donoghue, 2010) for analysis. No significant difference was found between interventions (p=0.077)*

4.3. Sprint

Table.4. illustrates the mean linear sprint times at 5m, 10m and 30m for each intervention. No significant difference was found between sprint times and intervention across all distances (*p*>0.05). Despite this, group mean results (Table.2.) suggest that the MO intervention slightly increased sprint time at 5, 10 and 30m, whilst DWUO was the second slowest at 5 and 10m but the quickest across 30m therefore the DWUAM intervention was the quickest intervention for 5m and 10m but not for total distance (30m). Although a slight time change can be observed, the apparent time differences are based on tenths or hundredths of a second which can hardly be rendered as influential on total performance in field hockey players. Figure.3. shows a comparison of sprinting distance across all interventions. From the graph is can be depicted that there is little difference between times across all intervention groups and distances which suggests minimal difference for performance outcome.

Table.4. *Mean ± SD time and intervention at 5, 10 and 30m, for all participants. No significant difference was found between interventions across all distances (p= 0.379; p= 0.147 and p= 0.472 for 5, 10 and 30m respectively)*

	DWUO	MO	DWUAM
5m Sprint	1.13 ± 0.04	1.14 ± 0.04	1.12 ± 0.04
10m Sprint	1.95 ± 0.08	1.98 ± 0.08	1.95 ± 0.06
30m Sprint	4.88 ± 0.29	4.95 ± 0.28	4.92 ± 0.23

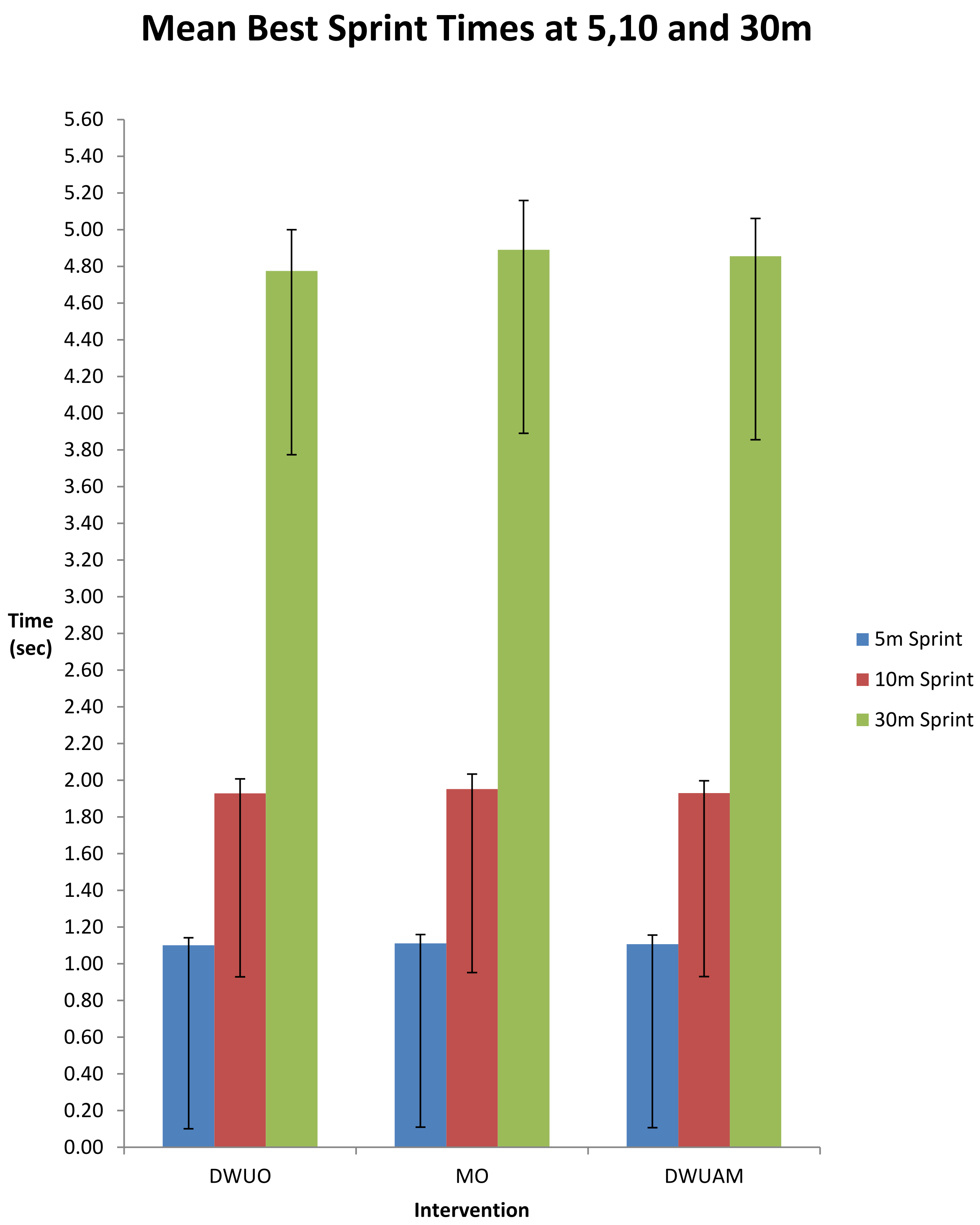

Figure.3. *Mean ± SD best Sprint data and intervention across all distances for all participants. This shows no difference between interventions and distances*

4.4. Pro agility

No significant results were identified between intervention groups (p>0.05) for the pro agility test as illustrated in Figure.4., which shows the mean total time for the pro agility scores for the whole group. There is the smallest indication that MO intervention increased time across all distances and that DWUO was the quickest among the interventions. However, as the difference is minimal this cannot be considered important.

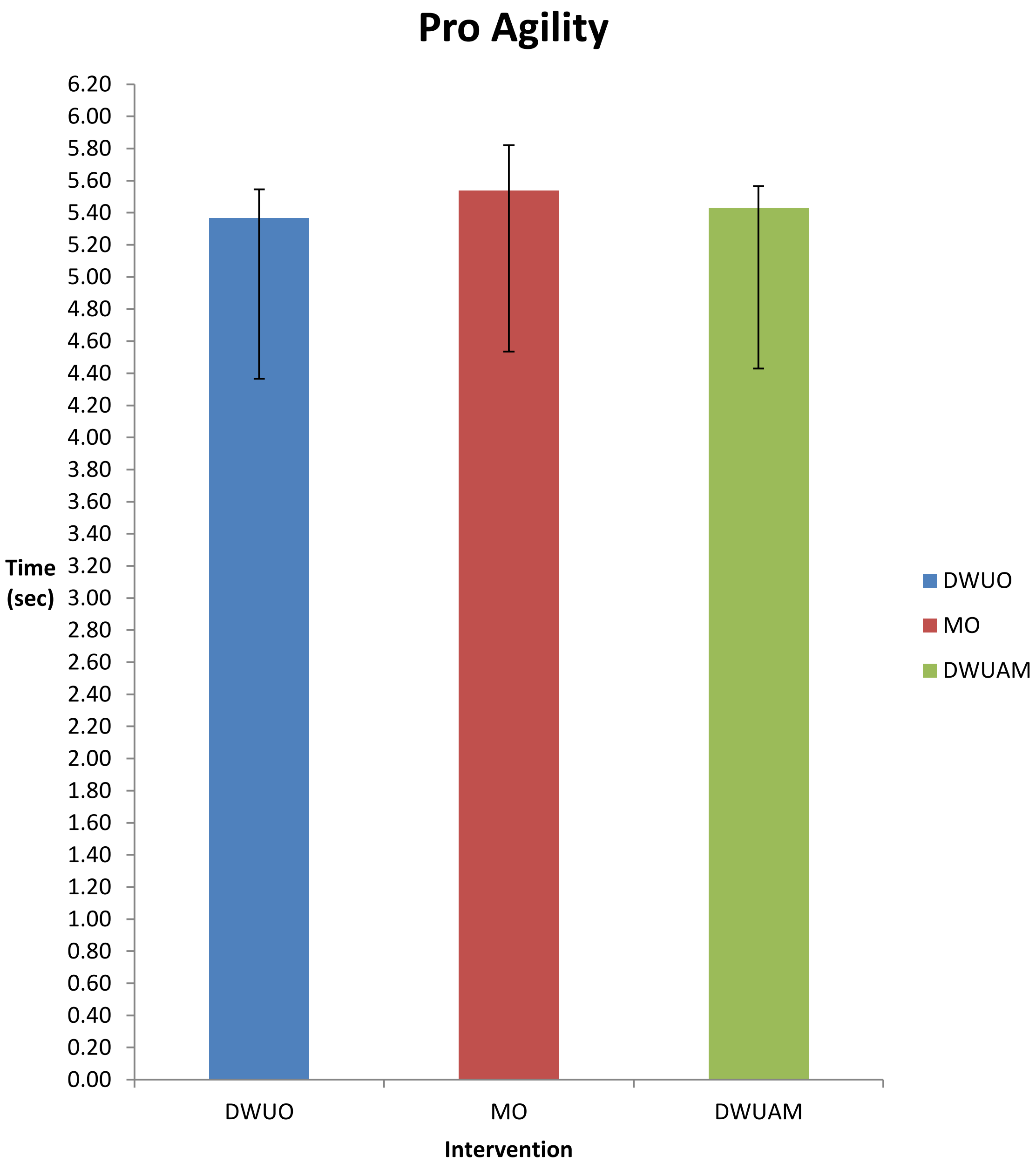

Figure.4. *Mean ± SD Total time Pro Agility scores for all participants. No significant difference was found between interventions (P>0.05)*

CHAPTER V:

DISCUSSION

5.0. Discussion

5.1. Countermovement Jump

Although there was no significance ($p>0.05$) that an upper limb massage affected jump performance across DWUO, MO and DWUAM interventions, the significance recorded was p= 0.077 which approached significance and therefore should be considered. It is known that arm swing during vertical and countermovement jumps significantly ($p<0.05$) improves jump height attributable to additional energy provided by the movement of the upper limb (Lees *et al*., 2004; Harman *et al.*, 1990). Participants were given a briefing and demonstration on how to execute the countermovement jump therefore variability on jump technique should have been eradicated. This was to see how intervention groups influenced jump height using an arm swing because otherwise, performance outcome could have been determined based on participant's varying jump techniques. Despite this, a few anomalies were reported for countermovement jump. One participant's best jump resulted at 44.74cm on her third trial of DWUO (over 10cm of previous DWUO trials), whilst another participant only reported 0.57 and 0.67cm height on trial one and two of the MO intervention. Participants could have been instructed to repeat the jump in order to remove anomalies however this was not incorporated. The Smart Jump system (Fusion Sports, Brisbane, Australia) calculated height by measuring contact time difference on the mat (Fushion Sport, 2010). The apparent excessive high and low values could be contributable to jump technique factors such as bringing the feet up whilst airborne as opposed to keeping straight legs or performing a 'double jump' before executing the jumping movement. The data could have been removed when calculating mean values in order to produce more accurate results buthis was unlikely to have affected the significance results attained. However, it could be suggested that because of the considerable height difference of participant one's DWUO trial and participant five's very low scores on the MO intervention that the DWUO could have presented lower values as shown on Figure.2. This would therefore measure more equal with the DWUAM intervention whereas the MO may have presented higher on the graph which potentially could suggest the differences between DWUO, MO and DWUAM were even more minimal than identified. The current result depicted that the MO intervention slightly produced the lowest jump height, whilst DWUO slightly produced the greatest jump height. This is in agreement with Goodwin (2002) who suggested massage has a detrimental effect on vertical jump performance in comparison to an active warm up. Goodwin (2002) suggested poor performance in massage interventions may have been a result of decreased muscle stiffness and neural activation whereas an improved warm up may be attributed to increased muscle temperature, which is suggested to increased short term (<10 seconds duration) performance (Bishop, 2003). From this, it can be suggested that a massage may have been stimulatory however; insufficient achievement of increased muscle temperature in the MO intervention determined that performance decreased slightly in comparison to the DWUO intervention where increased muscle temperature was more likely to have been achieved.

5.2. Sprint

No significant data was obtained between any interventions or distance ($p>0.05$). The MO intervention depicted slightly decreased performance results. This is similar to result found by Goodwin *et al.,* (2007) who indicated that although no significant difference was found that massage affected performance, a massage intervention showed a slight trend to decrease performance in 30m sprint times. Goodwin *et al.,* (2007) did not determine a reason for decreased performance. However in the present study it was commonly observed that participants did not utilise arm movements during sprinting to maximum potential, if at all, despite being instructed to sprint maximally using the arms whilst carrying a hockey stick. As the massage protocol was aimed to create a stimulatory effect (Cash, 1996) of the upper limb, massage could have adversely produced physiological effects such as decreased muscle stiffness (Goodwin, 2002) and reduced neuromuscular excitability (Weerapong *et al.*, 2005) which in turn could have slightly slowed the rate of arm drive whilst sprinting. This could be a suggestion as to why MO showed slightly lower results in comparison to the DWUO intervention, despite no significant results emerging.

It was also observed that participants who were left handed sprinted carrying the stick in their left hand when in a game situation the stick is predominantly controlled and carried using the right hand in order to overcome opponents (Reilly & Borrie, 1992). Carrying a hockey stick is known to decrease running efficiency and hinder sprint mechanics (Lothian & Farrally, 1992; Reilly & Borrie, 1992) and this was highly apparent during testing. As the participants were required to execute the countermovement jump using their arms and also carrying a stick, this suggests participants may have utilised their arms more effectively whilst jumping in comparison to sprinting or agility activity. This could indicate why MO slightly decreased jump height ($p=0.077$) in comparison to the DWUO and DWUAM interventions. From this, it is potential that arm drive still could have an influence on sprinting performance in field hockey players; however the lack of education regarding sprinting technique in field may have hindered potential results. This is an area for consideration in future research.

5.3. Pro Agility

Similarly, the pro agility test identified no significant results ($p > 0.05$) between DWUO, MO, DWUAM intervention groups. In the current study, agility was measured as a planned test. Agility can also be tested reactively by which participants are required to react to a stimulus during the test (Oliver & Meyers, 2009) however this was not incorporated in the methodology. Although no results were derived between interventions for pro agility performance, it could be suggested that, because massage is proposed to create a greater state of readiness prior to performance (Benjamin & Lamp, 2005) that in terms of agility, a stimulatory massage may enhance an athlete’s ability to react to a stimulus and therefore better results may have emerged from a reactive agility test, as opposed to a planned agility test such as pro agility.

5.4. Practical Applications and Considerations

5.4.1. Physiological factors

Some participants may have not had massage prior to the study and therefore had not ever received tapotement or vibratory techniques. Tapotement is a percussive technique commonly utilised before or during games or competition with a view to stimulate muscular tissue, trigger cutaneous reflexes and cause vasodilatation (Goats, 1993, Weerapong *et al*., 2005). Vasodilatation occurs through the action of the sympathetic nervous system by directing blood away from non essential areas to areas that are active during exercise (Wilmore *et al.*, 2008; Powers & Howley, 2009).

This happens by smooth muscle relaxing around major blood vessels which increase the supply of blood, thus oxygen, into to the working muscles (Wilmore *et al*., 2008; Powers & Howley, 2009). If this were to occur as a result of massage, it could be suggested that blood was diverted away from the lower limb to facilitate the needs of the upper limb during massage. As the legs are the main contributor to speed (Mann, 1983), if there was a decreased supply of blood, this could suggest a detrimental effect on sprinting performance. However, Shoemaker *et al.,* (1997) measured the effects of massage on blood flow. Tapotement techniques were administered within the protocol, in combination with effleurage and petrissage. This was applied to the right forearm and quadriceps muscles and blood flow was measured about the brachial and femoral arteries using Doppler ultrasound. The results indicated that manual massage did not elevate muscle blood flow irrespective of massage technique or the muscle type receiving the treatment (Shoemaker *et al*., 1997). This implies that a pre performance massage would have no differing effect in terms of blood flow on sprint performance therefore suggesting alternate mechanisms as to why massage illustrated a very slight indication of slowing performance across jumping, sprinting and pro agility performance.

Vibration is a massage technique which is generally used to increase circulation, facilitate muscle relaxation, stimulate nerve endings and decrease muscle tone (Callaghan, 1993; King, 1993) and is thought to increase muscle tone when used vigorously. However, the physiological effects of these massage techniques has yet to be certified (Weerapong *et al*., 2005; Mancinelli *et al*., 2006) which suggests that massage actually may have decreased muscle tone prior to performance rather than increase it , potentially indicating why there was a slightly decremented performance outcome in the MO intervention.

5.4.2. Psychological factors

Benjamin & Lamp (2005) identified that research rarely considers for a mind to body connection for performance outcome. There have been few studies that have considered the effects of psychology on performance. Micklewright *et al.,* (2005) researched the effects of mood state following a 30 minute pre performance back massage on Wingate anaerobic cycling performance. No significant difference was detected between rest or massage intervals however results indicated that Wingate performance increased following massage. This is supportive of early research undertaken by Weinberg *et al.,* (1988) who found that 30 minute whole body Swedish massage indicated an enhanced positive mood state prior performance when combined with a running intervention, despite results also being insignificant. Micklewright *et al*., (2005) incorporated effleurage and petrissage techniques within the massage protocol. The exact techniques were not identified within the study of Weinberg *et al*., (1988), however it could be suggested that as similar results were derived between the two studies, that similar techniques were employed. It has been stated that different sensations associated with various massage techniques may evoke different changes in mood state, since each technique varies in terms of the frequency, rate, and intensity of pressure applied to the tissues (Micklewright *et al*., 2005 p248). This is applicable to the current study as vigorous tapotement and vibratory techniques were incorporated within the massage protocol in order to create a stimulatory effect (Cash, 1996) as opposed to effleurage and petrissage techniques (Micklewright *et al*., 2005), which are commonly known for producing relaxation effects (Benjamin & Lamp, 2005). This suggests that varying psychological responses could have emerged among participants. As some participants had not received either technique prior execution of testing, the individual response of such techniques had not been determined. Therefore, massage potentially could have positively or negatively affected psychological response prior the execution of performance measures which ultimately could have affected the participant's state of readiness (Benjamin & Lamp, 2005). This could be eradicated by ensuring as part of participant criteria that an introduction to massage was held prior execution of testing as incorporated by Weinberg *et al*., (1988). This would suggest that any negative psychological response as result of tapotement or vibratory massage would be previously identified.

5.5. Limitations

There were several limitations to the study. The number of completed data sets used for analysis equalled to eleven participants. If the sample size had been bigger, results may have approached or reached significance, in particular with reference to deriving a positive correlation between counter movement jump and intervention as that was the nearest to significance (p=0.077).

As there is no consensus of what type of massage protocol is most effective in a pre event setting, it is difficult to adhere to what techniques are most effective and techniques are only justified based on proposed physiological responses. Although practitioners executing massage were timed and notified when to change technique, variables such as intensity, rhythm and pressure could not be regulated which suggests that intra practitioner variability was inevitable.

The study was not ecologically valid due to completion of testing occurring inside which decreases the specificity to field hockey as it was not performed outside. However, by performing testing inside, the environment was more controlled in terms of temperature and surface state which standardised the data collected. This may have not been viable in an outside environment due to weather conditions and temperature.

Tests were also performed in the same order across the testing period. From this, a test order effect can be suggested to have occurred. It has been suggested that in order to produce accurate and reliable results through testing, that learning order effects should be removed and therefore familiarisation sessions may by necessary to generate optimum results (Hopkins, 2000; Hopkins, 2001). However, in a study by Moir *et al*., (2004) which investigated the effects of familiarization of vertical jump performance and 10 and 20m acceleration sprinting performance, no significant difference was found between testing sessions and any performance measures across a three week duration of which five sessions were completed, each consisting of twelve jump trials and three sprint trials per session. With regard to the present study, participants only completed nine trials of the countermovement jump, 30m sprint and pro agility test across three testing sessions. Familiarisation potentially may have influenced the results of the study. However, in conjunction with findings by Moir *et al*., (2004), this is unlikely.

5.6. Potential Improvements

5.6.1. Massage

Benjamin & Lamp (2005) identified that most of the research on sports massage has been done from a mechanistic perspective with a focus on pre event application to look for some way of improving performance. They proclaimed that this type of research finds little evidence that massage immediately improves performance and therefore the more complex phenomenon of the whole athlete should be considered. Figure.5. illustrates a theoretical model regarding the mechanisms of massage as proposed by Weerapong *et al*., (2005). These include biomechanical, neurological, physiological and psychological responses of massage. In conjunction with Benjamin & Lamp's (2005) idea of a whole athlete complex, if the concepts employed by Weerapong *et al*., (2005) were incorporated into all massage research, it could be suggested that more relevant results would emerge. The current study did not directly measure any of these factors however there were a number of variables that could have been involved which would have potentially improved the study.

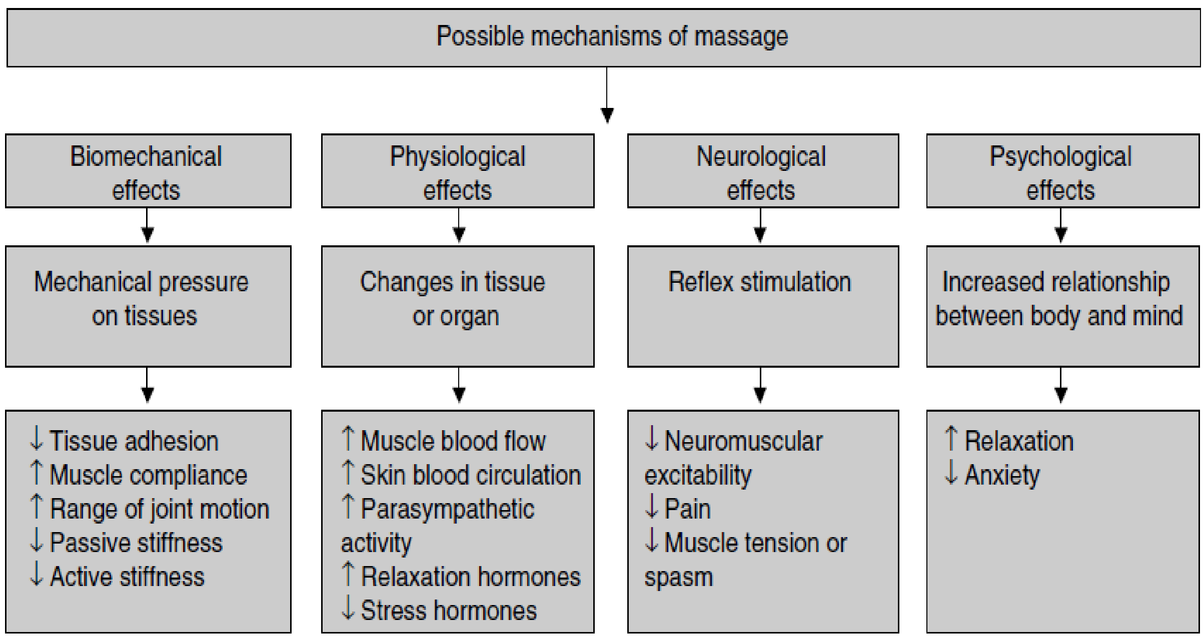

Figure.5. *A theoretical model of the expected mechanisms of massage. ↓ indicates decrease; ↑ indicates increase (Weerapong et al, 2005)*

5.6.1.1. Biomechanical factors

Massage involves the application of mechanical pressure on the muscle tissue in order to decrease tissue adhesion (Weerapong *et al*., 2005, p 238). This is measured by range of motion, passive and active stiffness (Weerapong *et al*., 2005). Objective markers could have been incorporated into the massage protocol to measure the effects of massage on range of movement pre and post massage. As a performance measure, a goniometer could be used to measure the degree of movement about the shoulder joint in terms of angular difference. By doing this, it could be suggested that by making the upper limb more mobile prior to execution of the tests, a greater arm frequency could have been generated which in turn would assist in increasing the stride frequency component of speed.

5.6.1.2 Physiological factors

Physiologically, massage is proposed to increase blood flow and circulation (Weerapong *et al*., 2005). As previously discussed, there is a lack of empirical evidence that demonstrates massage has an impact on either factor (Shoemaker et al, 1997). However, in order to make future massage research more meaningful, the physiological responses of massage should be measured in order to help reach a consensus on what type of massage techniques are most effective to improving performance and recovery. This could be achieved through the measurement of regional blood flow (Shoemaker *et al*., 1997) and muscular temperature during massage in all studies. From this, comparative data on how different massage techniques affect such variables could result, if any. This potentially would assist in generating a consensus on effective massage protocols if a positive link can be identified.

5.6.1.3. Neurological factors

MacLoed *et al*., (2007) identified a high to low intensity workload shift in game situations where players are regularly required to exert maximal or high intensity efforts repeatedly. This suggests physiological decrements through energy source depletion however Balsom *et al*., (1992) found that following 15 consecutive sprints every 30 seconds appeared to show no detrimental effect on performance. In field hockey, the average recovery time is two minutes for all players (Spencer *et al*.,

2004) therefore if a 2-3 second sprint is performed every minute during a game, performance is unlikely to be compromised (Spencer *et al*., 2005, p 1030), suggesting an alternate mechanism for performance decrement. Gibson *et al*., (2001) considered performance decrement in repetitive sprint activity may be a response of neurological factors. The authors proposed that during the first maximal sprint of activity, inhibitory processes may occur after the first couple of seconds of maximal activity, which consequently would result in muscular and cellular damage (Gibson *et al*., 2001). From a neurological perspective, massage is proposed to inhibit neuromuscular excitability and therefore reduce muscular tension (Weerapong *et al*., (2005) which would not be a desirable effect for a pre performance massage. However, the link between neurological factors and differing massage effects has not been identified in research (Weerapong *et al*., 2005) which suggests that if a link could be found, a neurological response of massage could be emphasised more as opposed to a physiological one.

As identified there is a lack of education regarding sprinting technique in field hockey players. In order to help reduce the high to low intensity shift depicted by MacLoed *et al*., (2007), it could be suggested that if arm drive was utilized more in a game situation with a view to drive the legs that movements will be more efficient thus energy expenditure will decrease. This potentially could maintain neurological excitability and therefore maintain muscular stimulation throughout a game situation, which potentially could help reduce the rate of fatigue during a game situation.

5.6.1.4. Psychological factors

Weerapong *et al*., (2005) suggested that massage influences the levels of anxiety, relaxation and perceived recovery of an athlete. It has been suggested that alternate psychological variables, such as emotion and stress also influence performance (Mellalieu, 2003). This was observed in the MO intervention, where some participants reacted negatively. Quotes such as “I don’t feel properly warmed up” and “I think I’m going to pull something” suggest that some participants emotionally did not perceive themselves to be physically prepared for activity. This could have ultimately meant that maximal performance was not achieved, which could be one reason as to why the massage only group illustrated slightly lower results for countermovement jump, 30m sprint and pro agility.

As participants were participating in a testing environment as opposed to a competitive environment, this also suggests the psychological responses may have differed. If testing was repeated in an actual sporting environment, the psychological measures of variables such as anxiety, excitement, motivation, muscular tension and nervousness and how massage impacts these factors could be more specifically measured. Similarly psychological variables such as perceived performance should be recorded using qualitative data in order to enhance an understanding of the psychological impact of massage on performance.

5.6.1.5. Future Massage Considerations

If the study was repeated, a number of variables could be changed in order to progression the study. As there is no consensus on pre performance massage protocols in terms of type, application, duration, or intensity, (King, 1993; Paine, 2000) it could be suggested that that the massage protocol provided was insufficient to meet optimum performance potential. Alternate massage techniques such as effleurage or stretching could be included within the massage protocol and the duration of massage and intensity could be extended and regulated. A metronome could be incorporated to regulate the rhythm of the massage in order to reduce intra practitioner variability further.

5.6.2. Sprinting and Recovery

The differences between intervention groups was minimal, essentially tenths or hundredths of a second. This is not essential to team sports performers however repeating the study with a specific sample group such as 100m sprinters may present different results as a tenth or a hundredth of a second could be the difference between winning a gold medal and coming fourth place as a scenario.

There was no measure of recovery during testing. Spencer *et al*., (2004; 2005) reported 95% of recovery following repeated sprinting activity within international field hockey competition was active in the form of a jogging intensity. Although this was incorporated into the study, the type of active recovery was not regulated therefore variations of walking and jogging and alternate movements were present among participants which consequently could have affected the rate of fatigue. Recovery between trials was not recorded either. Spencer *et al*., (2004; 2005) also depicted that the average time between sprinting activities was 2 minutes for all players. However, it was noted that 25% of recovery duration was <21 seconds (Spencer *et al*., 2004), indicating a variance among recovery time during field hockey play. This could be incorporated into the methodology of the study if it was repeated again to enhance the specificity of testing in terms of recovery of field hockey players.

5.6.3. Warm up

The warm up protocol may have also been insufficient to meet optimum performance potential. From the sample group of this study, there appears to be a lack of education and sprinting technique present in female field hockey players, in particular the use of the upper limb. Sprinting mechanics could be utilized into a dynamic warm up protocol or even still incorporated into the training programs of field hockey players with a view to increase speed. This could be investigated using a longitudinal study of how a sprinting technique, including the movement of upper limb incorporated into training programs and warm up improves speed performance in female field hockey players.

CHAPTER VI:

CONCLUSION

6.0. Conclusion

On the whole, it has been identified that a pre performance upper limb massage has no significant effect upon speed, agility and countermovement jump performance. The effect of massage can not be advertised to be a pre performance enhancement mechanism which is in agreement with previous research (Goodwin, 2002, Goodwin *et al*., 2007). This suggests that massage should not be used prior the start of a game or race and that the athlete's time should be more focused on dynamic warm up activity, which is suggested to produce greater performance results (Goodwin, 2002, Goodwin *et al*., 2007). Massage has been shown to enhance mood state prior performance and impact psychological variables such as emotion or stress (Micklewright *et al*., 2005; Weinberg *et al*., 1988). However, as the psychological responses of massage is unpredictable, it should be used with caution as a pre performance benefactor (Mellalieu, 2003), in particular with athlete's who have never received massage as individual responses have not been identified.

Future research needs to address and measure all possible biomechanical, physiological, neurological and psychological mechanisms of massage (Weerapong *et al*., 2005) and incorporate these factors into research in order to derive meaningful and relevant result of the effects of massage. This would then comply with Benjamin & Lamp's (2005) idea of a whole athlete model and assist in attaining a general consensus on massage protocols with a view for enhancing performance potential.

The lack of technique apparent in the sample population suggests that there is a lack of education regarding sprinting technique in field hockey players. Factors such as carrying the stick, the arm and shoulder and running in a bent over position are known to decrease energy efficiency and hinder sprint mechanics (Lothian & Farrally, 1994; Reilly & Borrie, 1992). However if coaches placed greater emphasis on sprinting technique development using the stick during training sessions in order to progress areas such as speed and agility, which are known to be an important aspect in the game of field hockey and a determinant of performance (Keogh *et al*., 2003; Sheppard & Young, 2006), efficiency of movements can be suggested to improve greatly. Therefore a potential decreases in energy expenditure may become apparent which potentially cold delay fatigue from a high to low intensity work shift (MacLoed *et al*., 2007).

REFERENCES

REFERENCES

Arabaci, R. (2008). Acute Effects of Pre- Even Lower Limb Massage on Explosive and High Speed Motor Capacities and Flexibility. *Journal of Sports Science and Medicine.* **7**, 549-555

Balsom, P.D., Seger, J.Y., Sjodin, B and Ekblom, B. (1992). Physiological Responses to Maximal Intensity Intermittent Exercise. *European Journal of Applied Physiology.* **65**, 144-149 *(abstract)*

Barlow, A., Clarke, R., Johnson, N., Seabourne, B., Thomas, D and Gal, J. (2004). The Effect of Massage of the Hamstring Muscle Group on Performance of the Sit and Reach Test. *British journal of Sports Medicine*. **38**, 349-351

Benjamin, P.J and Lamp, S.P. (2005). *Understanding Sports Massage*. Leeds, UK. Human Kinetics.

Bhowmick, S., and Bhattacharyya, A.K (1988). Kinematic Analysis of Arm Movements in Sprint Start. *J. Sport Medicine and Physical Fitness.* **28**(4), 315–323.

Bishop, D. (2003).Warm up II: Performance Changes Following Active Warm up and How to Structure the Warm Up. *Sports Medicine*. **33**(7), 483-498.

Bishop, D., Lawrence, S and Spencer, M. (2003). Predictors of Repeated Sprint Ability in Elite Female Hockey Players. *Journal of Science and Medicine in Sport*. **6**(2), 199-209

Bishop, D., Spencer, M., Duffield, R and Lawrence, S. The Validity of a Repeated Sprint Ability Test. (2001). *Journal of Science and Medicine in Sport.* **4**(1), 19-29

Boddington, M.K., Lambert, M.I., St Clair Gibson, A and Noakes, T.D. (2002). A Time motion Study of Female Field Hockey Players. *Journal of Human Movement Studies*. **43**, 229-249

Brown, L.E & Ferrigno, V.A. (2005). *Training for Speed, Agility and Quickness*. Leeds.UK. Human kinetics.

Cash, M. (1996). *Sport and Remedial Massage Therapy*. London, UK. Ebury Press

Callaghan, M.J. (1993). The Role of Massage in the Management of the Athlete: A Review. *British Journal of Sports Medicine*. **27**(1), 28-33

Canavan, P.K and Vescovi, J.D. (2004). Evaluation of Power Predicions Equations: Peak Vertical Jumping Power in Women. *Medicine and Science in Sport.* **36**, 1589-1593.

Carfarelli, E., Sim, J., Carolan, B and Liebesman, J. (1990). Vibratory Massage and Short Term Recovery from Muscular Fatigue. *International Journal of Sports Medicine.* **11**(6), 474-478 (*abstract)*

Chapman, A.E. (2008). *Biomechanical Analysis of Fundamental Human Movement*. Champaign. Leeds, UK. Human Kinetics

Clark, M.A., Lucett, S.C and Corn, R.J. (2008) *NASM Essentials of: Personal Fitness Testing Third Edition*. London, UK. Lippincott Williams & Wilkins.

Cochrane, D.J and Stannard, S.R. (2005). Acute Whole Body Training Increase Vertical Jump and Flexibility Performance in Elite Female Field Hockey players. *British journal of Sports Medicine*. **39**, 860-865

Deutsch, M and Woo, M. (2006). Fusion Sport International. Timing Accuracy: Are you up to Speed. [Online] http://fusionsport.com/portal/images/stories/web/timing_accuracy_research_update.pdf [Accessed 5th March 2010].

Dintiman, G, B and Ward, R.D. (2003). *Sports Speed Third Edition*. Leeds, UK. Human Kinetics.

Fushion Sport. (2010). Smart Jump [Online]. http://fusionsport.com/portal/content/view/133/290/ [Accessed 5th March, 2010].

Gibson, A.S.C., Lambert, M.I and Noakes, T.D. (2001). Neural Control of Force Output Durng Maximal and Submaximal Exercise. *Sports Medicine.* **31**(9), 637-650

Goats, G.C. (1994). Massage-The Scientific Basis of an Ancient Art: Part 1. The Techniques. *British Journal of Sports Medicine*. **28**(3), 149-152

Goats, G.C. (1994). Massage- The Scientific Basis of an Ancient Art: Part 2: Physiological and Therapeutic Effects. *British Journal of Sports Medicine.* **28**(3), 153-156

Goodwin, J.E. (2002). A Comparison of Massage and Sub-Maximal Exercise as Warm up Protocols Combined with a Stretch for Vertical Jump Performance. *Journal of Sport Sciences.* **20**(1), 48-49

Goodwin, J.E, Glaister, M, Howatson, G, Lockey, R.A and McInnes, G. (2007). Effect of Pre Performance Lower Limb Massage on Thirty Meter Sprint Running .*Journal of Strength and Conditioning Research*. **21**(4), 1028-1031

Harman, E., Garhammer, J and Pandorf, C. (2000). Administration, scoring and interpretation of selected tests. Cited in, Reiman, M.P and Manske, R.C. (2009). *Functional testing in human performance*. Champaign. Leeds, UK. Human Kinetics.

Harman, E.A., Rosenstein, M.T., Frykman P.N and Rosenstein, R.M. (1990). The Effects of Arms and Countermovement on Vertical Jumping. *Medicine and Science in Sport*. **22**(6), 825-833

Hawley, J and Burke, L. (1998). *Peak Performance: Training and nutritional strategies for sport*. Australia. Allen & Unwin.

Holzabaur, K.R.S., Delp, S.L., Gold, G.E and Murray, W.M. (2007). Moment-Generating Capacity of Upper Limb Muscles in Healthy Adults. *Journal of Biomechanics.* **40**(11), 2442-24489

Hopkins, W.G. (2000). Measures of Reliability in Sports Medicine and Science. *Sports Medicine.* **30**(1), 1-15

Hopkins, W.G. (2001). Reliability of Power in Physical Performance Tests. *Sports Medicine.* **31**(3), 211-234

Issurin, V.B and Tenenbaum, G. (1999). Acute and Residual Effects of Vibratory Stimulation on Explosive Strength in Elite and Amateur Athletes. *Journal of Sport Sciences.* **17**, 177-182

Keogh, J.W.L., Weber, C.L and Dalton, C.T. (2003). Evaluation of Anthropometrical, Physiological, and Skill Related Tests for Talent Identification in Female Field Hockey

King, R.K. (1993). *Performance massage.* Leeds, UK. Human Kinetics.

Lees, A., Vanrenterghem, J and Clercq, D.D. (2004) Understanding How an Arm Swing Enhances Performance in the Vertical Jump. *Journal of Biomechanics*. **37**, 1929-1940.

Lockie, R.G., Murphy, A.J., and Spinks, C.D. (2003).Effects of Resisted Sled Towing on Sprint Kinematics in Field-Sport Athletes. *Journal of Strength and Conditioning Research*. **17**(4), 760–767

Lothian, F and Farrally, M. (1992). Estimating the Energy Cost of Women's Hockey Using Heart Rate and Video Analysis. *Journal of Human Movement studies*. 23, 215-231

Lothian, F and Farrally, M. (1994). A Time Motion Analysis of Women's Hockey. *Journal of Human Movement Studies*. **26**, 255-265

MacLoed, H., Bussel, C and Sunderland, C. (2007). Time Motion Analysis of Elite Women's Field Hockey, with Particular Reference to Maximum Intensity Movement Pattern. *International Journal of Performance analysis in Sport.* **7**(2), 1-12

Mancinelli, C.A., Davis, D.S., Aboulhosm, L., Brady, M., Eisenhofer, J and Foutty, S. (2006). The Effects of Massage on Delayed Onset Muscle Soreness and Physical Performance in Female Collegiate Athletes. *Physical Therapy in Sport.* **7,** 5-13

Mann, R.V. (1981). A Kinetic Analysis of Sprinting. *Medicine and Science in Sports and Exercise.* **13**(5), 325-328

McKechnie, G.J.B., Young, W.B and Behm, D, G. (2007). Acute Effects of Two Massage Techniques on Ankle Joint Flexibility and Power of the Plantar Flexors. *Journal of Sports Science and Medicine.* **6**, 498-504

McNair, P and Stanley, S. (1996). Effect of Passive Stretching and Jogging on the Series Elastic Muscle Stiffness and Range of Motion of the Ankle Joint. *Journal of Sports Medicine*. **30**, 313-18

Mellalieu, S.D. (2003). Mood matters: But How Much? A Comment on Terry and Lane (2000). *Journal of Applied Sport Psychology*, **15**(2), 99-114.

Micklewright, D., Griffin, M., Gladwell, V and Beneke, R. (2005). Mood State Response to Massage and Subsequent Exercise Performance. *The Sports Psychologist.* **19**, 234-250

Moir, G., Button, C., Glaister, M and Stone, M.H. (2004). Influence of Familiarization on the Reliability of Vertical Jump and Acceleration Sprinting Performance in Physically Active Men. *Journal of Strength and Conditioning.* **18**(2), 276-280

Murphy, A.J., Lockie, R.G and Coutts, A.J. (2003). Kinematic Determinants of Early Acceleration in Field Sports Athletes. *Journal of Sports Science and Medicine*. **2**, 144-150

Murtaugh, K. (2001). Injury Patterns among Female Field Hockey Players. *Medicine & Science in Sports & Exercise*. **33**(2), 201-207

O'Donoghue, P. (2010). *Research Methods for Sports Performance Analysis.* Abingdon, UK. Routledge

Oliver, J.L and Meyers, R.W. (2009). Reliability and Generality of Measures of Acceleration Planned Agility and Reactive Agility. *International Journal of Sports Physiology and Performance.* **4**, 345-354

Reilly, R and Borrie, A. (1992). Physiology Applied to Field Hockey. *Journal of Sports Medicine*. **14**(1), 10-26.

Reilly, T and Seaton, A. (1990). Physiological strain unique to field hockey. *Journal of Medicine and Physical fitness*. **30**(2) 142-6

Reiman, M.P and Manske, R.C. (2009). *Functional testing in human performance*. Champaign. Leeds, UK. Human Kinetics.

Paine,T. (2000). *The Complete Guide to Sports Massage.* London, UK. A & C Black

Powers, S.K and Howley, E.T. (2009). *Exercise Physiology: Theory and Application to Fitness and Performance seventh Edition*. USA. McGraw- Hill New York.

Saltin, B., Gagge, A.P and Stolwijk, J.A.J. (1968). Muscle Temperature during Sub maximal Exercise in Man. Journal of Applied Physiology. **25**, 679-688, cited in, Shoemaker, K.J., Tiidus, P.M and Mader, R. (1997). Failure of Manual Massage to Alter Blood Flow by Doppler Ultrasound. Medicine and Science in Sports and Exercise. 29(5), 610-614

Sheppard, J.M & Young, W.B. (2006). Agility Literature Review: Classifications, Training and Testing. *Journal of Sport Sciences.* **24**(9), 919-932

Shoemaker, K.J., Tiidus, P.M and Mader, R. (1997). Failure of Manual Massage to Alter Blood Flow by Doppler Ultrasound. Medicine and Science in Sports and Exercise. 29(5), 610-614

Spencer, M., Bishop, D., Dawson, B., and Goodman, C. (2005). Physiological and Metabolic Responses of Repeated Sprint Activities Specific to Field Based Team Sports. *Journal of Sports Medicine*. **35**(12), 1025-1044.

Spencer, M., Lawrence, S., Rechichi, C., Bishop, D., Dawson, B and Goodman, C. (2004). Time Motion Analysis of Elite Field Hockey, With Special Reference to Repeated- Sprint Activity. *Journal of Sports Sciences*. **22**, 843-850

Spencer, M., Rechichi, C., Lawrence, S., Dawson, B and Goodman, C. (2005). Time Motion Analysis of Elite Field Hockey During Several Games in Sucession: A Tournament Scenario. *Journal of Science and Medicine in Sport.* **8**(4), 382-391

Vescovi, J.D and McGuigan, M.R. (2008). Relationship Between Sprinting, Agility and Jump Performance in Female Athletes. *Journal of Sport Sciences.* **26**(1), 97-107

Weerapong, P., Hume, P.A and Kolt, G.S. (2005). The Mechanisms of Massage and Effects on Performance, Muscle Recovery and Injury Prevention. *Sports Medicine*. **35**(3), 235-256

Weinberg, R., Jackson, A and Kolodny, K. (1988). The Relationship of Massage and Exercise to Mood Enhancement. *The Sport Psychologist.* **2**, 202-211

Wiktorsson- Moller, M., Oberg, B., Ekstrand and Gillquist. J. (1983). Effects of Warming Up, Massage, and Stretching on Range of Motion and Muscle Strength in the Lower Extremity. *The American Journal of Sports Medicine.* **11**(4), 249-252

Wilmore, J.H., Costill, D.L and Kenney, W.L. (2008). *Physiology of Sport and Exercise Third edition*. Leeds, UK. Human Kinetics.

APPENDICES

Appendix A

Appendix A: Informed Consent Form

CARDIFF SCHOOL OF SPORT
YSGOL CHWARAEON CAERDYDD

UWIC

UWIC PARTICIPANT INFORMED CONSENT FORM

UREC Reference No:
Title of Project: Does a pre- event upper limb massage affect speed and agility and countermovemnt jump performance in female field hockey players
Name of Researcher: Kimberley Haynes

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet dated .... for this evaluation study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand my participation in this study is voluntary and that it is possible to stop taking part at any time, without giving a reason. ☐
3. I also understand that if this happens, our relationships with UWIC, or our legal rights, will not be affected. ☐
4. I understand that information from the study may be used for Reporting purposes, but that my personal information will be kept anonymous to everyone except the research team. ☐
5. I agree to take part in this investigation. ☐

____
Name of Participant

____
Signature of Participant

____
Date

* When completed, one copy for participant and one copy for researcher's files.

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Appendix B

Appendix B- Participant Information Sheet

UREC reference number: XXXXXX

Title of Project:

Does a Pre- event upper limb massage affect speed, agility and countermovement jump performance in female field hockey players?

Participation Information Sheet

Background

This project is an attempt to investigate and understand whether a pre- event 5 minute upper limb massage affects speed and agility and countermovement jump performance in female field hockey players.

As a hockey player yourself, you are aware of the need for speed and agility in relation to performance and overcoming opponents in field hockey.This study is concerned with investigating whether an invention of massage either solely or combined with a dynamic warm up prior the start of an game affects levels of speed, agility and counter movement jump activity and performance in comparison to a dynamic warm up only in players aged 18-21.

This investigation will be presented as a report to SASP and might also be published.

Your participation in the research project

Why you have been asked

You have been selected for this study as you represent the desired sample required for the study as you are a) between 18-21 b) a member of UWIC hockey 1st team and c) I believe this selection of people will benefit most from this study and provide an appropriate insight into the results of the research intended.

What would happen if you agreed to be part of this investigation?

If you agree to join the study, there are four main things that will happen.

1. You will be required to participate in a series of 3 tests including a 30 metre linear sprint, pro agility test and countermovement jump of which 3 trials will be taken and recorded.
2. Have your height and weight recorded.
3. You will be randomly assigned into 3 groups. Each participant will take part in all three interventions of: massage only; massage and dynamic warm up and dynamic warm up only as part of a cross over design.
4. We will be repeating these speed, agility and jump tests every week across a three week period. Across each testing week, your group will undertake a different intervention.

Are there any risks?

We do not think there are any significant risks to you by taking part in this study. If you are feeling unwell, we'd advise that you do not take part. And in any case you should do anything that you don not want to – just tell us and you will remain exempt from the investigation. For health and safety reasons, you will be screened for contraindications before taking part.

Your rights

Taking part in the investigation does not mean that you give up any legal rights. In the very unlikely event of something going wrong during the investigation, UWIC fully indemnifies its staff, and participants are covered by its insurance. You have a right to withdraw at any stage from the investigation without providing a reason.

What happens to the results of the study?

The measurements that are taken at the start and the data collected will be stored securely in locked filing cabinets at UWIC. They will be coded so that we can remove names, but we need to keep a record of the codes to compare each participant's results. We will present this information together for all of the participants individually, but there will be no description that would identify individuals.

We will present a report and might also write research papers for publication (in journals).No names or identifying data will appear in any report or publications.

Are there any benefits from taking part?

Yes, you will become more educated in the provisions for using massage and warm ups as a method for affecting performance among its other benefits. If desired, a short report can be produced for individuals containing their results and a short evaluation by which you will be able to understand and then choose what strategies you use in the future to potentially help enhance your performance on the field.

What happens next?

There is an informed consent form to be completed which is required for your participation in this study if you would like to participate in this study.

How we protect your privacy:

Everyone working on the study will respect your privacy. We have taken very careful steps to make sure that you cannot be identified from any of the information that we have about you.

All the information about you will be stored securely away from the consent and assent forms. At the end of the study we will destroy the information we have gathered about you. We will only keep the consent and assent forms with your name and address. We keep these for ten years because we are required to do so by UWIC.

Further information

If you have any questions about the research or how we intend to conduct the study, please contact me.

Kimberley Haynes

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Appendix C

Appendix C: Dynamic Warm up Protocol

Warm Up Protocol
Participants moving around low and changing direction in coned area
Hamstring sweeps then backward run to line
Lunge (With elbow in step) then run backward to line
Lunge (With upright rotation)
Participants moving around low and changing direction in coned area
Front Crucifix
Back Crucifix
Side lie- Quads Micro stretch
Calf Swap-over’s
Spiderman
Participants moving around low and changing direction in coned area
Standing arm swings
Standing stationary arm swings
Shoulder Stretch
Triceps and Latissimus Dorsi Stretch
Falling starts 5m

Appendix D

Appendix D- Warm up Exercises Explanations

Lunge with rotation/ elbow in step: *Athlete takes an exaggerated step and deliberately flexes the hip of the lead leg knee of lead leg is flexed in line with the toes at the front foot of the lead leg. At the same time, the athlete comes on to the ball of the foot on the trail leg. The truck is rotated so the upper body is turned away from the lead leg (Brewer, 2008). This is can also be adapted by putting the elbow into the inside of the foot on the step*

Front Crucifix: *The athlete lies on their back, in the crucifix position, with arms straight out to the side and legs together. Keeping the hands and shoulders in the same position, the athlete alternates between touching left foot to right hand and right foot to left hand (Brewer, 2008, p 199)*

Back Crucifix: *The athlete lies on their front with arms straight out to the side and legs together. Keeping the hands and shoulder in the same position, the athlete attempts to rotate the trunk to the rear touching the left foot to the right hand. This is alternated between left foot to right hand and right foot to left hand (Brewer, 2008, p 199)*

Side Lie Quads Micro Stretch: *Lie on your side and raise the heel towards the buttocks. Exhale, grasp the raised ankle and pull the heel towards the buttocks without over compressing the knee (Alter, 1997, p 129)*

Calf Swap over's: *From a push up position, move your hands closer to your feet to raise your hips and form a triangle. At the highest point of the triangle, slowly press heels to the floor or alternate slowly by flexing one knee while keeping your opposite leg extended (Alter, 1997, p88)*

Spiderman: *In a press up position, bring foot up as close to the hand as possible, alternate left to right.*

Standing Stationary arm swings: *Stand with feet together and swing arms in sprinting motion. Each arm should move as on piece with the elbow bent at about 90º. The arm action should be forward and back without crossing the midline of the body (Brown & Ferrigno, p23)*

Shoulder Stretch: *The athlete stands, and moves one arm across in front of the body, keeping the palm facing forward and the arm at shoulder height. They now bend the other hand underneath this arm, at a position slightly abow the elbow and, as they exhale, they pull the elbow across the body, while keeping the trunk facing forward. After holding at the appropriate point, they repeat the stretch with their arm rotated so that the palm faces towards the body (Brewer, 2008, p 221)*

Triceps and Latissimus Dorsi Stretch: *The athlete stands with one arm raised overhead, as close to the ear as possible and flexed at the elbow, so the hand is resting behind them, on the opposite shoulder blade. With the other hand, the athlete grasps the utside of the flexed elbow and pulls the elbow behind the head to an appropriate hold position (Brewer, 2008, p 222)*

Falling Starts 5m: *Stand with feet together and lean forward until balance is lost. At this point accelerate at full speed to catch yourself (Brown & Ferrigno, 2005, p 46). Sprint for 5m*

References for Appendix D

Alter, M.J. (1998). *Sport Stretch: 311 Stretches for 41 Sports. Second Edition.* Leeds, UK. Human Kinetics

Brewer, C. (2008). *Strength and Conditioning for Sport*: *A Practical Guide for Coaches*. Leeds, UK. Sports Coaching UK

Brown, L.E & Ferrigno, V.A. (2005). *Training for Speed, Agility and Quickness.* Leeds.UK. Human kinetics.

Appendix E

<u>Appendix E- Massage Hand Skill Definitions</u>

Hacking: *Repetitive contact of the skin using the ulnar borders of each hand (Callaghan, 1993)*

Cupping: *The therapist cups the hands and strikes the patient's skin smartly with the concave palmar surface. On impact the hollow space traps an air cushion next to the skin which reduces the stinging sensation and disperses the shock more evenly through the tissues (Goats, 1994 p150)*

Slapping: *The therapist uses the entire palm surface and lightly but rapidly slaps the part to be massaged (Sykaras et al, 2003, 154)*

Vibrations: *The therapist can elevate the extremity to encourage the venous and lymphatic return and then shake the limb. (Callaghan, 1993, p 29)*. *'Vibrations' are delivered by trembling both hands held firmly in contact with the skin (Goats, 1994 p150)*