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An investigation into the effects of traditional neuromuscular training Vs rider specific training on novice rider position

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AN INVESTIGATION INTO THE EFFECTS OF TRADITIONAL NEUROMUSCULAR TRAINING VS RIDER SPECIFIC TRAINING ON NOVICE RIDER POSITION

by

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Abstract

The equine industry and within it, the competition rider community, is increasingly acknowledging that rider strength and fitness is vital in achieving the best results in competition. The sport of horse riding is described as unique in its posture and motion patterns and cannot be easily be compared to the actions of any other athletic endeavour. There are several factors that cause a horse to not move correctly, the most common being an unbalanced rider. Other sporting disciplines are more aware of the potential of the utilisation of additional methods to improve performance, for example Pilates is commonly used to develop optimal strength and balance in modern dance and ballet. In the absence of published work on the benefits of additional dismounted exercise on rider posture, this study aimed to determine a quantifiable measure to assess progress in the development of a novice mounted rider's position using two different dismounted treatments to determine the key factors in promoting the benefits of a fitness programme.

Students at Duchy College (n=16) were divided into two treatment groups, Rider Specific training (n=7) and Traditional Neuromuscular training (n=9) and completed the allocated training regime for 8 weeks and 5 weeks respectively between 26th January 2012 to 23rd March 2012.

Measurements were taken whilst subjects were mounted on horseback before any additional training treatment was administered, riding in walk, sitting trot and rising trot as well as on a weekly basis until the fitness programmes had been completed. A final data collection session was filmed upon conclusion of the additional fitness treatments. In addition to the mounted measurements, fitness data were collected using the 20m shuttle run, resting heart rate and the sit and reach test before and after additional dismounted exercise. Each rider had 3D spherical markers attached at specific anatomical landmarks; top of hat, shoulder, hip and heel. Using Quintic Sports Biomechanics Video Analysis Software package a vertical line was drawn through the hip marker and the deviation of each marker from this line was recorded. Leg length data were collected by measuring the distance between the hip and heel marker before and after the treatment sessions.

All data were collated using MS Excel software and tested for normality of distribution using an Anderson Darling test in the Minitab™ v16 statistical analysis package. If a normal distribution was present a paired t test was used to determine the extent of differences in all fitness tests and leg length pre- and post- fitness treatments. The deviations from the ear, shoulder, hip and heel (ESHH) alignment were not normally distributed. The deviation of the marker in relation to time, marker placement; gait and repeat stride were tested using a Friedman test. The comparison between rider (subject) and marker (factor) were analysed using a Kruskal Wallis test. For all statistical tests a probability of $P<0.05$ alpha was used.

Engagement in additional dismounted exercise, either traditional neuromuscular training or rider specific training methods did not result in a significant difference in Resting Heart Rate (RHR) ($t_7=3.18$; $p>0.05$) or Bleep Test (BT) ($t_1=2.0$; $p>0.05$) in the rider specific training group in comparison to the traditional neuromuscular training group that showed significant difference in the (RHR) and (BT) ($t_5=6.15$; $p<0.001$ and $t_4=11.83$; $p<0.05$) respectively, in the traditional neuromuscular training treatment group. The Sit and Reach test showed there was a significant difference in rider specific training group (9.17 ± 3.05) ($t_4=10.55$; $p<0.05$) in comparison to no significant changes ($t_2=2.55$; $p>0.05$) in the traditional neuromuscular training (6.3 ± 1.5 (cm).Both Rider Specific training showed significant improvement in rider position ($P<0.005$) as well improvements in the Traditional Neuromuscular training treatment ($P<0.005$). Each gait had a significant effect on the deviation from the ESHH alignment (N=16, $H_2=221.53$; $P<0.001$). Both treatment groups demonstrated a similar significant effect (n=7, $H_2=133.25$; $P<0.001$, n=9, $H_2=101.75$; $P<0.001$) respectively. The deviation of markers in the rider specific training (n=7, $H_2=351.38$; $P<0.001$) displayed a significant difference of each markers deviation in line with the findings of the ball sports (n=9, $H_2=377.48$; $P<0.001$). Both treatments had a significant impact on mounted leg length, treatment group one, rider specific training ($t_6= -7.91$; $p=0.001$) and treatment group two ($t_2=3.77$; $p<0.05$) traditional neuromuscular training. This study demonstrated that additional dismounted exercise significantly ($p<0.05$) improves mounted rider position. It is reasonable to assume that the relationship between the treatment and decrease in deviation from the ESHH alignment is due to the general implementation of an additional exercise regime. However, the traditional neuromuscular training treatment group showed

improvements at a quicker rate over the rider specific training group. The impact of personal participation was identified as a major contributing factor in using dismounted exercise in improving novice rider position and therefore assists in our understanding the role of exercise that could be most beneficial to further education equine students. Even though this study was undertaken on a relatively small sample of Further Education students, these findings suggest a role for additional team exercises in promoting fitness and improvement of mounted rider position in novice equine athletes.

KEYWORDS: Horse Rider, Fitness, Pilates, Traditional Neuromuscular Training, Ball Sports, Equine Students

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Authors Declaration

At no time during the registration for the Degree of Research Masters has the author been registered for any other University award without prior agreement of the Graduate Committee.

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1.0 Introduction

The exact date that horses were domesticated to be ridden remains a topic of controversy, although records suggest that horses were ridden in 4500 BC. It is known that equestrianism was part of the 1900 modern Olympic Games; highlighting the increasing popularity of horseback riding (British Horse Society, 1990; Meyners, 2009). Horse riding is described as unique sport because of the posture and motion patterns that are required by the rider. This is because the rider is aiming to achieve harmony with the horse across the interface of the horse's dynamic back motions at a variety of speeds, and therefore cannot be easily be compared to the actions of any other athletic endeavour. It is important to understand how the horse should be moving whilst being ridden to enable the rider to understand the potential influencing factors. A correctly moving horse should be moving straight, with each hind hoof falling in the same indentation of the forelimb hoof; whilst covering the ground in an even rhythm dependent on the speed. There are several factors that cause a horse to not move correctly, such as lameness, ill-fitting saddle and most commonly an unbalanced rider. It is agreed that a balanced horse rider can provide a stabilising effect on the ridden horse as less variance in gait (pace) is shown in comparison to the free-schooled horse (Peham *et al*., 2004; Warren-Smith, 2007). The British Horse Society (BHS) describe the 'correct' influence of the rider on the mounted horse as "*independent and able to regulate energy created by the legs, in order to control the movement of the horse, whilst regulating the speed with the hand".* This highlights the level of control the mounted horse rider possesses over the way the horse moves. It has been suggested that a rider who has correctly prepared themselves for horse riding by undertaking a proper fitness regime is able to achieve more accurate application of the instructions given to the horse whilst in the saddle (Blokhuis *et al.,* 2010). Co-ordination is typically defined in sport science literature as the muscular interplay of all partial movements that make up a specific motion (Meyners, 2011). Riding involves more diverse characteristics of muscle coordination and movement in comparison to other sports such as football, athletics or rugby due to the repetition and incorporating the influence of the horses' stride cycle. A desirable attribute of a horse rider is to be realistic concerning awareness of their personal degree of stiffness and flexibility whilst understanding the extent they are required to co-ordinate the intensity whilst training. The main issue with researching horse rider position is the subjective nature of 'scoring' a horse riders position (Symes and Ellis, 2009) and overall posture. Developing a methodology to enable a quantifiable assessment to measure position and consequently assess improvement as well as a potential marker to encourage the rider to feel a correct, upright position could result in the riders being able to assess their own, mounted position. The aim of this study was to use a quantifiable measure to assess progress in a novice mounted rider's position using two different dismounted treatments to determine the key factors in promoting the benefits of a fitness programme.

1.1 **A brief history of domestication (of the horses) and development of equestrianism.**

The popularity of equestrianism has grown in many parts of the world even though horse related sports are sometimes fatal. The dangers of horse riding have consistently been communicated in a range of literatures (BETA, 2006; Blokhuis *et al.,* 2008; Hawson *et al*., 2010). However, there are few deterred from working in the industry due to injury risk factors as evidenced by substantial demand for highly trained staff (BETA, 2006).

The nationally recognised courses offered by Equine colleges provide the means to improve individual's education and experience to develop a strong ground knowledge in horse management as well as provide a qualification at the end of a course which will certify the student is of a competent standard to progress. However; a suggested addition to college syllabus is; to promote control and balance (whilst mounted) to ultimately improve safety as well as potentially being an advantage point for gaining employment in the competitive industry (Bromily, 2000; BETA, 2006;Hawson *et al.,* 2010). An imbalanced rider can have a negative impact on the horses consequently resulting in compromised horse welfare; highlighting the importance of the syllabus of equine colleges. Leisk and Johnson (2010) identified that many rider instructors focus on the development of the horse, often overlooking the impact of the riders' position on the horse. It is felt that successful graduates of equine courses should be able to safeguard the welfare of the horses in their care. Having access to coaches and experts in colleges that offer equine courses allow students to avoid making common mistakes in fundamental equitation such as being unbalanced in the saddle or giving the horses incorrect instructions. Whilst teaching groups of College students the Instructors have the knowledge and the opportunity to correct unnecessary errors as well as encourage 'feel' of the ideal way of riding.

1.2 What equestrianism means and the interface between horse and human

There has been a limited amount of research into rider position, possibly due to difficulties in dealing with large amount of variables in the horse and rider. However, it is known that horse riders need stamina for the intense muscular demands that are requested when maintaining the correct posture. It is important for riders to have a strong 'core', abdominal muscles with all of the main muscle groups working together to enable the rider to remain stable and upright. The transfer of information between the horse and rider is affected by the skill and ability of the rider to provide the right physical signals at the appropriate time and to being able to react quickly enough in unpredictable situations.

Proprioception is the provision of information to the body regarding position and movements of the joints and effort, timing and force of a muscle contraction (Bishop, 2003; Behm *et al.,* 2006) consequently incorporating exercises that increases self-awareness as well as coordination can be beneficial for horse riders. A correct rider position is widely accepted to translate into a higher performance score during competition or personal result achieved during training. The way that people measure the performance of an animal either, in the competition forum or during training, is highly subjective. Increasing the awareness of how important balance is to the rider is important and needs to be taken into account when developing objective performance markers. Maintaining a straight line down the lateral points of a rider's position through alignment of markers enables an instructor to visually assess the riders' position and therefore monitor the impact on the horse's performance. Recently it has been re-acknowledged that art of riding is derived from the effectiveness of the interface between the horse and rider (the seat) Blokhuis *et al.,* 2010; Halliday *et al.,* 2010). Within equitation riders use their 'seat' to communicate with the horse, ie provide a signal (within equitation known as an aid) to influence the actions of the horse.

It has been observed that a heavy seat will cause a horse to hold the head high, neck tensed and often cause stiffness of the movement (BHS, 1990; Odberg and Bouissou, 1999) although the coupling between horse and rider has not been fully investigated and a well ridden horse should be as balanced as a free schooled horse (Weishaupt *et al*., 2006).

The communication between the horse and rider is influenced by the rider skills (McGreevy and McLean, 2010), and levels of physical fitness and rider weight can substantially influence the horse's movement and gait kinematics (Symes and Ellis, 2009; De Cocq *et al*., 2010; Munsters *et al.,* 2012). The performance of a rider, and consequently how effectively a horse is ridden, is not only determined by the position of the rider, but also the interface between horse and rider.

A prerequisite of all training should be relaxed muscles which can be identified by equal and loose strides allowing the horse to be able to cover the ground in a balanced manner as described by the British Horse Society (BHS, 1990) A rider should perform in harmony with the horses' motion and allow the back muscles to work free from tension (British Dressage, 2012; Fédération Equestre Internationale (FEI), 2012).

1.3 The horses' natural movement ('way of going')

It is important to understand the way a horse moves in order to understand the other possible factors that need to be accounted for whilst assessing rider position due to the forces felt by the horse rider during motion, which could in turn affect the riders' positioning in the saddle. The levels of physical fitness and physical attributes such as 'asymmetry' and the weight of rider can also influence the mobility of the horse and its gait kinematics (Licka *et al*., 2004; Symes and Ellis, 2009; De Cocq *et al*., 2010). The equine gaits are identified by repetitive cycles of individual limb movements and should be able to deliver speed within the limitations of efficient energy used (Back *et al.,* 1997; McGreevy and McClean, 2010) defined by Clayton (1989) as "a complex and strictly co-ordinated rhythmic and automatic movement of the limbs and entire body length of the animal, which results in the production of progressive movements". The horse has four main gaits - walk, trot, canter and gallop. The walk is a four beat gait in which limbs move in an alternative diagonal action (Figure 1). If the horse strikes off with the left foreleg the sequence of footfalls would be: left foreleg, right hind, right fore and right hind. As the horse moves forward in the walk the horses top line contracts and extends corresponding with the horses' footfall. It is for this reason that a horse's head should be allowed to freely move through riders hands following the action of the horses head and the seat of the rider follows a sweeping motion. The horse's trot is made of the limbs moving in symmetrical, diagonal pairs. Between each movement of diagonal pairs there is a moment of suspension. The head and neck of the horse remains still whilst trotting allowing the riders hands to remain still and equal whilst holding the reins. The reins are the direct link between the metal in the horses' mouth and the riders hand (Plate 1). Trot is commonly used in scientific studies of rider symmetry as its physical dynamics allow lameness to be exhibited. Canter is a non-symmetrical gait comprising the three beats made up of a hind leg, then a diagonal pair, then the leading foreleg, the full stride cycle is completed with a moment of suspension. The fastest gait of the horse is the gallop. The formula: stride rate x stride length has been used to estimate the speed of the horses gallop. The length of the horses' stride increases relatively with the speed of the pace whereas the amount of strides per cycle does not relate linearly (Clayton, 1989; Pelham *et al.,* 2010; McGreevy and McClean, 2010). It is important for the dynamics of the three gaits to be fully understood; since the different stride patterns of each gait require a different sequence from the riders' position.

Using biomechanical assessments the movements of a horse can be reduced into the following elements, acceleration, and deceleration, turning on the front legs (forehand) and turning on the back legs (haunches). It also allows for the identification of the factors which enable these changes; protraction and retraction for increasing and reducing speed, and adduction and abduction for any turning movements. The abduction and adduction of the limb is for producing and reducing the speed of the gait. It is the stance phase of the limb, started at impact with ground and finished when the limb left the ground, which enables energy to be produced by the acting forces on the ground. Once the limb has left the ground the limb is said to be in swing phase and has no further impact on the speed of the horse (Clayton, 1989; McGreevy, 2007; McGreevy and McLean, 2010). This information can be used by riders in order to understand the origin of the force and how this will impact the position especially whilst riding advanced movements involving collection and suspension such as Piaffe (Plate 1). The Piaffe is an advanced movement performed in advanced dressage and classical riding, in which the horse executes a slow, elevated trot without moving forward (FEI, 2012).

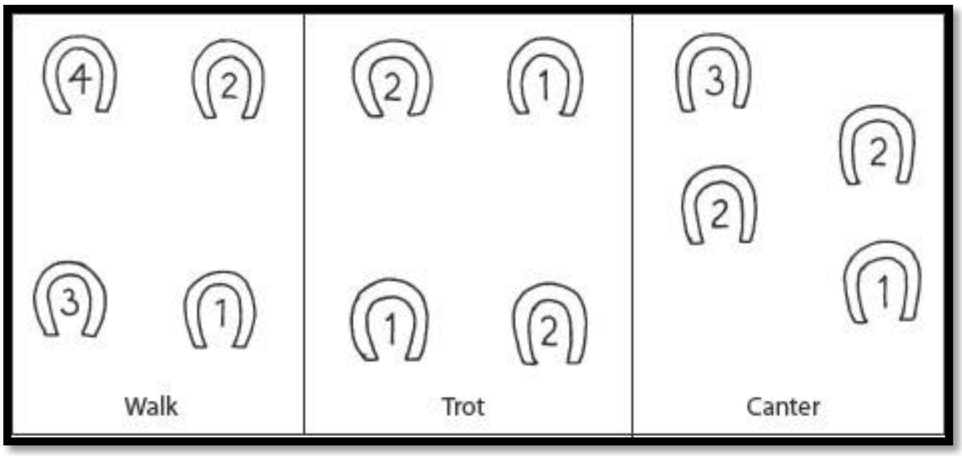


Figure 1: Foot fall sequence of Walk, Trot and Canter left.

Source: Anon (2013) Horses Gaits and Paces (Accessed 10/2/13)

Plate 1: Correct Rider position whilst executing the advanced dressage movement, Piaffe.

Source: CharlotteDujardin.co.uk (2012) Page accessed 10/11/12

If Newton's third law (every motion has an equal and opposite reaction) is applied to the horse and rider, when the horse applies a force on the ground (stance phase) an opposite force is sent up the horse's limb. These acting forces can be broken down into horizontal forces that propel the horse forward and vertical forces that move the horse upwards. These forces are then directly experienced by the rider through the motion. Fruehwirth *et al. (*2004) and McLean and McGreevy (2010) have identified that during the stride cycle of the trot, the rider potentially is responsible for two peaks of increased pressure which parallel to the end of the stance phase in the diagonal pair. The horses back moves in distinctly different ways depending on the gait. The rider is required to move their seat in a parallel motion to the defining stride cycles so to not disturb the motion of the gait. During rising trot, the horse 'rounds' its back whilst the legs are in the swing phase; the inertia causes the rider to be momentarily behind the motion; when the leg returns to the stance phase, the rider will catch up with the stride motion landing in the saddle, possibly more heavily than desired (Lagarde *et al.,* 2005). Studies have shown that the more experienced the rider, the lighter they will return to the saddle in rising trot possibly due to being more consistent with the movement of the horse (Pelham *et al.,* 2001; Lagarde *et al.,* 2005). The relationship between rider consistency with the movement of the horse and rider proprioception has been discussed by Meyners (2011) and Pitts (2011) both highlighting the importance of promoting the benefits of additional training methods to a novice audience.

1.4 The physical impact of the rider on the horse

It is recognised and widely accepted that a horse is unable to move at its full potential without optimal level of balance from the rider which can be improved through additional exercise, core strengthening regimes and general fitness. Postural Characteristics can be inherited, although it is more common for postural defects to be developed through incorrect use of the muscles (Jenson and Schultz, 1970; Keeny and Levy, 2003; Licka *et al.*, 2004). Rider fitness and self-awareness has been associated with injury and underperformance in both the horse and rider (Dyson, 2002; Klimke and Klimke, 2006; Symes and Ellis 2009) suggesting that the improvement of fitness in the equine athlete would increase performance. The horse rider is responsible for a substantial amount of movement of the horse whilst mounted. Therefore, it is important for the rider to be able to maintain and control their upper body strength in order to maintain a consistent physical connection between the horse's mouth and riders hands (contact) (BHS,1990;FEI, 2012; Meyners 2011;) and transfer messages through the deepest part of the rider in the saddle (seat) and the legs successfully.

1.5 What is considered to be the correct rider position?

The impact of the rider on the horse highlights the importance of minimising the pressures on the back to allow the horse to move freely and therefore, improving the welfare of the horse. Horses are most likely to be effected by the experience of the rider whilst travelling in walk; this could be due to the nature of the pace and the requirements of the rider to allow the hip and hands to move with horse due to ethical equitation becoming a focus in the industry both in competition and the riding school scene (Dyson, 2003; Klimke and Klimke 2006; McLean and McGreevy, 2010). A common descriptive guide used within the equine industry is to imagine that if the horse was removed, the rider would be able to land and stay on their feet. The rider's weight should be pushed down into the seat bones (*ischial tuberosities*) if balance is to be successfully achieved. The 'correct' rider position has been clearly described by many authors, with no dispute that the basis of being an effective rider is having a correct position. In popular literature the 'correct' or 'ideal' position has been described as having an 'imaginary' straight line from the ear, through the shoulder, hip and heel (ESHH) (see Plate 2), aligning all weight bearing segments allowing gravity to pass down to the rider's heel and avoid any muscle strain. The British Horse Society (1990) describes the correct rider position as "*[the rider] sits in the deepest part of the saddle with the weight evenly distributed on the two seat bones. The upper body should be vertical and held straight, without tension or stiffness. The upper arms hand lightly by the sides, close to the body with the elbows bent. The wrists should be slightly rounded, the thumbs uttermost and the hands tilted so that each thumb points towards the opposite ear. The whole leg should be in light contact, the knees relaxed and not gripping. The lower part of the inside of the calves should be touching the horse at, or slightly, behind the girth. There are two straight lines that can be observed from the ground. The first of these is from the rider's ear, through the shoulder and hip and his heel. The second is from the riders elbow to the horses' bit*". This description is in agreement with the suggestions of Jenson and Shultz (1970) who stated that the stirrup leather (A stirrup is a light frame that holds the foot of a rider, attached to a saddle by a strap, known as a stirrup leather as seen in Plate 2) should remain perpendicular to the ground with limited rotation of the legs, and the patellae and the feet should remain parallel to the side of the horse. When the ESHH line is maintained then ultimate balance and harmony can be achieved (in theory). Schils *et al*. (1993) demonstrated that it is possible to maintain this ESHH alignment whilst in motion as well as stating that the more advanced the rider is, the more stable the ESHH alignment. The physiological advantages of minimising the deviations from the ESHH alignment include encouraging the rider's spine to stay close to the 'neutral' position. The benefits of having a neutral spine allow muscles to have an optimal length and tension relationship, resulting in successful proprioceptive feedback being provided by the body to the mind and therefore a better riding position. Lovett and Hodson-Tole (2004) suggested that the position of horse riders in motion is influenced by the propulsive forces of the horse's hind limb. Posture has been defined by Winter (1995) as "*the orientation of any, body segment relative to the gravitational vector. It is an angular measure from the vertical*". Posture can be altered through the use of suitable training techniques and therefore improved by a well-informed riding or fitness coach. Winter (1995) also defines balance as a generic term describing the dynamics of body posture to prevent falling and considers it to be related to "*the inertial forces acting on the body and the inertial characteristics of body segments*". Using these descriptions, a rider and/coach is able to understand experience the importance of being able to work in 'harmony' as the influence of rider on gait is just as important as the gait on rider position. Common errors made by both rider and coach include failing to pursue the importance of correct equitation, such as subtle signalling, poorly timed horse riding and inconsistency of instructions including the seat.

Plate 2: Rider demonstrating ESHH alignment during the sitting phase of rising trot

Source: E. Boden (2010)

1.6 The impact of riding on equine welfare

The equine industry in general and the horse riding community in particular is increasingly acknowledging the importance of rider fitness as well as understanding that both the horse and the rider must be 'fit for purpose' as the sport of horse riding involves two athletes. It has been recognised that a horse is unable to move at its full potential without optimal level of balance from the rider which can be improved through additional exercise and core strengthening regimes (Blokhuis *et al.,* 2010; De Cocq *et al.,* 2010). An additional training programme without horses was found to be positive as well as improving the perceived riding position in agreement with parallel research in dancers, gymnasts, fencers and divers, who maintain straight postures to allow precision movements although, unlike horse riding, are required to hold positions resulting in rigidity (Fitt *et al*., 2004; Hewitt *et al*., 2011; Meyners, 2011).Other sports have undesirable impacts on posture such as swimming may cause a 'slouch' or relaxed posture.

1.7 Why rider fitness is important in relation to equine welfare.

The current movement towards understanding the influence of the rider on the horse and encouragement of acceptance of ethical equitation is an ideal time to introduce novel techniques such as dismounted exercises to improve mounted performance amongst horse sports; resulting in the horse being the primary beneficiary (Licka *et al.*, 2004; De Coq *et al.*, 2010; McLean and McGreevy, 2010). Being able to ride in an effective position, at any level, requires complete control of the abdominal region and a balanced muscular system. The control of the abdominal region allows the ear, shoulder, hip, heel (ESHH) alignment to be maintained (Plate 2). The smallest shift in rider position or centre of gravity can result in loss of alignment and in turn the harmony with the horse (Keener and Levy 2003; Blokhuis 2010; Leisk and Johnson 2010). These findings support Leisk and Johnson (2010) who suggested that supplementary exercises for riders may improve rider position concluding that if the rider position can be improved whilst dismounted, welfare of the horses may be improved and less falls may be experienced by the rider. Rider's biomechanics along with the rider knowledge and skill are responsible for a large element of training the horse indicating that the horse cannot perform to the best of its ability if the rider is lacking in either of those areas. The horse and rider relationship is as influential on the welfare of the horse as feeding and management regimes (husbandry) which may be improved through specific rider training whilst mounted as well as dismounted (Licka *et al.,* 2004;McGreevy and McLean, 2010; Meyners (2011). There has been a large amount of research and focus on how the immediate environment affects the welfare of horses (Odberg and Bouissou, 1999; Pritchard *et al*., 2005) with a lot less focus on the welfare implications of the horse and rider interaction (Warren-Smith *et al.,* 2007;De Cocq *et al.,* 2010).) McGreevy *et al.* (2009) identifies that riding horses requires the trainers and horse riders to use knowledge of learning theories to control a horse whilst mounted. This theory identified the foundation importance of giving the horse clear, well timed instructions and if ignored then the errors are highlighted through unpredictable behaviours being exhibited; accentuating the importance of a strong rider position which is proposed to be achievable through improving fitness.

Physical fitness can be broken down into performance and health related areas. Physical fitness is normally maintained by the elite athletes in order to achieve outstanding performance during competition. Conversely, a lack of exercise will result in a reduction of general muscle function. It is important for young adults, especially equine students, to understand the benefits of participating in regular, moderate exercise in order to maintain a level of fitness for their equestrian pursuits as well as for achieving better quality of life (Gallahue, 1996; Nielson and Anderson 2003; Chen and Lin, 2011).

Rider fitness *per se* is rarely addressed in current journals. An early description was provided by Xenophon in '*The Art of Horsemanship'* (circa 362 BC) where the importance of basic training was described for both the horse and the rider. It was reported that gymnastic exercises combined with the ridden activities formed the basis of the formal cavalry lessons. From this it can be seen that the cavalry recognised the importance of dismounted fitness instruction as well as mounted instruction.

The rider is required to be able to maintain balance whilst on top of the horse so therefore must be able to change their centre of gravity (COG) efficiently. Once the rider has achieved balance (whilst mounted) the harmony between the horse and rider can be maintained and rider skill can be improved through specific training whilst dismounted and mounted (Peham *et al.,* 2004; Leisk and Johnson, 2010; Meyners, 2011). It is widely accepted throughout a large range of ages, that ball games or ball skills are a valuable technique to encourage cognitive skills as well as improving balance, awareness of posture, improved hand- eye co-ordination and promoting physical fitness (Meyners, 2011).
Until the 1980's there had been limited investigation into the methods of training the equine athlete, although there was focus on developing the terminology, concepts identification of techniques. This was also the beginning of the developments of electronic, biomechanic systems enabling computer visualisation (Clayton, 1989). The recent development of new analytical procedures and technologies allow new training methods to be established such as biomechanical software as exemplified by Quintic™ and Dartfish™ movement analysis packages. The use of technology has enabled researchers to raise questions about the effect of exercise away from the saddle. For example it has been identified that during any stretching motions muscles should be relaxed so that they remain elastic as possible as well as preventing injury (Meyners, 2011; Pitts, 2011) as well as being as energy efficient. It is imperative for the equine athlete to transfer to the self-awareness gained through various daily tasks (walking) into information that can be utilised when

sitting in the saddle (Meyners, 2011), for example walking tall, shoulder blades relaxed and chin held straight also the position required whilst mounted, achieved whilst being aware of the surroundings and potential hazards.

1.8 Rider Performance in relation to fitness

Generally physical fitness can be defined as the result of a combination of several physical aptitudes; muscular strength, balance, flexibility, overall body composition and cardio-respiratory endurance (Heywood, 2002; Vanhees *et al.*, 2005; Batcho *et al.*, 2012). in comparison to the specific training requirements of neuromuscular coordination training specific to the demands of the performance.

Human physical fitness **is** an important factor of most aspects of life, since it largely determines the level of functional ability whilst executing an act which aims to result in a practical end result; for example, lifting and walking with a box. Myers *et al*. (2002) and Disseldorp *et al*. (2011) highlighted that reduced cardio-respiratory fitness is linked with a large number of characteristics of poor health. Resting heart rate (RHR) can be used to assess physical fitness in more sedentary individuals to allow a measure of improvement after intervention programmes to improve fitness parameters (; Huang , 1998; Chodzko-Zajko *et al.*, 2009 Batcho *et al.*, 2012).

A further reason for promoting the use of a fitness regimen is to increase the efficiency of the muscles as a trained individual uses five times less energy that the untrained individual (Jenson and Shultz, 1970; Lamb, 1984). This rationale is important to the horse rider due to the nature of the sport. The psychological and physiological benefits of a consistent exercise regime are well recognised (Bull and McGregor, 2000; Meyners, 2011) with agreement that the most challenging aspect of promoting of physical education is successfully gaining participation or maintaining attendance for the full length of the programme. However, there has been limited research into the difference in muscle development amongst individuals. It is possible for some muscles to increase (in mass) up to 5% a week which could be due to the muscles being in better condition before the uptake of an exercise programme (Jenson and Shultz, 1970).

Subsequently, a need to understand the impact of course length, has resulted in studies investigating the reason for rejecting exercise programme in order to identify, understand and modify potential contributory factors. This understanding could allow exercise programmes to be tailored to get maximal participation. The attitudes and exercise routine adopted by many adults has been related to the attitudes possessed whilst being an adolescent. Macfarlane (1997) and Guldan and Wu (1997) found that as many as 95% of high school students who did not take part in exercise daily watched at least four hours of television a day in contrast to the 13% who took part in exercise daily. These figures suggest that students have little regard for the importance of fitness promotion and a change in attitude towards physical activity. There are many factors which may prevent both the uptake and continuation of exercise. Bray *et al, (*2005) and Dishman and Sallis (1994) showed that individuals were affected by training environment, fitness instructor or exercise leadership styles. Chen and Lin (2011) and Eyigor *et al*, (2007) demonstrated that substance of the course as well as the timing of exercises over sixty minute instalments. Furthermore, Smith (2003) suggested that peers are important to the development as well as being vital to add to the enjoyment and competency development in agreement. Bray (2005) and Jenson and Shultz (1970) suggested that enjoyment encourages future involvement and continued participation thus the exercises and delivery method need to suitable for the target population. Psychological readiness is equally important, highlighting that an 'ideal' exercise regime needs the athlete to be prepared to contribute ultimate exertion throughout the specific exercise regime to enable maximal improvement. This information enables researchers to develop an exercise system which will encourage consistent participation and consequently increasing the reliability of results. Although it has been found that varying exercise programmes can be effective at increasing the strength of muscle as well as the improving the function, the most effective programmes for increasing physical performance have not been identified. Lamb (1984) suggested that *"physical fitness would result in a higher possibility for individual success when facing the challenges of one's life*". However, it is still necessary to highlight that prescriptive exercise programmes are necessary and improve fitness levels. There is limited understanding of the exact demands required of the appropriate quality, quantity and intensity of regimes needed to promote fitness to specific audiences (Dishman and Sallis, 1994; Bray *et al.,* 2005).

1.9 Commonly used aspects of fitness for horse riders

When learning a new sport, people use motion patterns that have been developed in other areas to aid the learning of the techniques required. Motion patterns are defined as approaches to structurally similar movements or techniques that are needed in specific situations. Horse riders are required to be able to sustain prolonged physical or mental effort as maintaining optimum performance is fundamental to training a horse. Physical fitness is an aspect that can directly be related to improving stamina as well as the overall capability of one's body to adapt to life and the environment [as well as being] closely linked to the effectiveness of working and learning [as well as] the efficiency to deal with occasional emergencies (Oxford Dictionary, 2011; Chen and Lin, 2011; Meyners, 2011).

Indoor rowing has grown in popularity amongst other athletes for cross training and conditioning as well as the use of elliptical trainers. The use of indoor rowing machines is common across many different athletic disciplines for improving fitness rather than improving their rowing technique. Substantial research has investigated the technically correct strokes of people rowing and the impact of correct pelvis rotation and found a stabilising effect of the pelvis. The action of rowing requires a substantial amount of postural control in the core to enable the transfer of the force during the action of rowing to be passed safely and efficiently (Bull and McGregor, 2000; O Sullivan *et al*, 2003). The research into the correct technique during rowing highlights the importance of abdominal control in spinal straightness in order to prevent injury very much the same as the requirements of a horse rider whilst performing movements or downwards transitions. Similar to horse riding, rowing technique relies on understanding the physical forces applied during motion, however, unlike riding a horse, the speed of a boat is an important factor in determining the rowing performance (O Sullivan *et al*, 2000; Cerne *et al* 2011).

A good approach for a riders' full body conditioning would include elliptical trainers. Elliptical trainers are similar to treadmills, but with less loading or impact on the lower joints; as well as facilitating inter-limb coordination. Furthermore elliptical trainers allow greater knee and hip flexion than that allowed whilst walking, which can be directly applied the needs of the horse rider (McMillan *et al.,* 1998; Porcari, *et al*. 2002; Lou et al., 2007). An advantage to using an elliptical trainer over a treadmill includes that working backwards (Flynn, 1993) in a safe manner enables the athletes to utilise the hamstrings in an efficient and safe situation whilst improving core and lower back strength. There has been limited research into the use of elliptical trainers although a study by Prosser *et al.*, (2011) examined the comparable muscle activation whilst undertaking elliptical training, stationary cycling and treadmill walking which found that the elliptical trainers had the highest muscle activation in the hamstring group.

Skipping or jump rope, is an exercise that requires repetitive and continuous motions, the nature of the repetitive motions can be directly linked into the stride cycle of a horse. Not only is skipping a familiar game to many children, it is also a traditional exercise used by many different types of athletes. The previous studies, that have investigated the oxygen usage during jump rope exercises, have suggested that the oxygen consumption exceeded 70% highlighting the intensity of this aerobic exercise. In contrast to other fitness activities, such as running, skipping does not require the use of expensive equipment or a large amount of room to perform (Quirk and Sinning, 1982; Kiwano *et al.,* 2012). Skipping or jump rope exercises has a continuous and frequent set of motion skills and can be divided into two stages; the landing phase and mid-air phase. Each 'jump' requires the use of similar muscle groups as used in riding, skipping is seen as being able to positively contribute to the correct development of muscles due to the physiological demands of performing a body projection (Jenson and Schultz, 1970; Hsieh and Chiu, 2007). The individual muscle groups that are required during the phases of skipping, rowing and elliptical training; a different group of muscles are being engaged and used independently therefore being applicable to the horse. An area of rider position which cannot be assessed, although improved, using elliptical training techniques is the elasticity of muscles such as the hamstring. Sit and Reach tests are also commonly used in physical fitness tests to assess an individual's range of movement (Lou *et al.,* 2007; Ritchie, 2008; Cerne *et al.,* 2011; Prosser *et al.,* 2011; Chen and Lin, 2011).

1.10 Popular equine fitness training

Pilates was developed in order to rehabilitate wounded soldiers in during World War I, through encouraging movement, and subsequently strength, through incorporating springs and straps over harmed soldiers' beds. Joseph Pilates, developed the 'universal reformer' exercise machine. The Universal reformer consisted of a rectangular frame, approximately seven feet long and two feet wide, metal tracks run the length of the frame, allowing guidance for a wheeled and padded seat attached to the frame with springs at one end and a handle-and-strap pulley system at the other the distance between the shoulder blocks and foot bar to accommodate different movements and body types. The Universal reformer highlights the importance of utilising the core abdominals and the lower back muscles to secure the torso and enable the whole body to move independently, inspiring methods of strengthening techniques such as mat and ball work. The Pilates Exercise balls are common place in physiotherapy units in aiding rehabilitation programmes having been identified as an important tool for improving postural muscle activation justified through having to develop co-ordination, expand muscle recruitment in order to maintain a stable position whilst working on an exercise ball (Sekendiz *et al.,* 2006; Weaver *et al.,* 2012**).** Several conditions are understood to influence the rate in which the muscle develops and therefore riders are required to incorporate different aspects of training to achieve the ultimate performance. Duncan (2009) suggested that training on an unstable surface, such as an exercise ball, will demand an increased challenge for the musculature of the trunk thus improving dynamic balance as well as using an exercise ball in order to develop an improved dynamic muscular ability. The current movement towards understanding the influence of the rider on the horse and encouragement of acceptance of ethical equitation is an ideal time to introduce novel techniques such as dismounted exercises to improve mounted performances.

The inclusion of mat work in a rider specific training regimen is to incorporate and encourage development of abdominal and lower back (core) muscular strength through using strong resistance techniques with a high repetition. The benefits of Pilates include the versatility of the exercises enabling adaptations for individuals of varying fitness levels. Pilates accentuates correct breathing and pelvic stability through using the lower back , abdominals and gluteals as a 'power centre'; resulting in the body being able to move freely whilst creating a symmetrical workout for all muscle groups. Pilates exercises are common place in dance workouts to increase muscle flexibility, improve alignment thus creating a more balanced platform to develop musculature (Jenson and Schutz, 1970; Ahearn, 2011).

In Pilates there are several key terms that the participants should be familiar with as well as understanding the vital Principles of Pilates. The Principles of Pilates are: control, concentration, centring, flow of movement, precision and breathing (McMillan *et al*., 2006; Ahearn, 2011). The foundation of the Pilates methods is Control; which can be directly related to the demands of the mounted horse rider (Meyners, 2004) and can be similarly described as being free from extraneous or haphazard movements throughout any exercise session. The movements should be executed with complete attention to detail in muscle control and self-awareness the importance of following these simple tasks will reduce the likelihood of an injury occurring as well as achieving maximal desirable results. Pilates instructors and horse riding instructors share similar requirements in highlighting the importance of promoting each part of the body to have an individual function as well as a specific place, which has been described as 'essential' for a dancers (Ahearn, 2011; Meyners, 2011). All Pilates exercises are initiated using a group of muscles described as the 'powerhouse'; comprising of abdominals, gluteals, hips and lower back which are also contribute to the strength of a mounted horse rider position. Furthermore, the 'Box' is a fundamental element to successfully executing Pilates movements which is a line drawn from each of the shoulders and hip to hip; the box serves to promote and remind the candidate of symmetry through mental and physical markers, interestingly this technique has been adapted and used in similar studies into asymmetry (Symes and Ellis, 2009). An area which is less transferable in Pilates to horse riding is the discouragement to hyper-extend, in horse riding the rider is required to promote a heel, lower than toe position in contrast to the Pilates where hyper-extension should never be seen (Fitt *et al*, 1994; Ahearn 2011).

1.11 Fitness and the impact of position on riding performance and equine welfare

The equine student does not need to be training for high speed bursts of energy, but to maintain stamina and performance for the length of the hour ride session. The exercise regimes that the equine student requires are regular controlled exercise to achieve maximal benefits as well as improve the welfare of the horse.

Suitable training techniques for equine students ideally will involve physically and technically demanding activity that requires the use of all muscle groups; such as rowing, the use of elliptical trainers and skipping. One of the fundamental challenges for horse riders, especially equine students, is finding time to incorporate fitness into the daily routine due to the course workload and/or other priorities (Broom, 2011;Pitt , 2011). The lack of time may be due to not appreciating the importance of rider fitness and therefore not prioritising their own fitness regime highly amongst other daily tasks; hence the reason for implementing fitness into the syllabus of students within an equine College environment.

<u>1.12 Rider Education in Equine Colleges</u>

Equine colleges provide students to theoretical situations which can be applied to the supervised, timetabled practical sessions, providing the motives for correct execution of handling horses and successful horse riding (Peham *et al*.,2004; Blokhuis *et al*., 2008). The practical application of theory learnt in the classroom provides the students with the experience, which can be directly applied into industry situation thus increasing employability.

Being able to focus on one aspect of interest (equine) makes way for significant changes during the transition to from secondary school to college, which, in turn may have a 'knock on' affect to attitude towards life situations. The most noticeable changes from post compulsory education and college is that there are no 'compulsory' subjects including physical education (PE). This lack of compulsory PE can result in a change in attitude towards physical exercise and the importance of general fitness. The possible increase in weight due to lack of physical exercise will hinder the muscle performance as fatty tissues are unable to contract resulting in no contribution to the individual task as well as causing unnecessary friction during muscle contraction. The students' attitudes towards nutrition and fitness that are developed whilst living in the college environment are likely to have a long-lasting influence on their health and fitness. It is therefore important to address these factors whilst it is possible as well as investigating the reason for the change in attitude (Subramaniam and Silverman, 2007). Through challenging a lot of the teaching methods used in a college as well as the common policy to live on campus during the first year of study (Pummell *et al.,* 2008; Eun-Jeong and Caine-Bish, 2009).). The importance of general well-being and health is important for all individuals especially during a time of important learning and career opportunities. College level resources occasionally provide the opportunity for mat based exercises for example Pilates. In an ideal situation these classes would complement the general fitness advantages gained through regular riding as part of their equine courses.

Hewitt *et al*. (2011) trialled this approach at the Goucher School of Dance, where students have the opportunity to enrol in a Pilates course for academic marks which ultimately contributes to the final grade awarded for the course the student has enrolled on it has been made a compulsory element.

1.13 Rider Safety

Equine colleges recognise that prevention of accidents is the best approach to protecting students, but is also the most difficult to achieve especially when working with large, live animals. Injuries to handlers and riders of horses can be long lasting and have very serious effects. The emerging discipline of Equitation Science has a focus on safety in relation to ensuring the welfare and sustainable use of the horse (McLean and McGreevy,2010; Hawson *et al*. 2010) which will reduce the occurrence of injuries by making situations more predictable with respect to the horse-human relationship.

There are many factors to be considered when identifying why riders get injured during general handing of horses or falling from a horse. It is sometimes simply that the rider 'lost balance' or the horse became fearful due to environmental stimuli. There is currently no reliable method of measuring the security of a rider whilst mounted. However; it is still recognised by industry practitioners that if a rider's position is more upright and the rider is more aware of each limb in isolation, then the rider is less likely to lose balance. In the event that the rider was to fall off due to the horse shying away from an object or bucking, a rider who was able to isolate each body segment, due to an increased awareness of position would be more likely to be able to counter-act the sudden unexpected motion and stay mounted. Therefore, it can be suggested that the likelihood of accidents occurring whilst mounted, can be reduced through strengthening the rider's position. It can be argued that fitness is an important element of safety due to the increased security of the riders' position as well as welfare of the animal, as a more balanced position is less likely to cause negative physical impact on the horse (Hawson *et al.,* 2010; Ladewig, 2011).

Therefore this study will examine the implementation of fitness training to investigate the effect on rider fitness and ability to maintain the technically correct riding position (ESHH) alignment.

2.0 Methods and Materials

All candidates (N=16) were required to carry out the fitness tests; sit and reach, 20m shuttle run and resting heart rate both before and after additional dismounted exercises. Candidates were allocated into either treatment group 1, rider specific training, or treatment group 2, traditional neuromuscular/ball sports and attended each treatment On a weekly basis for an hour session. In addition to attending the weekly treatment, the candidates were required to be filmed on a weekly basis in walk, sitting trot and rising trot, down a 6m track way in a familiar, outdoor riding arena whilst wearing markers on predetermined anatomical landmarks; the markers enabled a vertical line to be established in Quintic™ software. The deviation of each marker was recorded and analysed using a Kruskal Wallis or a Friedman test (dependent on the independent factor). The fitness data was tested using a paired t test.

This study was performed with approval from Plymouth University Faculty of Science and Technology Human Ethics Committee (1) incorporating all aspects of the data collection procedures and fitness regimes. Written informed consent was obtained from each candidate before data collection commenced (Appendix 2). A risk assessment was in place for all elements of the data collection sessions as well as the gymnasium elements of the experimental design (Appendix 3). It has been thought by many that posture can be improved through following a specifically designed programme to strengthen muscles which will in turn improve the ability to maintain an improved ESHH alignment as well as adding flexibility to opposing muscles (Taylor *et al*., 2006;Meyners, 2011).). It has been suggested that the most common and successful techniques include; prescribed exercise programmes, specific to the problem; as well as reviewing the improvements and effects of the regime on a regular basis. All individual lifestyle variables (additional exercise, socialising or smoking) were self-reported and were to be continued throughout the study to ensure that any changes in the rider position were not due to a change in exercise habits. Before any information of treatment group was provided to the candidates a baseline data acquisition was endured in an hour gym session. The baseline measurements of fitness markers allowed a comparison upon completion of the treatments. The fitness tests used were the twenty metre shuttle run (BT), sit and reach test (S&R) and resting heart rate (RHR).

2.1 Pilot Study

A pilot study was carried out using one candidate who was not participating in the main trial and riding a horse who they had ridden before. The rider was required to ride down a track (defined by jump poles) in a 30m x 20m indoor arena. The surface was a fully prepared (harrowed) rubber, sand fibre mix. The rider was required to wear circular, white (4mm) markers and was filmed from the midway point, perpendicular to the track way, at a distance of 1m. The proposed methods and analysis techniques were amended as a result such as the size of the markers used due to the thickness of the drawing tool in the Quintic™ software. Altering the size of the markers further validates the reliability of the measurements collected.

2.2 Basis of rider selection

Further education, equine students (N=16) (Nelson *et al*., 2003; Mandengue *et al*., 2005;Blokhuis *et al*., 2008; Chen and Lin, 2011) were recruited for this research by qualified riding instructors who identified each candidate as 'novice' and grouped based on skill to eradicate bias factors. The 'fitness sessions had been timetabled into the syllabus for the January- April 2011 Term and attendance was mandatory. All candidates were free of any predisposing issues as assessed by a physical activity readiness questionnaire).All candidates were self-reported as 'sedentary' (Appendix 4) (less than 1hour exercise a week) or 'recreationally active' (more than 1hour less than 8hour exercise a week) as defined by Owen *et al,* (2008). All candidates had previous horse riding experience 'graded' as novice by qualified riding instructors based at Duchy College.

This study was carried out between 26th January 2012 to 23rd March 2012.

2.2.1 Allocation of treatment groups

The treatment groups were pre-determined by the timetabled riding sessions. Statistical analysis was carried out to ensure no significant (p>0.05) difference was found between groups before starting the study ensuring that the study was starting with a balanced sample population to eliminate bias.

Table 1: Rider Characteristics (N=16)

Variable	Mean ± SD
Age (Years)	16.93 ± 1.2
Height (cm)	158.55 ± 5.54
Body Mass (kg)	58.69 ± 10.10

2.3 Candidate requirements

All candidates were required to attend every fitness session and filming session. If any sessions were missed the candidate was excluded from the study. During the fitness sessions the candidates were asked to wear appropriate gym wear and trainers to prevent any clothing from restricting movement. Whilst filming to rider in a timetabled riding session, on a weekly basis, across the data collection period, in the event of a candidate missing a session, they would be excluded from the study. During the data collection sessions, all riders were requested to wear, dark, tight fitting jodhpurs and a fitted long-sleeved top in order to allow easy identification of the markers whilst minimising the possibility of marker displacement. It was important for the riders to wear familiar boots and gloves as well as a safety standard riding hat.

2.4 Fitness testing before and after treatments

Generally Physical fitness is defined as being an amalgamation of various physical capabilities including, endurance, strength, balance and flexibility (Batcho *et al.*, 2012).

The pre/post treatment tests

2.4.1 20m shuttle run test

The 20m 'Eurofit shuttle run test', also known as the 'bleep test' where the candidates are required to run between two markers set at a distance of 20m apart (Figure 2). The test starts at a pace of 8.5km/hour the speed for the 20m was continuously increased at 1minute intervals by 0.5 km/hour using a pre-recorded compact disc used regularly by the

Duchy College sport department (Taylor *et al.*, 2009). The candidates were instructed to exhaust all energy and push themselves to maximal point. The level at which the candidate left the bleep test was recorded in an excel spread sheet (Taylor *et al.,* 2009; Ortega *et al.,* 2008). An exact repeat measurement was recorded after the treatments had been fulfilled.

Figure Two: Layout of the 20m shuttle run (bleep test)

Source: Total Physical Fitness (2011) page accessed 13/2/13 via thefinebalance.net

2.4.2 Sit and Reach test

The decision to use the traditional sit and reach method was due to no significant difference found previously between sit and reach techniques by Minarro *et al*. (2006). The sit and reach used in this study was originally designed by Wells and Dillon in 1952 to be used as a physical fitness test. Variations in the tests are used dependent on the individual requirements of the candidates, for example, elderly patients are tested whilst sitting on a chair and are asked to 'reach' from an upright position (Minarro *et al*., 2006; Sekendiz *et al.,* 2006). Sit and reach tests are rapidly becoming a common tool in assessing the flexibility of subjects possibly due to the consistency of the testing procedures as well as being commonly used as a tool to measure the flexibility of the lower back and hamstring. The candidates warmed up for five minutes using a routine comprising of walking, jogging and hamstring stretches. The candidates were instructed to sit on the floor of the gymnasium with the soles of their feet flat against the sit and reach box (Plate 3) keeping the hips flexed to approximately 90 degrees (i.e. sitting up straight). The candidates were then encouraged to assume a 'reach forward' position as far as possible ensuring that, knees, fingers and arms remained fully extended (Plate 3). Verbal instructions were given at the beginning of each candidates assessment ''*slowly reach forward towards your toes as far as possible while keeping your knees, arms, and fingers fully extended, with palms down and placing one hand on top of the other and hold the position of maximal reach for approximately 6 seconds*'' (Minarro *et al*, 2006; Sekendiz *et al*, 2006).

Plate Three: Sit and Reach (SR) being executed correctly

Source: Top End Sports (2013) page accessed 13/2/13 via thefinebalance.net

2.4.3 Resting Heart Rate

Heart rate has been accepted as a reliable indicator of general fitness at all ages (Oretga *et al*.2007). All candidates had a resting heart rate (RHR) measurement taken during a theory session after they had been seated and confirmed to have been physically inactive for 20 minutes. Using the methods of (Ortega *et al.,* 2007) each student was talked through the procedure for counting their pulse prior to any measurements being recorded. Three repeat measurements were taken with a minute in between each repetition. The arithmetic mean of RHR (bpm) –was calculated and recorded for each candidate.

2.5 The equine specific training course (Treatment 1)

Seven healthy young adults, that were self-reported as 'sedentary' or 'recreationally active' as well as being classified as a 'novice' horse rider and enrolled on an equine, further education course at Duchy College attended weekly sessions held in the college sports hall, with access to a large amount of equipment inclusive of 90cm x 75cm x 2.5cm foam gym mats which were used during the Pilates exercises. Treatment 1 was based upon the theory that dismounted exercises are able to improve mounted rider position resulting in being more efficient in the saddle, outlined by Eckart Meyners (2011) in the book 'Rider Fitness: body and brain'. The fundamental function of the book is to create the ultimate workout regime that targets specific areas of the horse rider that more conventional sports do not take into consideration due to the nature of the activities. The focus of the routines designed is to create the optimal coordinative conditions to be transferable into riding whilst addressing common areas of weakness in the horse rider. The American College of Sports medicine has suggested that physical exercise should be carried out in an intermittent manner contradicting the suggestions of Minarro *et al.* (2006) who suggests that exercise should be carried out in a regular fashion especially in young people to encourage sustained participation. The weekly sessions were carried out in a circuit training situation, with a five minute session at each station of skipping, rider specific stretches, low intensity step exercises, rowing and elliptical training ; the circuit was completed twice in a session.

2.5.1 The warm up period

All candidates were required to carry out 10 minutes warm up (Chen and Lin, 2011), prior to the hour recorded data collection. The warm up comprised of walking around the perimeter of the sports hall for one lap, followed by 3 more laps of side stepping, high knee skipping and lunges at an 'active' pace that enables physical exertion for improvement of health. Meyners (2011) suggests that this type of warm up is directly applied to riders as it reduces tension in muscles and prepares the processes involved in co-ordination as well as targeting as many muscles as possible. Furthermore, in addition to the four previous laps, a lap of 'freestyle' i.e. moving limbs (arms and legs) in various directions whilst travelling in a range of directions was completed prior to commencing any treatment sessions. Once the 'general' warm up had be executed a set of kinetic exercises were performed to develop cross co-ordination which comprised of stretching the left arm and right leg whilst moving forwards, backwards and across the body, swapping leg/arm after repeating the exercise three times.

2.5.2 Rider Specific Exercises

Upon successful completion of the warm up routine, the session was moved into a phase of 'mat work' based on Pilates movements and 'co-ordination exercises'. Once the candidates had been suitably warmed up in preparation for the hour treatment session, the candidates were allocated a gym mat (1.2m x1.8m). Each rider specific stretch was demonstrated by the instructor before the candidate was instructed through the movement to ensure maximal effort was attained. Each stretch was repeated 5 times and held for a maximum of 10 s. Each stretch increased intensity relative to the week until the candidates were able to maintain the plank until fatigue.

The candidates were required to carry out five minutes continuous skipping exercises with a repeat of two whilst being instructed to maintain activation of their core muscles and a straight line from the ear, shoulder and hip mimicking a similar posture to a riding position. Rowing is understood to be a technically and physically demanding motion which utilises a large number of muscle groups in the body at one time. The candidates were required to row for three minutes on a symmetrical handled rowing machine, following the descriptive procedure as suggested by Cerne *et al*. (2002), at the beginning of a stroke the pull was made whilst the back was orientated slightly forward whilst the knees and ankles were flexed to maximum followed by the forward thrust of the legs. When the legs in full extension, the back was slightly behind the vertical, the recovery phase of the motion cycle, started with a bent forward torso, bending of the knees gently sliding the seat forward in preparation for the sequence to be repeated.

Meyners (2011) suggested that step ups can be used to improve co-ordination and understanding of self-awareness which in turn will enable the rider to follow the motion of a horse when mounted. Using a specific 'box step' at a height of 28cm, with one foot placed on top, the candidates stretched upward until they are stood with one foot on the box with a straight back and aligned hips. Exercise was repeated 3 times with each leg.

Elliptical trainers have been used as an alternative method facilitating inter-limb coordination which is transferable into horse riders in comparison to the weight bearing aspects of elliptical trainers which is not desirable in training the equine athlete. The elliptical trainer creates lower pedal reaction forces than that of the ground however, causes greater knee and hip flexion than general walking which is similarly useful to thhorse riders position (Prosser *et al*. 2011).

2.6 Rider specific training exercises.

Front Plank and Side plank (Plate 4 and 5)

The candidates supported themselves on their forearms, lift the buttocks through stretching the hip joints upward, whilst the upper body and legs to stay in horizontal line. The side plank uses the forearm to support lifting the pelvis until a straight line is achieved.

Plate 4: A candidate demonstrating the correct front plank posture

Source: E.Boden (2011)

Plate 5: A candidate demonstrating the correct side plank posture

Source: E.Boden (2011)

Oblique stretch (Plate 6)

Lying flat on the back arms stretched out to the sides, the knees and hips bent to a right angle, repeated until the knees touched the ground with ease.

Plate 6: Correct positioning during the Oblique stretch

Source: Adapted from John Barban (2013) page accessed 13/2/13 via thefinebalance.net

Whole body stretch

Whilst lying on the stomach and stretching the arms out in front, the candidates were required to simultaneously lift the upper body and legs away from the ground, ensuring that the straight line from, ear, shoulder, heel and heel is maintained; irrelevant of being horizontal.

2.7 Traditional Neuromuscular and ball sports regime (treatment 2)

The general fitness and ball sport sessions were led by a qualified sports coach who is a full time member of sports academy staff at Duchy College. Similarly to treatment group 1, the warm up was executed prior to the 60 minutes exercise session. The group was required to attend weekly sessions over a 5 week period.

2.7.1 The warm up

The warm ups used in this treatment session were a more traditional variation incorporating exercises that will improve subsequent performances such as sub maximal running in a controlled situation, static stretches and integrating sport specific movements such as passing of a ball depending on the team ball sport that was being played during that weekly session. The ball sport for that week was decided by the physical education instructor.

2.7.2 General Fitness and Ball sports

Each week the candidates would follow the same warm up procedure consisting of consistent running exercise, around the games field, for 10 minutes. The sport that was going to be played, remained undisclosed until the 10 minute warm up had been completed. The format of which the sessions were run can be seen in table 2.

Table 2: The (weekly) TNT training schedule over the 5 weeks

Week	Sport
1	Handball
2	Football
3	Touch Rugby
4	Basketball
5	Handball

The sessions lasted an hour and were structured to incorporate time to allow familiarisation with the type of ball, mechanics of the throw/kick as well as increase the heart rate through exercises such as throwing the ball and following the pass.

2.8 Data collection protocol

The candidates (N=16) were filmed on a weekly basis, during a timetabled sessions, on a familiar horse in a 50m long by 20m wide arena (Figure 3) on an outdoor prepared rubber fibre and sand mix surface. The riders were asked to ride a horse they had ridden before. The participants were instructed to ride down a 6m wide track, defined by show jumping poles, situation on either side of the centre line to allow films to be captured. The track way

(2m width) was set down the centre of the school (centre line) to avoid any preference of rein direction which could impact on the horses and subsequently the riders' position. A Sony HDRPJ260VE camera was set at 9.5m, midway down the track way, perpendicular to the guided track-way on a HAMA U1004175 Stativ Star Tripod set to a height of 1m.

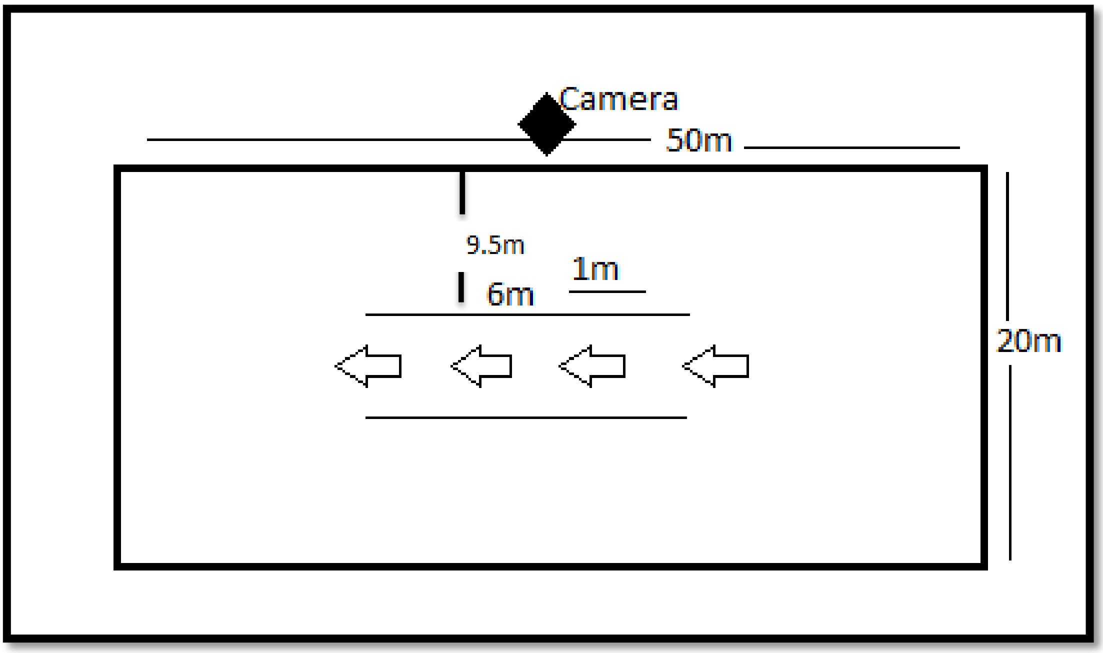


Figure 3: Arena set up during data collection sessions.

Source: E.Boden (2012)

2.8.1 Placement of markers

The researcher attached 60mm spherical polystyrene markers attached with semi-permanent double- sided adhesive pads to anatomical landmarks down the right hand side of the body as seen in Plate 7. The pads remained on the sweatshirts, jodhpurs and boots throughout the whole 8 weeks data collection period to prevent any inaccuracies in repeat marker placements. Anatomical landmarks were identified by palpitation prior to marker attachment at the commencement of the study. The shoulder (glenohumeral joint centre), hip (greater troncanter of the femur) and heel of the riding boot adapted from Lagarde *et al*. (2007). The markers enable an accurate measurement of deviation from the ear, shoulder, hip and heel (ESHH) alignment.

Plate 7: Marker placement on rider indicating anatomical landmarks to determine ESHH

Source: E.Boden (2011)

2.9 Measuring deviation of the markers

Using Quintic™ biomechanical software the videos that had been collected were validated using a meter stick in every captured stride reducing any possible areas for error in the data sampling. The first stride and the last stride were discarded to reduce the potential impact of the horse turning down the guided track may have imposed on the rider position. In all paces, the point at which the video was stopped and the measurement taken was when the off fore was in full stance phase (fetlock perpendicular to the ground).

A vertical line was drawn using the automatic drawing tool by selecting the centre point of the hip marker. The hip marker was selected as the measuring point as it is the most stable part of the riders' seat. The ESHH alignment can be seen on page 10 in Plate 2.

This vertical line enabled an imaginary ear, shoulder, hip, heel (ESHH) alignment to be visualised and the deviations to be measured. The measuring tool in the Quintic™ software package was used to find the centre of each marker to enable a more accurate placement of measurements.

The measurements were recorded in an Excel spreadsheet on a weekly basis for each individual rider and specific marker.

2.10 Leg Length

Leg length was measured at the 2nd stride of walk on the 2nd repeat before the treatment has been undertaken as well as in the last data collection session. The distance was established using Quintic™ biomechanical software by measuring the distance between the hip marker and the heel marker.

2.11 Data analysis

All data were collated using MS Excel software and tested for normality using the Anderson-Darling test of distribution using a goodness of fit in the Minitab™ v16 statistical analysis package. The fitness markers were normally distributed and a paired t test was used to determine significance differences in all fitness tests elements and leg length pre- versus post- treatments.

The deviations from the ESHH alignments were not normally distributed. The deviation of the marker in relation to time, marker placement, gait and repeat stride were tested using a Friedman test to detect differences of factors across multiple test attempts. The comparison between rider (subject) and marker (factor) were tested using a Kruskal Wallis. For all statistical tests a probability of $P<0.05$ alpha was used.

3.0 Results

Sixteen female candidates who were enrolled on a Further Education Equine programme (BTEC, National Certificate) at Duchy College, Cornwall, U.K. took part in this study, between 26th January 2012 to 23rd March 2012 . Commonly used fitness tests, (Sit and Reach test , Bleep test, Resting Heart Rate (bpm) were carried out prior to the treatment sessions as well as on completion of the full treatment sessions and riding data collections. Selected candidate details are shown in Table 3. All candidates were deemed healthy, following completion of a questionnaire (Appendix 4) and able to take part in research and completed a consent form (Appendix 2).

Table 3: Candidate characteristic details of the sample group.

Variable	Mean ± SD
N	16
Age (Years)	16.93 ± 1.4
Height (cm)	158.55 ± 5.54
Body Mass (kg)	58.69 ± 10.10

Female (N=16) aged between 16-18 years old. Data collected prior to study commencing.

3.1 Fitness Testing

Each measure of Resting Heart Rate (RHR) (BPM), Bleep Test (BT) and Sit and Reach (S&R) was completed before any additional fitness was carried out during the weekly treatment sessions. All fitness data were tested for normality using an Anderson- Darling normality test, RHR, BT and S&R data were normally distributed ($P>0.05$).Paired t-tests were conducted on Minitab™ v16 statistical software to determine if there was a significant difference between the measurements of the sit and reach (SR) shuttle run (BT) and resting heart rate (bpm) before and after the treatments had been completed.

No significant difference was found in RHR ($t_7=3.18$; $p>0.05$) and BT ($t_1=2.0$; $p>0.05$) in rider specific training group (treatment group 1) after an 8 week course of rider specific training. Paired t-tests revealed that there was a significant difference in the Resting Heart Rate

(RHR) and Bleep Test (BT) (t_5=6.15; p<0.001 and t_4=11.83; p<0.05) respectively in treatment group two as seen in Table 4 and Table 5. The Sit and Reach test before and after the completion of the treatments suggested that there was a significant difference in rider specific training group (9.17 ± 3.05 cm) ($t_{4=}$10.55; p<0.05) in comparison to no significant changes (t_2=2.55; p>0.05) in the traditional neuromuscular training (6.3 ± 1.5 cm).

Table 4: Fitness results for Rider Specific training group (RST).

Candidate	Resting Heart Rate (bpm)		Sit and Reach (cm)		Bleep test (level)	
	Before	**After**	**Before**	**After**	**Before**	**After**
1	91 ± 1	70 ± 2	19	23	4	5
2	80 ± 2	74 ± 2	24	35	5	5.4
3	92 ± 1	75 ± 5	25	28	4	4
4	67 ± 2	70 ± 8	19	17	5	5.2
5	65 ± 2	66 ± 3	17	22	4	5.2
6	70 ± 1	61 ± 1	19	22	5.4	8
7	65 ± 2	66 ± 7	24	35	6.2	7

Mean and standard deviation values of fitness results of the Rider Specific Training, (RST) before and after the completion of additional training regime. Significance is shown in text.

Table 5: Fitness results for Traditional Neuromuscular training (TNT).

Candidate	Resting Heart Rate (bpm)		Sit and Reach (cm)		Bleep test (level)	
	Before	**After**	**Before**	**After**	**Before**	**After**
1	89 ± 9	62 ± 6	25	28	3.1	5.1
2	83 ± 5	65 ± 5	24	30	5	7.5
3	76 ± 4	65 ± 4	10	16	4.2	8
4	80± 12	66 ± 3	27	29	2.2	5.1
5	92 ± 5	61 ± 7	27	28	3.5	5.6
6	89 ± 1	65 ± 4	3	5	3	5
7	81 ± 5	69 ± 3	10	25	3.5	6.1
8	86 ± 1	61 ± 3	20	15	4	6
9	72 ± 6	60 ± 4	25	25	6	9.1

Mean and standard deviation values of fitness results of the Traditional Neuromuscular training, (TNT) before and after the completion of the additional training regime. Significance is shown in text.

3.2 Rider Position

The rider position data were not normally distributed (Anderson Darling = 47.2; p>0.05) therefore rider position data were analysed using a non-parametric Kruskall-Wallis to determine the effect of time, marker placement, rider, gait and repeat stride.

3.2.1 Effects of the rider on deviation from the ESHH alignment

Each candidate demonstrated different basic riding abilities before the data collection was carried out (N=16, H_{15}=354.11; P<0.001). The riders were assessed for similar abilities in walk, sitting trot and rising trot. The treatment groups were divided by predetermined timetabled horse riding sessions. The data was analysed to test the reliability of the allocation of the treatment groups. The individual treatment groups illustrated a significant difference between each rider in the treatment groups highlighting that there was not individuals that excelled; thus ensuring no bias of results. The rider specific training (RST) showed a significant difference between riders (n=7, H_6=279.35; P<0.001) as well as the traditional neuromuscular/ball sports (TNT) returning significant difference between the individual candidates (n=9, H_8=78.56; P<0.001).

3.3 Deviation from the ESHH alignment in relation to marker position (anatomical landmarks)

The deviation of each marker from the ESHH alignment was significantly different in the whole horse rider sample (N=16, H_2=688.56; P<0.001). The rider specific training (treatment group 1) (n=7, H_2=351.38; P<0.001) also displayed a significant difference of each markers deviation after completion of the additional training regime. In addition the traditional neuromuscular training group found a significant difference between the anatomical landmarks once the treatment had been completed (n=9, H_2=377.48; P<0.001). The mean deviation of the placement anatomical marker walk, sitting trot and rising trot are shown in Figure 4. It can be seen from Figure 4 that the shoulder (in walk) had the least deviation before any treatments had been administered (4.2±1.6cm) in comparison to the heel (7.4±4.3cm) which was consistently the furthest from the ESHH alignment in all three gaits.

3.4 Effect of repeat stride on deviation from ESHH alignment

The strides that the data were collected from was not significant in the deviation from the ESHH alignment (N=16, H_3=26; P>0.5). Three strides were filmed for each experimental condition thus reducing to reduce the potential effect of the uncontrollable variables, for example the turn down to the guided track. A Friedman test was used to test each treatment groups' data in order to establish any significant differences between rider specific treatment group one, (n=7, H_3=0.49; P>0.5); and traditional ball sports: treatment group two (n=9, H_3=0.25; P>0.5). Deviation from the ESHH alignment was not significantly impacted by the repeat stride.

Figure 4: Effect of the filmed stride on deviation from the ESHH alignment.

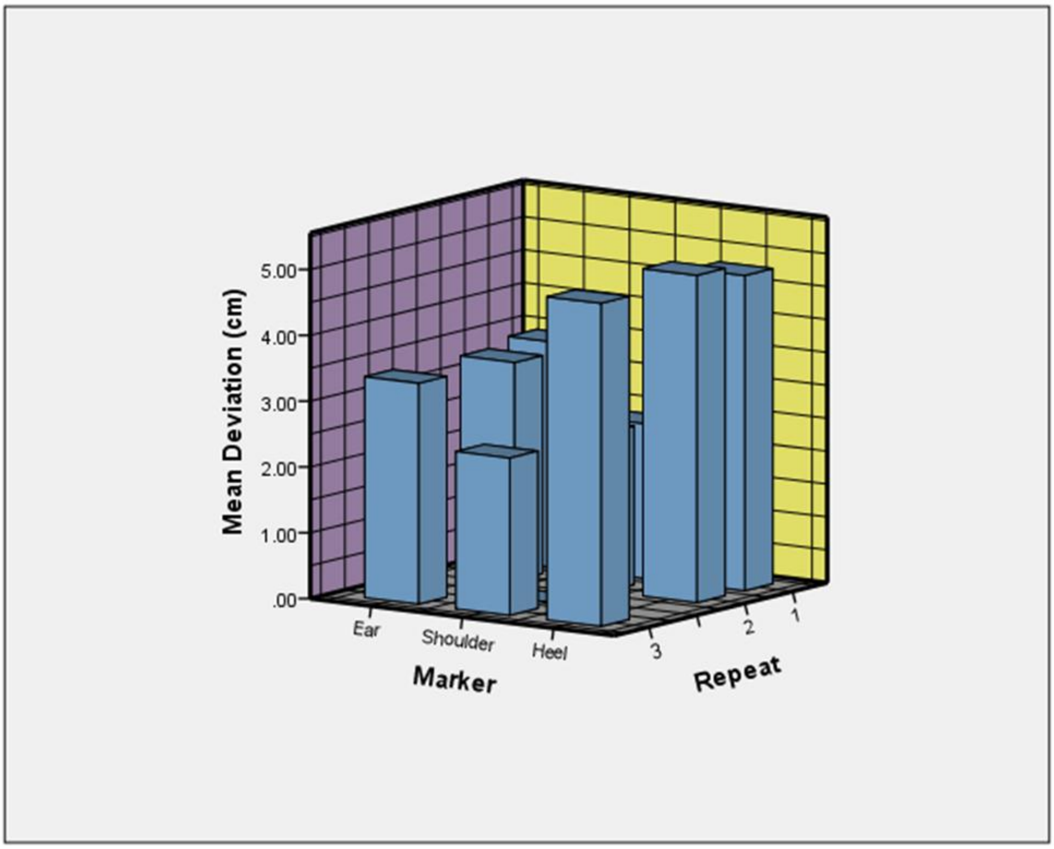
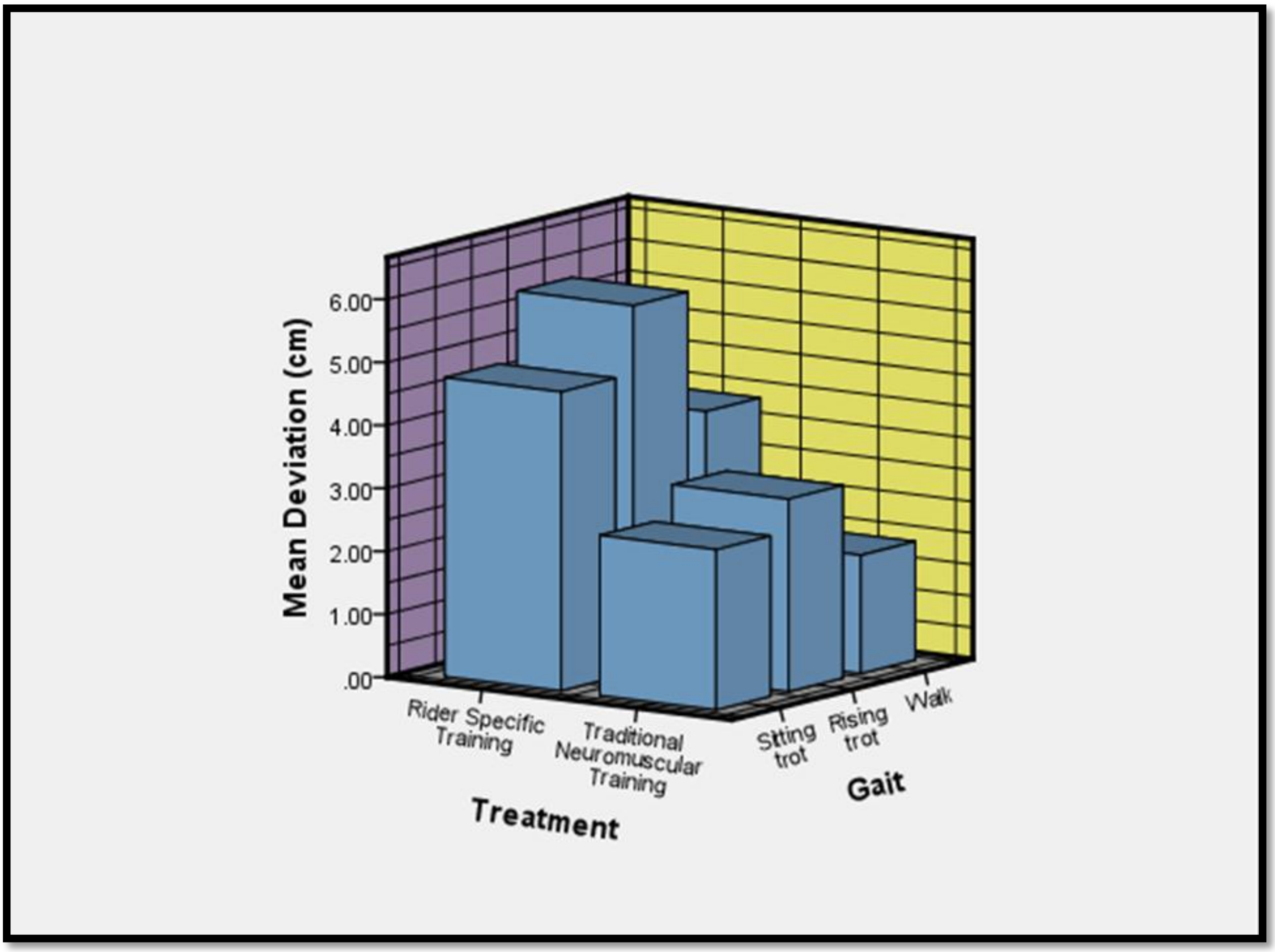


Figure 4: *Bars indicate the mean deviation from ESHH alignment in relation to marker position for three consecutive repeat observations are shown in sample of 16 riders who have undertaken an additional exercise regime.*

3.5 Effect of treatment group on rider position

Significant improvement was seen in both treatment groups; Rider Specific training (treatment group 1; $P<0.005$) and Traditional Neuromuscular training (treatment group 2; $P<0.005$). Further investigation was required to establish the effect of treatment instead if assuming natural progression. Further t tests were undertaken to determine the extent of improvement on a weekly basis results suggesting that Rider Specific training (Treatment Group 1) showed the highest significant ($p<0.005$) difference between week 2 and 4. Traditional Neuromuscular training (Treatment Group 2) showed significant improvements ($p<0.001$) at week 2 and 3. No significant difference between experimental treatment on rider position ($N=16$, $H_1=0.00$; $P>0.05$) as both treatment groups displayed a significant reduction in deviation from the ESHH alignment (Table 6 and 7).Upon further inspection of the results reveal that effects are driven by the gait data. Results showing the effects of gait and treatment group are presented in Figure 5.It is reasonable to assume that the relationship between the treatment and decrease in deviation from the ESHH alignment is due to the general implementation of an additional exercise regime.

Figure 5: The effect of RST and TNT groups in relation to Mean Deviation (cm) during Walk, Rising Trot and Sitting Trot.



Bars indicate the mean deviation from ESHH alignment in relation to marker position for three consecutive repeat observations are shown in sample of 16 riders who have undertaken additional training regimes.

Table 6: Deviation of Markers (cm) in Treatment group 1 (RSFT).

	Deviation from the EAR marker (cm) (Mean ± SD)		Deviation from SHOULDER marker (cm) (Mean ± SD)		Deviation from HEEL marker (cm) (Mean ± SD)	
Rider	Before	After	Before	After	Before	After
1	7.8 ± 2.7	2.0 ± 3.0	8.8 ± 3.2	1.8 ± 3.0	4.6 ± 2.0	1.8 ± 2.4
2	5.4 ± 2.8	1.6 ± 2.0	6.0 ± 1.3	1.2 ±3.4	8.6 ± 7.5	5.2 ± 2.3
3	7.8 ± 5.0	4.6 ± 3.0	5.6 ± 2.4	1.1 ± 4.4	3.3 ± 3.0	6.7 ± 2.7
4	8.7 ± 3.2	3.0 ± 3.1	5.8 ± 1.2	0.1 ± 5.2	5.5 ± 2.9	2.4 ± 2.3
5	6.2 ± 1.3	1.6 ± 2.4	4.8 ± 3.2	2.3 ± 2.4	2.4 ± 1.4	3.2 ± 2.4
6	10.4 ± 2.4	0.4 ± 3.0	*	0.3 ± 5.0	*	2.5 ± 3.7
7	*	0.5 ± 0.1	*	0.4 ± 3.2	*	7.5 ± 2.6
1	7.1 ± 2.3	1.1 ± 1.9	7.7 ± 0.9	0.1 ± 2.7	16.5 ±2.6	20.6 ± 2.0
2	9.6 ± 2.2	6.1 ± 3.8	9.3 ± 2.5	3.0 ± 2.2	7.5 ± 1.2	11.0 ± 2.6
3	12.7 ± 2.4	4.7 ± 3.6	8.1 ± 2.3	0.4 ± 3.6	7.5 ± 4.6	5.3 ± 4.1
4	13.1 ± 3.1	5.2± 3.2	8.3 ± 3.7	2.2 ± 2.8	10.2 ±0.9	3.6 ± 2.1
5	8.6 ± 2.0	5.8 ± 3.7	7.5 ± 3.1	0.8 ± 0.8	7.8 ± 0.8	10.4 ± 2.1
6	11.1 ± 3.2	2.5 ± 2.8	*	*	*	*
7	*	*	*	*	*	*
1	4.4 ± 2.3	0.5 ± 1.2	6.5 ± 0.9	1.7 ± 1.5	4.5± 6.1	7.6 ± 4.2
2	8.3 ± 3.0	2.3 ± 2.2	8.8 ± 2.5	0.3 ± 3.2	14.5 ±3.3	12.1± 2.5
3	3.1 ± 2.8	6.1 ± 3.1	4.1 ± 4.6	1.8 ± 0.8	8.3 ± 2.8	5.1 ± 4.1
4	11.6 ± 1.8	2.6 ± 2.3	8.6 ± 2.0	0.0 ± 3.1	12.1 ±4.0	5.5 ± 3.1
5	5.7 ± 2.0	3.2 ± 2.3	5.1 ± 3.4	1.3± 0.8	7.8 ± 3.7	16.2 ± 2.1
6	8.1 ± 2.3	3.2 ± 2.8	*	*	*	3.1 ± 3.2
7	*	2.1 ± 1.7	*	4.0 ± 1.1	*	5.4 ± 2.0

** indicate missing values. Hip values are missing due to the ESHH alignment being determined by the hip marker. Shading indicates gait; yellow- walk; purple-- rising trot; blue-sitting trot.*

Table 7: Deviation of Markers (cm) in Treatment group 2 (TNT).

	Deviation from the EAR marker (cm) (Mean ± SD)		Deviation from SHOULDER marker (cm) (Mean ± SD)		Deviation from HEEL marker (cm) (Mean ± SD)	
Rider	Before	After	Before	After	Before	After
1	4.3 ± 3.6	4.2 ± 3.4	4.4 ± 1.7	0.7 ± 3.1	12.4 ± 2.5	7.4 ± 2.6
2	3.2 ± 4.5	2.8 ± 2.2	1.8 ± 1.7	0.7 ± 1.2	7.4 ± 2.3	8.5 ± 3.8
3	4.1 ± 4.7	2.0 ± 2.5	1.6 ± 1.9	0.7 ± 1.0	5.4 ± 3.1	5.0 ± 3.1
4	1.6 ± 0.5	0.6 ± 0.9	1.5 ± 1.8	0.6 ± 1.6	4.5 ± 3.8	0.9 ± 2.5
5	2.8 ± 0.4	0.4 ± 2.4	3.7 ± 1.8	4.8 ± 0.2	10.4 ± 4.8	4.5 ± 3.6
6	4.6 ± 1.8	*	7.2 ± 2.2	*	5.4 ± 3.9	*
7	6.7 ± 1.2	1.8 ± 2.6	7.2 ± 1.4	2.6 ± 3.6	12.7 ± 4.8	2.3 ±6.5
8	5.1 ± 3.2	0.8 ± 3.8	5.8 ± 1.2	1.5 ± 1.3	7.4 ± 5.3	0.3 ± 16.9
9	7.2 ± 1.3	5.6 ± 5.1	5.0 ± 1.3	*	4.1 ± 4.4	*
1	6.6 ± 1.7	0.6 ± 3.1	*	0.2 ± 1.1	*	14.6 ± 6.4
2	6.7 ± 4.7	1.0 ± 3.0	6.1 ± 1.5	0.6 ± 1.4	7.0 ± 3.8	10.7 ± 4.8
3	5.6 ± 4.3	0.6 ± 3.1	8.0 ± 1.9	0.1 ± 1.1	9.4 ± 4.0	10.5 ± 2.8
4	2.8 ± 2.3	0.8 ± 2.0	6.6 ± 1.6	2.6±1.7	5.8 ± 2.6	2.6 ± 6.3
5	1.0 ± 0.4	0.1 ± 3.6	1.4 ± 1.4	1.6 ± 3.5	9.4 ± 3.4	2.4 ± 5.5
6	9.0 ± 1.7	*	11.6 ± 2.2	*	13.2 ± 2.6	*
7	9.4 ± 3.2	1.0 ± 3.0	10.1 ± 2.6	1.4 ± 0.9	10.7 ± 4.9	1.6 ± 6.4
8	7.7 ± 1.6	1.1 ± 7.4	9.0 ± 4.4	1.0 ± 5.3	10.7 ± 4.0	7.5 ± 3.3
9	9.0 ± 3.3	4.3 ± 3.2	9.1 ± 2.8	*	7.0 ± 6.7	*
1	8.0 ± 2.5	4.2 ± 2.6	*	1.7 ± 1.5	*	10.2 ± 5.3
2	5.6 ± 3.8	5.5 ± 2.5	6.1 ± 1.2	2.4 ± 1.4	5.2 ± 4.0	5.2 ± 1.4
3	9.5 ± 2.2	4.7 ± 2.6	12.4 ± 1.9	2.8 ± 1.5	11.2 ± 3.2	5.3 ± 3.1
4	4.8 ± 0.6	1.0 ± 3.0	6.6 ± 1.6	1.2 ± 1.7	5.6 ± 2.5	5.5 ± 2.3
5	6.5 ± 0.4	0.6 ± 4.6	6.8 ± 1.4	5.2± 3.5	9.3 ± 3.7	17.5± 6.4
6	9.6 ± 2.1	*	10.8 ± 2.9	*	6.6 ± 3.2	*
7	9.5 ± 2.3	2.7 ± 3.3	10.4 ± 2.8	1.3 ± 0.9	15.8 ± 4.0	1.2 ± 3.0
8	10.6 ± 1.4	1.0 ± 2.9	7.7 ± 1.6	1.0 ± 2.1	10.5 ± 4.8	1.0 ± 5.3
9	11.7 ± 3.2	10.7 ± 6.9	9.5 ± 2.8	*	6.2 ± 1.6	*

** indicate missing values. Hip values are missing due to the ESHH alignment being determined by the hip marker. Shading indicates gait; yellow- walk; purple-- rising trot; blue- sitting trot.*

3.6 **Effects of time on rider position deviation from the ESHH alignment**

The time that the riders were assessed has shown to significantly influence the deviation from the ESHH alignment (N=16, H_7=579.73; P<0.001). In both, Rider Specific treatment groups and Traditional Neuromuscular treatment group the effects of taking part in a regime (regardless of precise type) appear to be reducing the deviation from the ESHH alignment. At week 5 in both treatment groups the deviation from the ESHH in all gaits decreased significantly (p<0.005). Tukeys tests were carried to further determine the contributing effects significance of the particular marker over the data collection time. At week 5 in both treatment groups the deviation from the ESHH in all gaits decreased significantly (all q values; P<0.005).

3.7 Effect of gait on deviation from the ESHH alignment

Rider specific training (Treatment group 1) showed a significant decrease of deviation in walk, rising trot and sitting trot over the 8 week trial period, although the traditional neuromuscular treatment group displayed a greater reduction in deviation in all three gaits. Figure 6 illustrates the rate at which each of the deviations from the ESHH alignment varied over the weeks in relation to the gait. Each gait had a significant effect on the deviation from the ESHH alignment (N=16, H_2=221.53; p<0.001). Both treatment groups demonstrated a similar significant effect (n=7, H_2=133.25; p<0.001) and (n=9, H_2=101.75; p<0.001), respectively. The gait which demonstrated the quickest improvement varied between groups. A Rider specific training regime showed a steady rate of improvement across all three paces, highlighted by each linear regression following a similar pattern. In comparison to the traditional neuromuscular training which shows that sitting trot is improved after completing one week of the programme although does regress at week three before a constant and regular reduction in deviation until the end of the regime.

Treatment group one demonstrates that rising trot had the largest deviation consistently until week 4, although returns to be the slowest at improving over the 8 data collection weeks. Walk appears to be the pace which plateaus the earliest and shows the most consistent improvement. Figure 6 shows that walk, and sitting trot, have the lowest deviation in both treatment groups in comparison to rising trot.

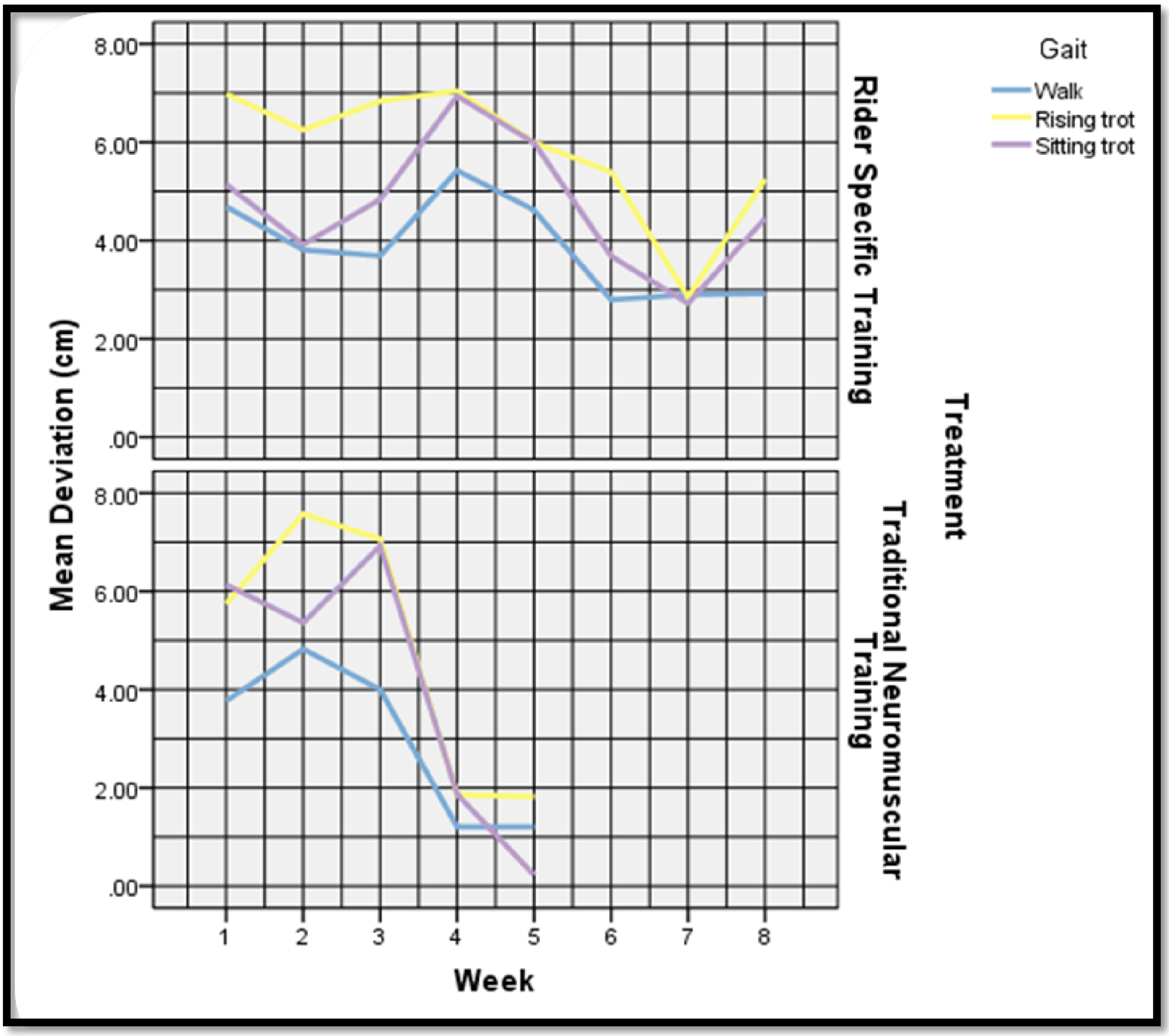


Figure 6: Impact of gait, training TNT (n=7) and RST (n=9) on deviation (cm) from ESHH alignment.

3.8 Leg Length

Both treatments had a significant impact on leg length. Paired t-tests were used to determine the impact of the two different treatments on the length of the riders' leg whilst mounted. Treatment group one, rider specific training regime (t_6=-7.91; $p<0.001$) and treatment group two (t_2=3.77; $p<0.05$) traditional neuromuscular training. Further to a paired t test, an independent t test ($p>0.05$) was carried out to evaluate the improved measurements of both the treatment groups.

Table 8: Leg lengths (cm) of sample whilst mounted on horseback.

Treatment Group	Prior to treatment (cm)	After Completion of treatment (cm)	Improvement (cm)
1	60	70	10
1	60	79	19
1	65	82	17
1	60	81	21
1	49	79	30
1	*	*	*
1	64	95	29
2	53	85	32
2	57	58	1
2	52	*	*
2	59	79	20
2	52	70	18
2	67	78	11
2	74	78	4
2	65	75	10
2	74	78	4

*(N=16) before and after additional training regimes. * indicate missing data.*

4.0 Discussion

The horse rider position that was measured in this study (ear, shoulder, hip and heel -ESHH alignment) was taken from British Horse Society description used for the Preliminary Teaching Test examination guide (BHS, 1990). When horse riders are first introduced to the correct position it is the straight line through the anatomical landmarks which is initially addressed. All the riders used in this study were aware of this theory and the importance of sitting straight in the saddle. Riders are discouraged from slouching and gripping with knees from a very early stage of learning to ride. All candidates involved in this study were female and classified as novice riders; and enrolled on an equine course at Duchy College. The students had a 'fitness' session timetabled into the syllabus during the spring term to ensure the weekly assembly was compulsory thus minimising the likelihood of none-attendance. The results of this study were consistent with the findings of Hart and Tracy (2008) and Hewitt *et al*. (2011) who concluded complimentary, dismounted exercises could improve balance, muscular endurance and improved proprioceptive awareness. It is widely believed that horse riders should be upright, balanced, elastic to enable subtle and accurate interactions between horse and rider whilst performing even the most simple of movements however, the exact physiological demands of a horse rider is still unknown.

The purpose of this study was to examine the efficiency of two different fitness treatments on novice horse riders. Consistent with the hypothesis, all riders showed regular decreased deviations from the ESHH alignment with the use of complementary fitness regimes. Significant improvements can potentially be gained in posture of the mounted equine athlete in walk, sitting trot and rising trot. However, unexpectedly treatment group 2 showed a more dramatic decline in all three gaits as can be seen from the results. Leg length (whilst mounted) increased dramatically after the individual trial periods of each treatment as originally suggested by industry practitioners. Interestingly the different treatments both result in provided significant improvement, notably in treatment group 2 who showed significantly greater reduction in deviation over the experimental period.

4.1 Effect of Treatment on rider position

Previous reports on rider fitness and posture in relation to rider performance (Halliday *et al.,* 2010; Meyners,2011;) have reported that horse riding alone is not enough to increase fitness markers and promote a healthy lifestyle as well as effecting horses' movement. It is understood that riding is a coordinated sport and requires the rider to be able to correct responses whilst providing signals (aids) which can be easily deciphered by the horse so that the horse can carry out the required movements without increased pressure or the introduction of artificial aids such as whips or spurs.

The results presented in this study demonstrate that a rider specific training regime (treatment 1) can lead to significant improvements in what over the course of 8 weeks. Interestingly however, the candidates that took part in the 8 week rider specific training regimen did not show significant improvements in the 20 m shuttle run although did show a significant improvement in the sit and reach test measurements. This lack of improvement on an endurance related measure could possibly be due to the absence of exertion and increase in heart rate during the rider specific regime. The exercises required during (RST) were low intensity with a high repetition rate to enable optimal results to be produced as noted by Ahearn (2011) and Melander (2012).

There is limited scientific basis to support the use of static stretching in exercise regimes, however, moderately low intensity aerobic exercise is a significant component of any routine as the muscle temperature, which in turn is responsible for a number of mechanisms which affect performance. Examples of short term improvements made by low intensity include improved range of motion about joints, which directly relates to the requirements of the horse rider. In contrast to the findings of this study Fowles *et al*.(2000) and Power *et al*. (2004) suggested that static stretching inhibit performance in strength activities. Interestingly intense bouts of stretches have been shown to hinder balance, reaction time and movement (Behm *et al*., 2004; Taylor *et al*., 2009). These suggestions contrast the horse rider specific exercise treatment group, who predominately completed a routine of stretches to promote self-awareness and core-strength and still displayed a reduction in deviation from the ESHH alignment. Candidates undertaking the rider specific training regime took longer to display signs of progress to the treatment in comparison to the neuromuscular training treatment group. The nature of the dynamic exercise routines has been shown to improve a larger range of performance markers (Fletcher *et al*., 2004; McMillian *et al*., 2006) such as sprinting and leg extension power. Furthermore, in contrast to the results of this study, Young and Behm (2003) found that the use of exercise regimes to act as a ‘rehearsal to an activity’ and ‘opened up’ the neural pathways required to complete a desired quantifiable motion. Application of the Young and Behm (2003) theory would suggest that the rider specific training regime would, in fact have triggered a reduction in deviation from the ESHH alignment. In reality, supporting the suggestions of Meyners (2011) of horse riding being a wholly unlike any other athletic endeavour and therefore does not respond to complementary activities in the same way that more mainstream activities, such as football, do. However, horse riding is a physical activity that requires conditioning of the human body systems and therefore an improvement in performance.

The findings of the sit and reach test present a contrast to previous studies (Osternig *et al.*, 1989; Chandler *et al*., 1990; Pastor, 2000). An example of this Pastor (2000) suggested that none-elite swimmers had a greater range of motion in the spine so therefore would influence the results of a sit and reach test. However, Ayala *et al*. (2012) suggested that recreationally active adolescents are an ideal population to apply sit and reach test due to the ease of the technique and measurement scores; additionally the physical action requires minimal training whilst enabling researchers to carry out a substantial collection in a short period of time. The sit and reach test was used in this study to be an indirect measure of the elasticity of the hamstring and lower back since the action requires a whole body motion including to range of flexibility of the shoulders and spine which is supported by the findings of Hemmatinezhad *et al.* (2009) and López-Miñarro *et al*. (2009).The suggestions made by Hewitt *et al*. (2011) align with the findings that that flexibility significantly improved with participation of eight weeks of Pilates, however, addresses that flexibility relates closely to mobility which directly applies to horse riders.

A surprising finding within this study; was the decreased deviation from the ESHH upon completion of the 5 week training programme as seen in Figure 5. The improvement of rider alignment after the five week intensive neuromuscular training (Ball games) programme which required a large element of fitness work i.e. running; in contrast with the many suggestions of literature around the improvements that Pilates can offer (Fitt *et al*, 1994;Meyners, 2004; Ahearn 2011).

Following a course of rider specific training can reduce mean deviation from the ESHH alignment. The influencing factors that need to be taken into consideration include length of course, the coaching environment and activities of the candidates outside the study.

It has been well established that social aspects interpose the quality of the experience during physical activity with a large amount of research is focused on coaching styles and the physical and psychological benefits if regular exercise (Smith, 2003; Bray *et al*., 2005).

It has been thought that a quality physical experience is one that encourages devotion and commitment to a more active lifestyle. Smith (2003) proposes that physical activities can facilitate social development, motor competencies and positive self-perceptions. The literature into sport psychology (Salmon *et al., 2*003) highlights the importance of teachers and peers in the context of physical activity and the impact of these factors on the outcome. It is felt that this aspect of the study was underestimated and therefore, was not factored into the methodology. However, the extent that this could have been addressed would have been minor due to the limited resources available; although the candidate allocation into treatment groups may have been a little more detailed to promote peer engagement, which ultimately could have developed a deeper interest in the individuals resulting in more effort and therefore different results over the data collection period. Furthermore, the different treatment groups were led by different coaches. Due to the nature of the sessions and activities the leadership requirements and styles were different; the neuromuscular-ball sports group were led by a sports coaching lecturer which had experience in working in an elite environment from a professional view point and promoted engagement through a personal passion for sport. Nielsen *et al.* (2003), Bray *et al.* (2004) and Thorell *et al.* (2009) maintain that enthusiasm is easily promoted to individuals in a team situation; this may not have been the case in this study for the rider specific training treatment group. In comparison to this current study Thorell *et al.* (2009) noted the riders (in their study of fitness testing horse riders) proved difficult to motivate during individual fitness regimes thus impacting the potential fitness results. The results of this study suggest that both group-based exercise regimes and individual exercise regimens produce significant results. In support of the suggestions made by Broom (2011) and Pitts (2011). Treatment group 2 (TNT) did produce significant results more quickly than the rider specific training (RST) group (treatment 1) as it appears that women would rather exercise in a group, team situation rather than independently and a fitness session is seen as a social occasion instead of exercise (Maquire and Mansfield 1998; Prichard and Tiggeman, 2008). This difference could be due to the separate environments as well as leadership styles as discussed by Eyigor *et al*. (2007), Prichard and Tiggemann (2008) and Davis and Cooper (2011). Similarly Prichard and Tiggemann (2008) presented results similar to those found in this study; cardiovascular sporting activities being more popular amongst female participants potentially due to the direct relationship with the impact on appearance. Interestingly, a further suggestion for the slower reduction in deviation from the ESHH is that mirrors may have a negative impact on mental attitude towards exercise (Ginis *et al*, 2003) which would be consistent with methodologies of this study.

The resting heart rate was used as a marker to measure general fitness in all candidates. The rider specific group showed improvements in all three aspects of fitness although only the sit and reach test indicated a significant improvement contrast with the findings of Hewitt *et al*. (2011), who suggested that Pilates may be considered comparable to traditional aerobic exercise.

The results shown in table 4.show that the rider specific regime did not significantly improve endurance fitness tested by means of a bleep test. In line with the findings of Halliday *et al*., (2010) who identified that horse riders were physically weaker and have a poorer aerobic ability than athletes of other sports which in turn may result in poorer judgement and slower reaction times potentially negatively impacting the safety of both horse and rider. The regime that was undertaken by the rider specific training candidates was not designed to increase heart rate through aerobic exercises, but to engage the riders in self-awareness and engaging core-strength through carrying out the 8 week course of proprioceptive activities. The 8 week treatment involved a mixture of exercises in each session such as skipping and static stretches; the tasks required limited exertion and therefore an improvement in endurance markers would be a typical result (Sekendiz *et al.,* 2007, Meyners, 2011). The traditional neuromuscular training group produced significant improvements in the bleep test results. The nature of the exercises undertaken by the traditional neuromuscular group (ball sports) on a weekly basis, promoted cardiovascular fitness due to the requirements of 'chasing' during ball sports which could be directly related to the requirements of the 20m shuttle run test (Neilson *et al*., 2003; Bray *et al.*, 2005).

4.2 Impact of gait on rider position

The influence of gait on rider position was an unexpected finding of this study, although has provided some interesting suggestions and results. An interesting element of this research includes the pattern of deviation from ESHH alignment in each gait over the trial period. The rider specific training group displayed initial reductions in deviation from the ESHH alignment in all three paces in comparison to the traditional neuromuscular training group who displayed an increase in deviation after the first training session, followed by a more dramatic decline thereafter. There are many potential factors that could have contributed to these differences in the deviation of ESHH alignment of each gait. In this study both treatment group exhibited the same pattern of mean deviation throughout the study suggesting that the mechanics of the gait is partly responsible for the rider position and deviation from the ESHH alignment, as well as rider ability. This study indicates that rising trot has the most difficult stride cycle for riders to maintain an ESHH alignment. Rising trot is widely understood to be the most difficult element of horse riding as the rider is required to move away from the saddle and return softly to the horses back. The factors that influence the rising trot include muscular strength in the quadriceps and the abdominals; further research would determine the influence of individual, localised strength during different phases of rising trot.

The walk had the most consistent results between the two treatment groups. The stride patterns of the walk may be responsible for the lowest deviation from the ESHH alignment, as it is a four time, symmetrical gait, that is the slowest of the three measured. When riders are initially introduced to maintaining a dynamic balance, walk is the pace used due to the natural progression of learning to ride. Once the position has been described and demonstrated and achieved at a halt, the rider will typically be instructed to ask the horse to move on through correct application of the aids. It is at this early stage the rider will encounter the importance of the ‘seat’ and being able to isolate muscle groups to ensure balance to be maintained whilst moving, albeit slowly, to follow the horses movements.it is widely understood that teaching the correct seat is difficult (Visser *et al*., 2003; Blokhuis *et* *al*,2010; Meyners, 2011)) therefore achieving the correct position early in training particularly important to master the fundamental elements required during more advanced movements.

The 'novice' nature of the candidates could be the reason that walk shows the most consistently lower deviation from the ESHH alignment across each treatment group suggesting that walk is the slowest pace, suggesting that potentially the most effortless gain in maintaining a correct position. Interestingly the different treatments displayed distinctive traces from the initial week of data collection. The rider specific training candidates showed a decline in deviation from first week in all three paces in comparison to the ball sport treatment group who only displayed initial improvements in sitting trot. The walk exhibited an increase in deviation from the ESHH during the first two weeks of the study. The different patterns seen in the individual gaits in relation to the different treatment groups suggest that complimentary exercises do have an impact of the ability to isolate specific muscles during different stride cycles. The back of the horse acts as a 'bridge' connecting the front of the horse to the 'engine' at the back, when the horse rider lands too heavily or balances on their hands the horse is caused discomfort and the gait may be distorted resulting in the horse operating in a less than optimum manner, caused by a lack of relaxation which is directly attributable to rider error.

Interestingly, the gait in which maintained highest deviation from the ESHH was observed in both treatment groups was trot. Studies focus on the trot for many reasons with the main reason being the symmetrical nature of the gait (Warren-Smith *et al*.,2007; Moore, 2010) trot can be ridden in sitting or rising position. Rising trot is possibly the hardest gait for the rider to learn to rise to due to requirements of rising and returning to the saddle in a controlled manner. The walk does not require the same abduction from the saddle, rather more a 'sweeping' action of the seat where the riders bottom follows the movement of the saddle The abduction and adduction of the seat away from the saddle and horse creates a large opening for error. Common rider position faults which can be observed from a lateral view include; rounding of the shoulders and assuming an 'arm chair' position where the upper body is behind the vertical, causing the lower leg to go in front of the vertical, and resulting in a weakness in the core of the body. Whilst the horse rider is in these widely considered 'insecure' positions (BHS, 1990) balance is not able to be maintained. During the standing phase of rising trot, the leg underneath the body, allows for an 'anchor' to enable the rider to rise in a consistent and balanced manner. When the lower leg is in front of the ESHH alignment it may cause the rider to maintain balance using their hands instead and pulling on the horse's mouth which would potentially cause pain.

Impeding the way that a horse is able to move has been reported by many authors (Clayton *et al*., 2003; Warren-Smith *et al*., 2007)) with a common theme being the horse rider. The results of this study support the findings of McGreevy (2006) who stated that horse riding must rely on subtle interactions between horse and rider to remain humane as a result of horse riders having an overwhelming influence of the horse whilst mounted through providing stimuli with hands, weight in the saddle and legs positioned on either side of the horse. When the horse moves off into a gait, the novice horse rider has exhibited an increase in pressure, compromising the welfare of the horse highlighting the importance of the ESHH alignment resulting in an increase of balance in agreement with the findings of Lesimple *et al.*(2010) who found that teaching proper balance to novice riders to reduce the likelihood of injuring the horses back.

The trot ridden in a sitting position demonstrates that it is the first gait (at week 2) to show a reduction in deviation from the ESHH with a dramatic decline continuing when the walk and rising trot stabilize over time. There is a large element that can be improved in rider position during sitting trot and additional exercises support the muscles required in carrying out the complex requirements of the rider successfully obtaining an upright sitting trot. Similar research by Meyners (2011) suggested that because the horse and rider is in constant motion it is difficult to train improvement whilst sitting on a horse; therefore, dismounted, complimentary training can improve seat and body control.

Furthermore, it is suggested that during sitting trot the most common fault is the 'arm chair' due to the importance of having suppleness of the pelvis and lower back. The results of the current study would expect the rider specific treatment group to present a lower deviation from the ESHH. However in reality the traditional neuromuscular treatment group displayed greater improvements (ie less deviation from ESHH) when riding in sitting trot. The basis of any successful position is suppleness and ability to isolate muscle groups. There have been suggestions that learning to ride sitting trot is the hardest to learn because of the demanding requirements which would support the decrease in deviation and increase in 'fitness markers' integrity of the traditional neuromuscular treatment group.

As well as the importance of maintaining a correct position to ensure optimal horse welfare it is important to consider to role of position in safety. In the event of a horse running away from a negative stimulus, the rider would have limited ability to remain balanced and therefore mounted. The importance of maintaining the ESHH alignment in relation to safety cannot be stressed enough (BETA, 2006; Hawson *et al.,* 2010). Another reason that the different gaits have shown different deviation over the trial period may be due to other contributing factors such as the different horse's 'way of going'. An uncontrollable aspect element was not being able to use the same horses on a weekly basis, which is a variable that requires mentioning in relation to the impact of gait on rider position. It is profoundly understood that each horse has individual conformation characteristics which results in different ways of moving, for example a more active in the hind leg will create a 'bigger' trot stride and therefore feel more 'bouncy' resulting in a more difficult trot to sit to or land in a quiet manner. These variables may be responsible for the increase deviation in sitting trot and rising trot after the steady decrease during the initial six weeks.

4.3 Influence of time on rider position

There has been limited research into the optimum length of any fitness regimen to gain maximal results in mounted performance. This study suggests that weekly sessions of intensive traditional neuromuscular training over 5 weeks can improve the ESHH alignment. The reduction in deviation cannot be seen until the second week in sitting trot and week three for walk and rising trot. The sitting trot being the initial gait that shows improvement at week two is surprising as this is the most difficult position for a rider to maintain (Symes and Ellis, 2004; Meyners, 2011; British Horse Society, 2012).; The improvements seen after week three are dramatic in all three gaits. Interestingly at week five the results appear to plateau in comparison to sitting trot which continues to reduce at the final week. These findings suggest that there was further potential for improvement in the horse riders' position in sitting trot in comparison to the other gaits. The walk and the rising trot are the gaits that novice riders are introduced to first which may further suggest that the improvements shown in the second week were due to the untried nature of the gait and therefore bad 'habits' have not been developed. The results of the rider specific training and traditional neuromuscular training have produced similar results by the end of the trial period but the initial four weeks produced an increase in deviation in all the gaits suggesting that the rider specific treatment group required a little longer in experiencing changes in position. The most common length of a Pilates courses, which was the foundation of the rider specific course, is eight weeks (Javnbakht *et al*., 2009; Ahearn 2011; Hewitt *et al*., 2011). Upon further research this length of time is the minimum length that dancers required to improve muscular strength and balance, concluding, exercises that incorporated Pilates movements resulted in dancers being more expressive, body aligned and displaying more intention whilst executing dance sequences (Fitt *et al.,* 1994; Ahearn 2011). In addition the weekly programme generates a reference point of 'correct' feeling that can be used at a future stage. Furthermore, the use of Pilates has enabled Carver dancers to detect and correct errors without intervention from coaches, an example would be students who have the inclination to hyper-extend, will develop; a greater awareness, strength and control to correct the inconstancy. This 'reference' theory could potentially explain the effect of week in relation to the rider specific treatment group (Ahearn, 2011; Meyners, 2011). Although, it has been suggested that different exercise programs are effective at improving muscle capacity. However, which exercise programmes are most effective in advancing performance is less understood (Eyigor *et al*., 2007).

4.4 Leg length

Leg length whilst mounted showed a significant improvement as seen in Table 8. Literature suggests that the legs of the rider should be 'stretched down' utilising the hamstring muscle (Blokhuis *et al*, 2010; Broom, 2011; Meyners, 2011;) whilst maintaining a straight line through the ear, shoulder, hip and heel. Both treatment groups displayed an increase in leg length upon completion of the training programme; however, RSFT had a higher increase in difference in comparison to the other treatment group.

This difference could be due to the nature of exercises carried out over the trial period. RSFT was designed to promote correct posture through focusing on rider specific muscles whilst increasing self-awareness. Interestingly TNT showed significant improvements although the regime followed did not incorporate any proprioceptive activities A possible reason for this increase would be due to the hamstring stretched in the weekly warm up routine; as the candidates would not have been required to carry out these activities in any other situation; which in turn may have been responsible for the increase in leg length measurements supporting the suggestion that movements which are carried out on the ground are transferred into the mounted posture (Pitts, 2011) in contrast, it has been suggested that individuals respond differently to specific exercises which would contradict the suggestions of this study of being able to improve the leg length through specific stretches, although the repetition would be a factor for consideration. However, it is felt that due to the aetiology and function of the hamstring muscle group; comprising of three separate muscles: semitendinosus, semimembranosus and biceps femoris, the likelihood of improving these muscles through exercise.

Treatment group one (RSFT) displayed a greater increase in leg length. The regimen was specifically designed to 'elongate' the riders' position through a range of movements and stretches. Interestingly the findings of the sit and reach test support the suggestions and design of the rider specific training which would promote the use of additional stretches in novice riders to increase the length of leg as well as reduce the deviation of the ESHH alignment. However, this study does not measure the impact of increase leg length on efficiency of rider (Blockhuis *et al*., 2008); which in turn is the suggested reason for implementing novel fitness techniques alongside more traditional methods. A potential reason for this greater leg length could be linked to improved proprioception as well as an improved ability to use key part of the body independently (Broom, 2011; Weaver *et al*., 2012). The findings of this study contrast with the suggestions of Mulhall *et al*. (2002), who advised that the most common reason for leg length impairments are due to muscle tension or structural abnormalities of the pelvis. In relation to the recommendations of Mulhall *et al.* (2002) that structural abnormalities may be responsible for any discretions in length of the leg whilst mounted conflict with the improvements found within this study although muscle tension could be alleviated through specific stretches, in turn, increasing leg length whilst mounted.

5.0 Limitations of current study

It is important to note that this research was carried out in a working College environment which required scrupulous ethics examination to ensure that the study would not impede the progress of the students resulting in a limited amount of limitations which were out of the researcher's control. Although there was not a control group *per se* (ie a third, no activity group), each subject within the two groups acted as their own control (i.e. before vs after) (Ortega *et al.,* 2007; Weaver *et al.,* 2012).

A criticism of the current study includes the loss of three weeks of treatment group two due to unexpected factors due to a compulsory examination date being moved into the data collection period. This factor could not have been planned into the timetable; However, both Bray (2004) and Broom (2011) suggested that five weeks is enough time to produce significant changes which is supported by the findings of this study.

An uncontrollable factor when using a considerable sample size of candidates, as well as co-ordinating horses, without hindering the progress of either participant whilst maintaining the integrity of this research; for example the sessions were filmed in an outdoor arena which in theory could have impacted the results although all students and horses were habituated to riding in this environment; not only for research purposes but for ultimate safety. However, the weather is a factor which would need to be taken into consideration in the event of high winds or driving rain as this potentially could have affected the posture of the rider. Fortunately, during the data collection period there was no abnormal weather observed.

An unexpected aspect which was not addressed prior to the data collection was the mental preparation required before training or preparing to ride. The 'desire' or 'want' to succeed or improve has been highlighted through this research. It is felt that the results shown could have been affected by the attitude of the candidates during the fitness session (Bray *et al*, 2004; Eyigor *et al.*, 2007; Prichard and Tiggemann, 2008). It was not possible to quantify if the candidate was putting enough effort into each movement, stretch or activity. However, it is felt that during the activities involved in treatment group 2, the candidates were more motivated during the traditional neuromuscular training in line with the findings of Bray (2005) and Thorell *et al*,(2009) possibly due to the team spirit nature of the sports. Team sports are understood to enable individuals to contribute more effort as a result of increased enjoyment. It had been overestimated that the equine students would be as enthusiastic about the treatments as the researcher. It was addressed that the attitude of students may have had an impact on the attendance of the sessions, although this was addressed in the methods by disregarding any candidate who did not attend each session just not the amount of personal participation of the individual between each treatment group (Smith, 2003; Bray *et al.,* 2004; Sekendez *et al., 2007).*

The use of heart rate monitors in measuring the fitness would have been more suitable for measuring the fitness of the students during recovery after exercise. However, this piece of apparatus was not fundamental to the findings of this study. Heart rate monitors would have been ideal to have been utilised during the exercise sessions to allow monitoring of the intensity of the training, which would divulge information which could allow correlations to be drawn between results and participation as seen in research by Prichard and Tiggeman (2008).

6.0 Suggestions for further research

Knowing and understanding the exact physiological demands of a horse rider will enable development of a specific fitness regimen incorporating aspects targeting the specialised demands of the horse rider. This study could be used as preliminary work for research in this area. Further research is needed to fully understand the impact of attitude in the equine athlete towards fitness to enable development of a suitable regime that enables equine athletes to understand the requirements of an additional fitness regime to assist and support the improvement of mounted rider position.

7.0 Conclusion

This study has provided an account of and the reasons for using additional dismounted exercise in 16-18 year old equine students. Two different treatment methods were used to determine the impact of traditional neuromuscular training and rider specific training on novice rider position from a lateral view using ESHH alignment and leg length.

This project was undertaken to evaluate the effect of additional dismounted treatments on individual rider performance as well as investigating the impact of gait on deviations from the ear, shoulder and hip heel alignments.

One of the more significant findings to emerge from this study was that additional dismounted exercise significantly ($p<0.05$) improves mounted rider position. However, the traditional neuromuscular training treatment group showed improvements at a quicker rate over the rider specific training group.

The relevance of including additional dismounted exercises in equine student's timetable in addition to the weekly riding sessions is clearly supported by the current findings as the ear, shoulder, hip and heel alignment can be improved without the use of a horse thus, improving the safety and welfare of both horse and rider.

The impact of personal participation has been identified as a major contributing factor in using dismounted exercise in improving novice rider position and therefore assists in our understanding the role of exercise that could be most beneficial to further education equine students at Duchy College. The current findings add to a growing body of literature on the use of team sports and teaching styles on participation and retention numbers within the sporting community. The results of this research support the general idea that there is an increased likelihood that amateur athletes and adolescents are more likely to repeatedly attend a physical activity session if there is an element of team work and peer acceptance i.e., ball sports. Therefore, it seems that it would be a reasonable assumption that introducing a 'team' physical activity to the equine syllabus would enhance the rider's fitness and mounted performance. However, the influence of gait on the rider's position from a lateral view requires a deeper understanding to enable specialist equine instructors to focus on the 'rounding' of shoulders during the rising phase of the sitting trot.

The project was limited in several ways. First, the project did not use a control group as each rider represented their own improvements from before the treatment and after the treatment. It was not possible to implement a control group due to the limited availability of students and the limited amount of term time available as well as being a reasonable amount of time to assume that the candidates' learning would not be hindered by reducing the timetabled ride sessions or starting any additional outside exercise opportunities. However, with a small sample size, caution must be applied, as the findings might not be transferable to more advanced riders or to an older population.

Taken together, these findings suggest a role for additional team exercises in promoting fitness and improvement of mounted rider position in novice equine athletes.

8.0 Appendices

Appendix 1

Faculty of Science and Technology

Smeaton 009, Plymouth

To:	Eleanor Boden	From:	Paula Simson
cc:	Dr Hayley Randle, Prof Mick Fuller	Secretary to Human Ethics Committee	
Your Ref:		Our Ref:	scitech:\d:\human ethics:
Date:	26 January 2012	Phone Ext:	84503

Application for Ethical Approval

Thank you for submitting the ethical approval form and details concerning your project:

'Investigation into the effect of rider specific fitness using pilates on rider position'

I am pleased to inform you that this has been approved.

Kind regards

Paula Simson

Appendix 2

SELF-CONSENT FORM

UNIVERSITY OF PLYMOUTH

CONSENT TO PARTICIPATE IN RESEARCH PROJECT / PRACTICAL STUDY

Name of Principal Investigator
Hayley Randle

Title of Research

An investigation into the effects of rider specific fitness and pilates on rider position

---

Brief statement of purpose of work

To identify how fit the students are before the 8 week fitness regime.
To measure the rider position before the 8 weeks.
To carry out a fitness regime over 8 weeks.
To demonstrate if a fitness regime can improve rider position
To improve welfare of college horses.

The objectives of this research have been explained to me.

I understand that I am free to withdraw from the research at any stage, and ask for my data to be destroyed if I wish.

I understand that my anonymity is safe-guarded, unless I expressly state otherwise.

I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities (e.g. under COSSH regulations).

Under these circumstances, I agree to participate in the research.

Name: ……………………………………….
Signature: ....……………Date: ....…………..

CONSENT FORM FOR PARENT/LEGAL GUARDIAN

UNIVERSITY OF PLYMOUTH

CONSENT TO PARTICIPATE IN RESEARCH PROJECT / PRACTICAL STUDY

Name of Principal Investigator
Hayley Randle

Title of Research

An investigation into the effects of rider specific fitness and pilates on rider position

---

Brief statement of purpose of work
To identify how fit the students are before the 8 week fitness regime.
To measure the rider position before the 8 weeks.
To carry out a fitness regime over 8 weeks.
To demonstrate if a fitness regime can improve rider position
To improve welfare of college horses.

I am the *parent /legal guardian of ___________________________________

The objectives of this research have been explained to me.

I understand that *she/he is free to withdraw from the research at any stage, and ask for *his/her data to be destroyed if I wish.

I understand that *his/her anonymity is safe-guarded, unless I expressly state otherwise.

I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities (e.g. under COSSH regulations)

Under these circumstances, I agree for him/her to participate in the research.
** delete as appropriate*

Name: ……………………………………….

Signature: ....…………….Date: ....…………

FOR PARENT/LEGAL GUARDIAN

Consent form for generating and using media material

University of Plymouth

Consent for the filming and use of images in final thesis

Name of Principal Investigator
Hayley Randle

Title of Research

An investigation into the effects of rider specific fitness and pilates on rider position

---

Brief statement of purpose of work
To identify how fit the students are before the 8 week fitness regime.
To measure the rider position before the 8 weeks.
To carry out a fitness regime over 8 weeks.
To demonstrate if a fitness regime can improve rider position
To improve welfare of college horses.

I am the *parent /legal guardian of ___________________________________

The objectives of this research have been explained to me.

I understand that *she/he is free to withdraw from the research at any stage, and ask for *his/her data to be destroyed if I wish. Once the filming has been completed the images will be legally required to be kept by the university for 5 years. After the 5 years I understand the images will be destroyed.

I understand that *his/her anonymity is safe-guarded in the use of any images unless I expressly state otherwise.

I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities (e.g. under COSSH regulations)

Under these circumstances, I agree for him/her to participate in the research.
** delete as appropriate*

Name: ……………………………………

Signature: ....……………..Date: ....

SELF-CONSENT FORM

Consent form for generating and using media material
University of Plymouth
Consent for the filming and use of images in final thesis

Name of Principle researcher
Hayley Randle

Title of Research
An investigation into the effects of rider specific fitness and pilates on rider position

---

Brief statement of purpose of work
To identify how fit the students are before the 8 week fitness regime.
To measure the rider position before the 8 weeks.
To carry out a fitness regime over 8 weeks.
To demonstrate if a fitness regime can improve rider position
To improve welfare of college horses.

The objectives of this research have been explained to me.

I understand that I am free to withdraw from the research at any stage, and ask for my data to be destroyed if I wish.
I understand that I will be filmed on a weekly basis whilst riding down a 5m track and I give permission for the images to be used in the final research project.

I understand that my anonymity is safe-guarded, through the use of pixelating faces in any images, unless I expressly state otherwise.

All recordings are legally required to be kept for 5 years by the university and are kept confidential manner. After the 5 years all the recordings will be destroyed.

I understand that the Principal Investigator of this work will have attempted, as far as possible, to avoid any risks, and that safety and health risks will have been separately assessed by appropriate authorities (e.g. under COSSH regulations).

Under these circumstances, I agree to participate in the research.

Name: ……………………………………….

Signature: ....…………….

Date: ....…………..

INFORMATION SHEET

UNIVERSITY OF PLYMOUTH

RESEARCH INFORMATION SHEET

Name of Investigators:
Hayley Randle and Eleanor Boden

Title of Research:
An investigation into the effects of rider specific fitness and pilates on rider position.

Aim of research:
To identify if rider position can be improved from an 8 week course of rider specific fitness and Pilates methods.

Description of procedures:
The candidates will take part in an initial fitness session held in the gym; they will be required to be weighed and measured before completing some fitness ‘testing’ exercises such as the bleep test and the sit and reach test. The exact same tests will be repeated at the end of the eight weeks.
On a weekly basis the students will participate in a number of pilates exercises that are rider specific designed to increase range of motion and increase core strength as well as complete a circuit of circuit training including ; **push ups, sit ups; high knee sprints; ‘burpees’; shuttle running and rider specific stretches. Then candidates will be filmed before the eight weeks of fitness as well as during and after completion of the course.**
The candidates will also be required to ride the same horse (that they will be familiar with) once a week over the 8 weeks in walk, rising trot and sitting trot , down a 5 meter prepared track, guided by dressage markers to be filmed for measurement. They will be required to be marked up using 3d spherical markers on the top of the riding hat, point of shoulder, point of hip and heel as instructed by Eleanor Boden to ensure accurate placement of the markers.
Whilst being filmed on horseback, the riders are not required to wear anything different from what they would normally wear whilst riding other than a tighter fitting long sleeved top so not to displace the markers.

Description of risks
The risks that are associated with the investigation are limited. Although all the riders have completed a health questionnaire, are familiar with all the horses and completed an induction to riding. A risk assessment has been completed for all tasks that are to be carried out.

All rules of the riding school, gym and the personalised safety statement must be adhered to; further minimising the risks.

Benefits of proposed research

The benefits of proposed research include; the candidates will be able to take part in a fitness programme and be filmed whilst riding; each candidate will have access to the results as mentioned in my debriefing.

Right to withdraw

All candidates that take part in the investigation maintain the right to withdraw at any point in the study. The data collected from this candidate will be destroyed after withdrawal.

If you are dissatisfied with the way the research is conducted, please contact the principal investigator in the first instance: telephone number: 01579 372286

Appendix 3

Risk Assessments

Reference No. EB2

Activity										Location	
General activity within the equestrian arenas										Department/Unit Room / Building Campus/Location	Duchy College Equestrian Centre / Indoor School A & B plus the outdoor school.
Having referred to the College risk assessment guidance and evaluated the overall level of risk, please tick the appropriate box below:											
Very High		High		Medium		Low		Insignificant ✓			

Hazards and Harm	Who is At Risk	How Are Risks Currently Controlled	Are additional Control Measures Needed (Y or N)
No roof light sheets in Indoor A, totally reliant on artificial lighting	Everyone in the arena - riders / spectators / researcher	Emergency exit lights come on when main system trips out. A member of Duchy College equestrian centre is available during the day to reset trip switch. Wardens phone number in notice board outside school for people to ring if it happens after 5pm.	Yes
Dust inhalation and grazes from landing on the surface	Riders / spectators / researcher	Schools are regularly skipped out to remove the droppings. The tracks are raked in and the surface levelled daily. Surfaces are watered as required to prevent them from drying out and becoming too deep and dusty.	No
Fall of horse or rider. Possibility of cuts, bruises, broken bones, head injuries	Riders	Organisers of events to ensure a suitably qualified first aider is always present at events. First aid equipment is accessible in all arenas. Organisers to stop any unsafe riding practices straight away. If the organisers deem a horse to be unsuitably trained or exhibiting dangerous behaviour, in an enclosed area they must ask the rider to dismount and leave the area. Organisers must ensure all riders wear PPE to current standards.	No
Manual handling, bruising, back injury from incorrect lifting of jump poles and dressage boards	Researcher	Correct lifting techniques to be followed.	No
Training mirrors on the wall of the large indoor school	Riders / researcher / Spectators	Horses not ridden too close to the mirrors and faced straight onwards to them. Keep horse in the centre of the school until it accepts the presence of the mirrors. Signs placed up on wall to warn	No

		people not to present their horses directly to the mirror.	
Horse shies / frightened by noise or another animal	Riders / researcher/ Spectators	Signs are up around the outside of the arenas warning people to keep noise to a minimum. Spectators are kept separate from the riding area. Organisers to ensure all riders wear PPE up to current standard. If organisers deem a horse presents dangerous behaviour they must ask the rider to dismount and leave the area. First aid equipment is accessible in all arenas. Dogs are not allowed at equestrian events.	No
Horse / rider /spectator kicked by a horse	Riders / researcher / spectators	Organisers to ensure riding areas do not become too crowded and limited the number of riders using an arena at any one time. The layout of the event must ensure that spectators and riders are always kept separate. If organisers deem a horse presents dangerous behaviour they must ask the rider to dismount and leave the area. First aid equipment is accessible in all arenas.	No
Fire	Everyone in the area	Catering equipment / van parked away from the arenas - the College suggests at the top of the slope outside Sam's cafeteria. There are two exits, one at each end of the arena for each indoor school. No smoking signs outside the arenas - organisers to ensure people attending the events do not smoke. Hose pipe at the end of Indoor School A.	No
Slips / trips and falls	Everyone in the area	Organisers to ensure area does not become too crowded. If any area becomes slippery organisers must fence off the area. Any trip hazards to have a warning sign. Appropriate footwear to be worn by everyone at the event.	No

Risk Assessment Action Plan

Immediate Action Required to Reduce Risk	By whom
This risk assessment to be given to all candidates before the research data collection is carried out.	Researcher

Further Action Needed to Reduce Risk	By whom	When

Person Carrying Out Risk Assessment				Has This Risk Assessment Been Communicated to All Relevant Persons			
Name (please print)	Position	Date of Assessment	Review Date				
Eleanor Boden	Researcher	9th Nov 2011	4th Feb 2012	Yes	✓	No	

Line Manager: Please sign to confirm you agree with the findings of the assessment and actions proposed			
Signature	Name (please print)	Position	Date

Risk Assessment

EB2

Activity										Location	
Riding on the flat or over fences in the arenas										Department/Unit Room / Building Campus/Location	Duchy College Equestrian Centre. 2 indoor arenas and the outdoor arena
Having referred to the College risk assessment guidance and evaluated the overall level of risk, please tick the appropriate box below:											
Very High		High		Medium		Low		Insignificant ✓			

Hazards and Harm	**Who is At Risk**	**How Are Risks Currently Controlled**	**Are additional Control Measures Needed (Y or N)**
Fall of horse or rider. Possibility of cuts, bruises, broken bones, head injuries - applies to all hazards	Students, other riders and instructors	All riders are matched in ability to a suitable horse. All riders trained to take BHS examinations. PPE to current standards. Qualified instructors are always present. Instructional standards to matched to student ability. First aid equipment accessible in all schools. All instructors hold a valid first aid at work certificate. Purpose built mounting blocks available in all schools	No
Horse shies/ frightened by noise or other animals	Students, other riders and instructors	All riders are matched in ability to a suitable horse. All riders trained to take BHS examinations. PPE to current standards. Qualified instructors are always present. Instructional standards are matched to student ability. First aid equipment accessible in all schools. All instructors hold a valid first aid at work certificate. Signs up around the arena regarding noise and horses	Yes
Horse/rider kicked by another horse	Students, other riders and instructors	Correct school rules to be followed. Limited number of riders to instructors on the surfaces.	No

Exposure to elements	Students, other riders and instructors	Clothing appropriate to weather. No riding in icy weather, very high winds or thunder	No
Training mirrors on the wall of the large indoor school	Students, riders, instructors	Horses are ridden as normal but if worried remain in the centre of the arena until accepting the mirrors Experienced staff ride the horses that are worried about the mirrors until they accept them	No
Failure of the lights in the large indoor school (ISA)	Students, staff, riders, general public	All riders to be briefed as to what to do in the case of lighting failure. Which is stand still until the doors are opened and then dismount and lead horses from the arena	Yes

Risk Assessment Action Plan

Immediate Action Required to Reduce Risk	**By whom**
Regarding lighting in the large indoor school: All students to be briefed what to do in the case of lighting failure.	Researcher

Further Action Needed to Reduce Risk	**By whom**	**When**
Ensure all PPE is up to current standard. Noise around the arenas is a constant problem	Instructor. Health and safety committee	Induction and ongoing. Ongoing issue

Person Carrying Out Risk Assessment				**Has This Risk Assessment Been Communicated to All Relevant Persons**			
Name (please print)	**Position**	**Date of Assessment**	**Review Date**				
Eleanor Boden	Researcher	9th Nov 2011	4th Feb 2012	Yes	✓	No	

Line Manager: Please sign to confirm you agree with the findings of the assessment and actions proposed			
Signature	**Name (please print)**	**Position**	**Date**

Appendix 4

Fitness Assesment Questionnaire

Age (years): 16 17 18 19 20 20+ ☐ ☐ ☐ ☐ ☐ ☐

Course: FE ☐ HE ☐

Do you consider yourself sedentary? (<1hr a week) Yes ☐ No ☐

Year of Study: 1 ☐ 2 ☐ 3 ☐

Do you live on campus? Yes ☐ No ☐

Do you do **enjoy** exercising? Yes ☐ No ☐

Please mark on the scales below:

1. How fit do **you feel**? **1= NOT FIT** **10= very FIT**

1 2 3 4 5 6 7 8 9 10

2. How many hours of exercise **a week** do you do (out of college)?

1 2 3 4 5 6 7 8 9 10

3. How many hours a week do you **ride at college**?

1 2 3 4 5 6 7 8 9 10

4. How important do **you rate fitness in your life?**

1=not important 10=very important

1 2 3 4 5 6 7 8 9 10

5. How important do you rate **fitness to affect riding position?**

1=not important 10=very important

1 2 3 4 5 6 7 8 9 10

Thank you for filling in these questionnaires.
The results will only be used in my final research project

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