This article has been accepted for publication in Comparative exercise physiology. The original publication is available at https://doi.org/10.3920/CEP180006

A preliminary study to investigate the prevalence of pain in international event riders during competition, in the United Kingdom

Lewis, V. and Baldwin, K
Equestrian Performance Research and Knowledge Exchange Arena
Hartpury University Centre, Hartpury, Gloucestershire, England, GL19 3BE;
** Corresponding author* Victoria.lewis@hartpury.ac.uk

Abstract

The aim of the study was to investigate the prevalence of riders at the international levels in eventing, competing with pain, the location of their pain, factors affecting their pain and whether they perceived this pain to have an effect on their performance. *Thirty-one questionnaires were completed by international event riders (FEI CCI *, CCI **, CIC ***) at the Hartpury International Horse Trials, UK, to establish the prevalence of riders competing with pain.*

Ninety-six percent of international event riders competed while experiencing pain, 76% of riders stated that this pain was in the neck, upper back or shoulders. All female riders reported pain, giving a significant correlation between gender and pain (X= -0.479, P=0.006).

Fifty-five percent of riders felt their pain affected their riding performance, giving an odds ratio of 1.14, compared to those riders who felt their pain did not effect their performance. Pain was perceived to influence performance by affecting fatigue, their concentration, and anxiety levels. Ninety-six percent of riders reporting pain used medication to alleviate *their symptoms.*

This high incidence of international event riders who compete with pain, particularly back pain, could be problematic given the longevity of a rider's career, which can span over four decades and could potentially increase the risk of a serious or fatal fall in the cross-country phase. This research reports rider's perceptions and self-reported pain and management options, which may affect the data. Further research is needed to establish the causes of back pain and appropriate management strategies.

Keywords: Equestrian, Event riders, chronic pain, back pain

Introduction

Horse riding is considered to be more dangerous than motorcycling, skiing, car racing, football and rugby (Norwood *et al*., 2000; Sorli, 2000). Riding creates a high-risk situation with the rider placed 3 metres above the ground whilst on an unpredictable animal weighing 500 kg or more that can travel at speeds of 65-75 kmh^{-1} (Ball *et al*., 2007). Whilst most injuries occur during riding, 15% of injuries occur off the horse during related activities such as handling and feeding (Maffulli, 2005).The hospitalisation rate for equestrian activity is 49 for every1000 hours of riding (Sorli, 2005) compared to rugby that has a hospital rate of 93 per 1000 hours (Stokes, *et al.,* 2015). One in five equestrian athletes is seriously injured during their riding career (Ball *et al*., 2007; Mayberry *et al*., 2007). Sixty percent of patients hospitalised following an equestrian related trauma injury, had either fallen or were thrown from a horse (Ball *et al.*, 2009). The Federation Equestrian Internationale (FEI) suggests a fall in competition has an incidence rate of one fall per eighteen starters and 32% of riders injured in competitions, were seriously or fatally injured.

The Olympic discipline of eventing, considered the triathlon of equestrian sport, is one of the most dangerous within equestrianism (Whitlock, 1999; Murray, *et al*., 2006). Eventing takes the complex horse and rider relationship to extremes (Wolframm, 2014; Thompson *et al.,* 2016) with the cross-country (XC) phase generally viewed as the riskiest for both horse and rider (Paix, 1999; Whitlock 1999). The injury rate in eventing has been reported as between 0.88 - 1.1 % starts (Paix, 1999; Whitlock, 1999). Injuries in eventing are most often caused by the jump itself and the action of the horse jumping, resulting in a fall of horse and/or the rider (O' Brien, 2016). 13 % of rider falls lead to an injury (Singer *et al.*, 2003) and Murray, *et al.,* (2006) suggested that there is a 36 % risk of a serious/fatal injury to the rider when the horse falls. These horse falls are often a rotational fall resulting from the horse hitting the solid cross-country fence. There have been 60 rider deaths in eventing between 1993 and 2017, raising serious concerns about the safety of the sport. Following epidemiological investigations (Singer *et al.,* 2003; Murray, *et al.,* 2004; Murray, *et al.,* 2006) and sporting governing body inquiries, rule changes have been implemented, there has been an introduction of frangible pins to the fence designs and improved safety equipment such as air jackets and further developments in helmet safety standards (BE, 2017; FEI, 2017).

While the prevalence of acute injuries in eventing has been well documented, chronic injuries have largely been overlooked. Ball *et al*., (2009) identified that over half of riders that had been hospitalized due to an acute riding injury, experienced chronic physical difficulties following their accident, including chronic pain, weakness, decreased balance, headaches, limited use of limbs, decreased memory and mood changes. With the high number of acute injuries seen in eventing it is likely that some of these riders will experience chronic pain issues. Chronic pain may also be a result of over-use musculoskeletal injuries from long term, repetitive movement. Kraft (2009) identified that 88 % of riders reported chronic back pain compared to 33 % of the non-rider control group. The majority of this back pain reported to be lower back pain. In elite competition riders, Lewis and Kennerly (2017) found 74% were competing with pain, the majority of which was lower back pain. To date, the prevalence of chronic pain amongst competitive event riders has not been established but it is likely that similar figures may be seen in an eventing population, however, the added demands of participating in the show jumping and XC phases may have an impact on incidence, levels of pain and location of the pain.

Chronic pain is a common cause of early retirement from many sports (Cook *et al*., 1997; Kettunen *et al.,* 2002), however, there is little evidence to suggest that this is a problem in the sport of eventing. Particularly as it is classed as an early start, late maturation sport and where the mean age of British Olympic riders is thirty-eight years old (Dumbell *et al.* 2015), chronic pain may not be an issue in the longevity of riders participating in the sport, but is worthy of further investigation. Ball *et al*. (2009), suggest that despite chronic pain issues, many riders continue to ride, but this may have performance limiting effects (Wipper, 2000; Munsters *et al.,* 2012; Munz *et al.,* 2014). Lewis & Kennerly (2017) found that there was a significant relationship between riders' pain and their perception that this pain effecting their performance in competition. During a time where the sport of eventing as an Olympic discipline receives funding dependant on participation numbers and international competition results (BEF, 2017), any decrease in participation or performance levels of the riders, due to chronic injury or pain could have detrimental effects on the sport as a whole.

Chronic pain may continue to be symptomatic long after the athlete ceases to compete (Schmitt *et al*., 2001; Kettunen *et al.*, 2002; Kujala *et al.*, 2005). General health and quality of life is likely to be affected as a longer-term consequence of chronic injury (Clarsen, 2015). Treatments of chronic injuries involve costs on individuals, employers and organisations (Clarsen, 2015).

The aim of the study was to investigate the prevalence of riders at the International CCI*, CCI** and CIC*** levels in eventing competing with pain, the location of their pain, factors affecting their pain and whether they perceived this pain to have an effect on their performance.

Materials and Methods

Participants

Following full institutional ethical approval, a purposeful sample of fifty paper based questionnaires were distributed to CCI *, CCI ** and CIC *** event riders at the Hartpury International Horse Trials. Riders were asked to compete after the event and a researcher was at hand during competition to clarify any questions. Thirty-one were completed, giving a response rate of 62%. Participants included 18 female riders and 13 male riders, with an age range of 18-55 years and a mean age of 32.5 years (SD = 10.17).

Measure

A five section survey was constructed using the principles put forward by Diem (2002). The survey containing twenty questions was developed containing a mixture of closed – response (e.g. Yes/no and Likert scale) and open-response items (Bruce, 2008). Section 1 asked respondents to state their eventing competition level. Section 2 asked questions related to previous injury and self reported level of pain (adapted from validated questions taken from short-form McGill Pain Questionnaire (Melzack, 1987) , location and cause of this pain. Section 3 was specific to the perceived impact this pain had on their performance. Section 4 asked what factors contributed to increased levels of pain when riding (e.g. saddle, movement of the horse, cold weather, yard work). The final section solicited information related to the participants management strategies for dealing with this pain (e.g. over the counter pain medication, prescription pain medication, manual therapy such as physical therapy, chiropractic treatment and other strategies). Validity evidence for the instrument was provided by reviewing the questionnaire for: (1) clarity of wording, (2) use of standard English and spelling (3) reliance of items, (4) absence of biased words and phrases, (5) formatting of items, and (6) clarity of instructions (Fowler, 2002). Two faculty senior academics experienced in survey design, were asked to use these guidelines to review the instrument. Based on the reviewers' comments the instrument was revised and as a pilot study the questionnaire was distributed to 10 competition event riders before further revisions were made prior to final administration.

Data analysis

Descriptive statistics were used to report frequencies and percentages within data. Spearman's correlation and odds ratios were utilized to assess prevalence of pain experienced by elite event riders. An alpha value was set at $p<0.05$ (confidence interval 95%) throughout unless otherwise stated. Data were analysed using SPSS for Windows version 24.

Results

Ninety-six percent of riders reported competing with pain meaning that event riders had an odds ratio demonstrating they are thirty times more likely to be competing with pain than without pain. Nineteen percent described their pain as mild, 42 % described their pain ranging from mild to moderate in severity, 23% moderate, 13 % described their pain as moderate to severe and 3 % of riders described their pain as severe.

This article has been accepted for publication in Comparative exercise physiology. The original publication is available at https://doi.org/10.3920/CEP180006

One hundred percent of the 36-45 year age group reported pain, 91% 18-25 years, 88% 26-35 years and only 25% for the 46-55 year old group. Figure 1 shows the pain scores (0 = no pain, 5 = severe pain) per age group and highlights the lower age groups 18-35 year old reported higher pain scores than the over 36 year olds. However, the correlation between reported pain scores and age was not significant (r_s (29) = 0.22, p = 0.885).

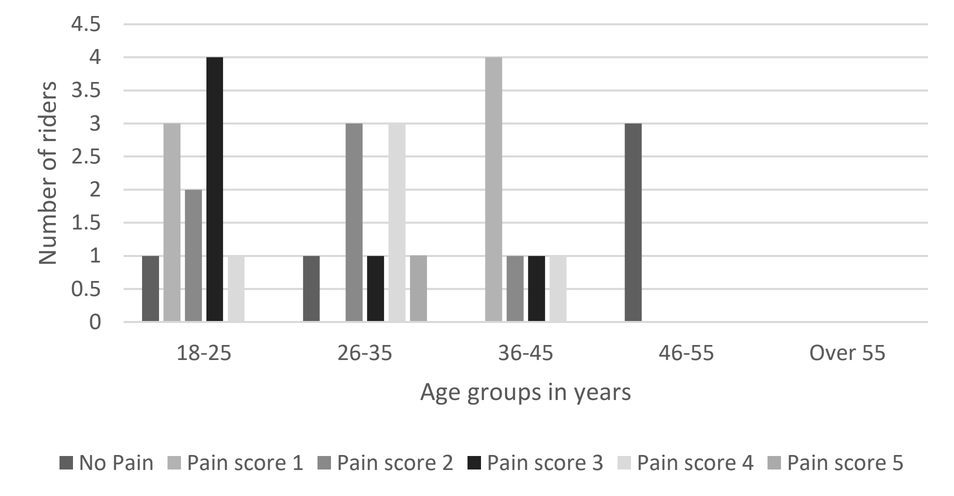


Figure 1. Pain scores for riders

All female riders reported pain, giving a significant correlation between gender and pain (X^2 *(1, n=31)* = -0.479, p=0.006).

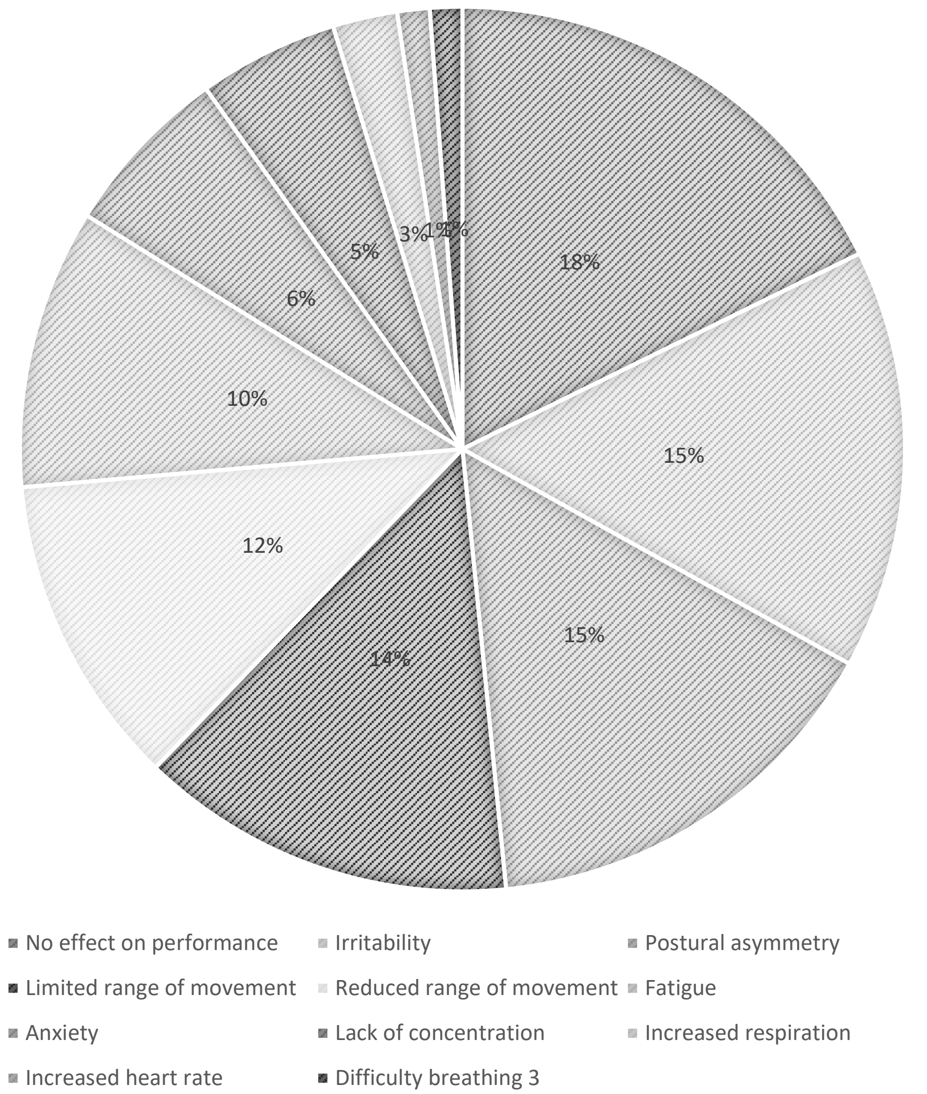
Fifty-two percent of riders reported pain in the lower back, 48% shoulder pain, 35% neck pain, 32% upper back pain, and 25% hip pain.

Fifty-one percent of riders did not attribute their pain to a previous injury, 26% attributed the pain to a previous injury as a result of a fall and 23% attribuited the pain to a previous injury that was not a result of a fall. There was not a significant relationship between reported pain scores and whether the riders percived that their pain was related to a previous injury or not (r_s (28) = 0.44, p = 0.781).

Fifty-five percent of riders felt their pain affected their riding performance, with an odds ratio of 1.14. Figure 2, shows riders perception of how they felt their pain effected their performance.

This article has been accepted for publication in Comparative exercise physiology. The original publication is available at https://doi.org/10.3920/CEP180006

FIGURE 2. RIDERS PERCEPTION OF HOW THEIR PAIN EFFECTED THEIR PERFORMANCE

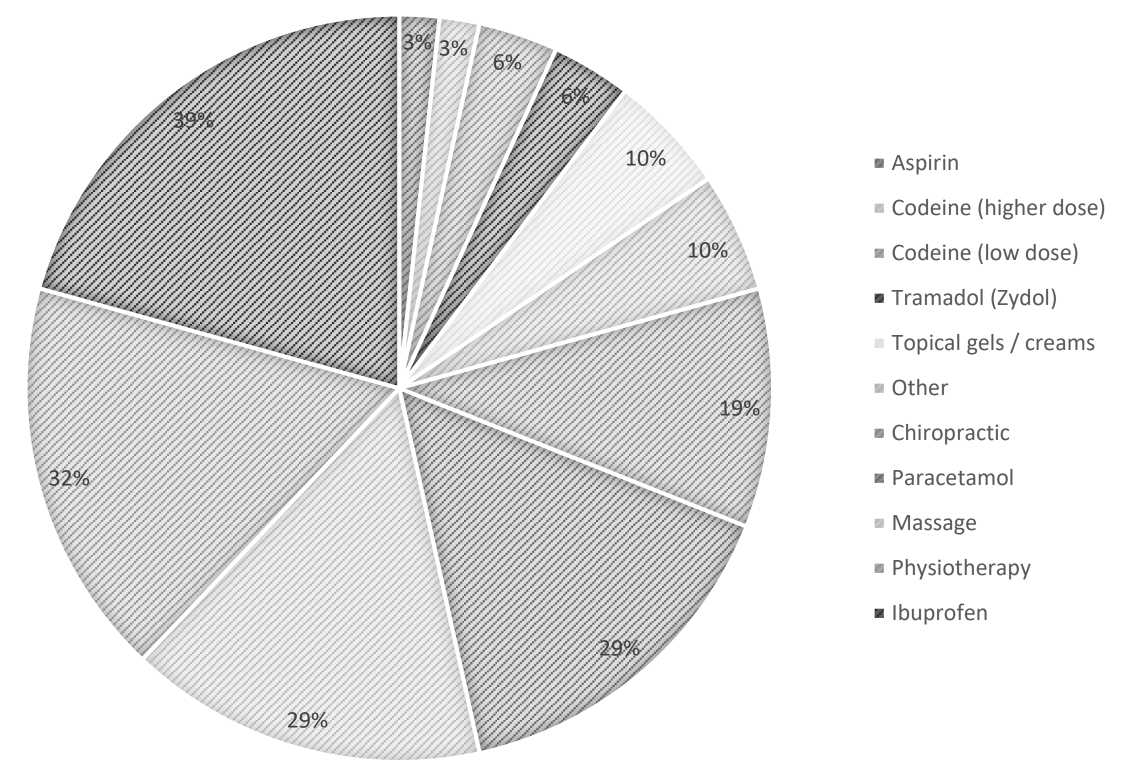


Sixty-eight percent attributed their pain to the activity of riding on the flat, 35% to performing stable duties, 16% of riders attributed their pain to saddle design, 16% to the weather, 16% to other factors and 10% to jumping.

Ninety-six percent of riders used pain medication to a control/alleviate their pain (see figure 3). Nineteen percent of participants used physiotherapy to help treat their pain, 35 % used sports massage, 6 % used chiropractic and 6 % used other unspecified forms of therapy.

This article has been accepted for publication in Comparative exercise physiology. The original publication is available at https://doi.org/10.3920/CEP180006

FIGURE 3. THE RIDERS' TREATMENT AND CONTROL OF PAIN



Discussion

This is a preliminary exploratory study, using a purposeful sample. The study identified that 96 % of the event riders who took part in the study were experiencing pain whilst competing. Whilst this study did not explore why they continue to compete with pain, it may be due to economic pressures to continue to compete for prize money, sponsor or owner pressures (Wolframm *et al*. 2015). Also, due to the unique dyad relationship, the fact that if the horse is not in pain or injured there is a demand on the rider to continue, particularly as the rider often does not consider themselves as an athlete (Douglas *et al. 2012)*, and rest and rehabilitation seen is other sports, may not be used.

Most riders described their pain as ranging from mild to moderate in severity, although 13 % described their pain as moderate to severe, 3 % of riders described their pain as severe. Fifty-five percent of participants felt their pain affected their riding performance, stating physiological limitations such as fatigue, increased heart rate, increased respiratory rate and difficulty breathing. The cross-country (XC) phase places high aerobic demands on the rider, higher than seen in other equestrian disciplines (Douglas, *et al.*, 2012; Roberts, *et al.*, 2009). Roberts *et.al.*, (2009) observed lactate concentration of 9.5 ± 2.7 mmol, grip strength decreased significantly from 32.3 ± 6.3 kg pre-competition to 29.8 ±5.5 kg post competition. Mean heart rates (HR) were noted to be 184 ± 11 beats per minute (Roberts, *et al.*, 2009), suggesting maximal oxygen uptake (VO_2 Max) >90 % (Douglas, *et al.*, 2012). At the International level XC phase riders need to maintain these physiological parameters for distances ranging from a minimum 3640 m at CCI* to a maximum 5500 m at CCI ** and a maximum distance of 3990 m at CIC ***, with optimum times ranging from 6 – 10 mins and jumping efforts 25 -35 fences (FEI, 2017). Singer, *et al.*, (2003) found a significant increase in risk of a fall XC with an increase number of jumps on the course and for jumping efforts later on the course, suggesting fatigue of the horse and/or the rider is a factor. Riders that stated their pain increased their fatigue levels potentially limits their body's ability to cope with the high physiological demands and could put these riders at an additional risk of not only a decrease in performance but could further increase the risk of a fall. Riders also identified decreased movement, range of motion, and postural asymmetry as effects of pain all of which is likely to impact on their position, effectiveness to control the horse, application of aids and the ability to better facilitate their balance (Hobbs, *et al.* 2014; Munz *et al.*, 2014; Largarde *et al.*, 2005; Symes and Ellis, 2009).

The location of pain was predominantly situated in the lower back, 52 % reported, this was smaller incidence in the event riders than seen in elite dressage riders, 76 % (Lewis & Kennerely, 2017) and 72 % in general horse-riders (Kraft, *et al.*, 2009). Lower back pain (LBP) can be caused by the cyclic loading nature of riding and large mechanical forces, which are imposed in the vertical axis of the body from the horse (Clayton *et al., 2009;* Kraft, *et al.*, 2007). The rider's position requires stabilization and isometric contraction of the back and core muscles (Terada *et al.*, 2004; Terada, 2004), damage to these muscle groups caused by repetitive strain can result in chronic LBP (Shepard, 1997). Poor endurance of the hip extensor muscle (*Gluteus maximus*) and hip abductors (*Gluteus medius*) has also been previously noted in individuals suffering with LBP (Nadler, 2000; Kankaanpaa *et al.*, 1998; McGill, 1997). This suggests that fatigue in these muscle groups in connection with LBP may have an impact on the rider maintaining a correct position. Research also suggests that rider pain or stiffness induces asymmetry and diminishes the rider's ability to follow the movement of the horse, both of which will have a negative impact on the rider's position and effectiveness, thus impacting on performance (Munz *et al.*, 2014; Largarde *et al.*, 2005; Symes and Ellis, 2009). Pain experienced in the hip region would decrease the rider's ability to stabilize and control the movement of the pelvis and the dissociation of leg movements when applying the leg aids.

The event riders in this study also reported pain in the upper back, shoulders and neck; this was much higher than reported in dressage riders (Lewis & Kennerley, 2017). This may be due to several factors: riders in the current study identified that performing stable duties attributed to their pain. The repetitive nature of such activities as sweeping, mucking-out, lifting bales of hay and shavings, pushing a wheel barrow etc. all increase the risk of neck and back pain (Côté *et al.* 2008; Hogg-Johnson *et al.* 2008; Ariëns, *et al.*2001). Walström, *et al.* (2004) identified that people performing similar type of repetitive work done on a daily basis, were 30-40 % times more likely to report three or more days of neck pain per month.

The differing position between flat work adopted for dressage riding and that of jumping and faster canter work could contribute to the higher levels of neck and upper back pain identified by eventers compared to dressage riders. Interestingly only ten percent contributed their pain to jump riding, whilst 68% attributed their pain to riding on the flat. As an eventer will spend more time in the jumping position than the dressage rider this position may be the root cause of the pain even though the riders may not realise it. This is because adopting the forward seat for fast work and jumping greatly increases the metabolic cost to the rider (Douglas, *et al.,* 2012). The rider is forced to maintain their balance through weight bearing via the legs only as opposed to the pelvis and legs as seen in the dressage position, a closed hip and thigh angle and a forward trunk position (Nankervis, *et al.* 2015; Douglas, *et al.* 2012; Patterson, *et al.*, 2010). High demands are placed on the rider to be able to control their body in terms of acceleration of body segments during the jump phase, particularly on landing. Patterson, *et al.*, (2010) highlighted the need for the rider to limit the acceleration or movement of their head on landing. As the head weighs approximately 5 kg, reliance on the neck muscles to maintain stability of the head is key. Strain on these neck muscles due to repetitive stress could explain the neck pain experienced by the event riders. Nankervis, *et al.* (2015) also highlighted the repetitive nature of the jump position suggesting elite riders made more changes to their upper body position prior to take-off.

Neck and upper back pain could be as a result of acute head and neck injuries, which account for 20-25 % of riding injuries (Sandiford, 2013; Ekberg, *et al.*, 2011; Hastler, *et al.* 2011; Smartt and Chalmers, 2009; Loder, *et al.* 2008; Moss, *et.al.*, 2002). The mechanics of these types of injuries resulting from a fall are likely to result in a forced flexion-extension trauma of the neck (acute whiplash injury). Whiplash injuries can result in chronic pain in the neck and upper back as well as decreased range of movement (ROM) lasting up to six months (Kasch, *et al.* 2001; Obelieniene *et al.,* 1999; Radanov, *et al., 1996*). Kasch, *et al.* (2001), reported a linear relationship between neck pain and mobility in subjects that had a whiplash injury as a result of a car-crash, with a median speed of 40 m.p.h. Riders at the FEI level will be going at a slower speed of 19-21 m.p.h (F.E.I. 2018), in order to make the optimum time but whiplash type injuries have been reported at speeds as low as 5-10 m.p.h. (Chirotrust, 2018). Riders in this study reported that pain resulted in reduced ROM. It is therefore possible that some of the event riders suffering from chronic pain in the neck and upper back is as a result of a previous whip-lash style injury.

The riders most likely to experience pain were aged 36-45 years old group, however, Jordan *et al.* (2010), identified that the highest age group in the general population to experience LBP was the 45-64 year age-group, 536 per 10,000 of GP consultations. Ageing can cause deterioration of the spine, intervertebral discs and muscles, leading to pain and stiffness (Warson and Hendrickson, 2007). Radiography and magnetic resonance imaging (MRI) can diagnose such problems (Warson and Hendrickson, 2007; O'Brien, 2016). However, Kraft, *et al.,* (2009) found no conclusive MRI evidence to suggest that riders' LBP was caused by disk degeneration, spondylolysis, spondylolisthesis or pathologic changes to the paraspinal muscles of the lumbar spine. This suggests that the back pain in riders may be functional, as attributed to muscular dis-balance (Balagué, *et al.*, 2012; Kraft, *et al.*, 2009; Andersson, 1999). However, the older age group (thirty-six year old and older) reported mainly mild to moderate pain, whereas the 18-35 group reported more moderate to severe pain. As equestrian sport is catergorised as early start, late specialization and late maturation (BEF, 2015) and considering the longevity of a competitive career in Eventing, the potential for chronic pain issues leading to burnout and dropout need to be carefully considered (Balyi, *et al*., 2013; Bompa, 2009). Therefore, an understanding of how these older riders have prevented, treated and managed their pain issues is needed.

Statistical analysis revealed a significant correlation between gender and pain, all the females in the study reported to be competing with pain. Back pain has been identified by Praemer, *et* *al.* (1992) as being more common in women (70.3 per 1000 population) than in men (57.3 per 1000 population).

Riders also reported irritability and anxiety as an effect of pain (Figure 2). This could have a role in determining personality traits as seen in higher level competitive riders, who were found to be less agreeable and conscientious (Wolframm *et al.*, 2015). Irritability and anxiety can also be highly detrimental to the delicate nature of the horse and rider interaction (Wipper, 2000; Munsters *et al.*, 2012). A study by Edwards and Bodle (2014), found that irritability, anxiety and lack of concentration are symptoms of post-concussion syndrome. Concussion in sport is a rapidly developing area of research and support for effects of concussion are widely reported (Johnson *et al.*, 2016; Baker *et al.*, 2016; Theadom *et al.*, 2016). The fact that 39% of riders report irritability, 16% report anxiety and 13% report a lack of concentration and 26% attribute their pain to a previous injury resulting from a fall, could suggest a relationship with previous concussion injury (Theadom *et al.*, 2016). This could have implications for recovery periods and return to play protocol in equestrian sport (Johnson *et al.*, 2016). However, further investigation is needed to identify concussion injuries that occurred, as a result of a fall.

The majority of riders used over-the-counter (OTC) non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen and paracetamol to medicate their pain. Only 3% of participants used prescription medication, suggesting that riders prefer to self-medicate. This is consistent with other sports where NSAIDs are widely used to enable athletes to continue their sporting activities despite acute or overload injuries, accelerate their return to play after an injury and in some cases as a preventive measure (Ziltener *et al.*, 2010; Warner *et al.*, 2002; Tricker, 2000). Berglund and Sundgot-Borgen (2001), estimated that Olympic athletes use NSAIDs six to ten times more often that the general population which could be as a result of higher or more frequent episodes of pain and/or pressures to continue to train and compete despite the pain. Petroczi and Naughton, (2009) identifies two risks to riders relying on OTC pain medication, firstly the risk of failing to comply with anti-doping regulations and secondly the side effects caused by the drugs such as gastrointestinal (GI) disorders and renal damage (Ziltener *et al.*, 2010). When taken frequently, all types of NSAIDs can cause adverse effects to the cardiovascular system, kidneys and liver with side effects including dyspepsia, nausea, ulcers and bleeding (Warner *et al.*, 2002; Ziltener *et al.*, 2010; Tricker, 2000; Bjarnason *et al.* 1993). Ziltener *et al.*, *(*2010) suggested that there was a higher relative risk of bleeding in the upper GI tract after only 1 month of regular NSAID doses. Whilst this present study did not examine doses or frequency of use of NSAIDs in event riders, effective pain management techniques require further investigation (Nicholas, *et al. 2016).*

Conclusion

This study using a small purposeful sample of riders at one event, established that there is a high incidence of elite event riders who compete with pain, particularly back pain, which is problematic given the longevity of an equestrian athletes' career, which can span over four decades. Riders report that this pain affected their position, decreased concentration, and increased fatigue, irritability and anxiety, all of which will have a negative impact on performance and could potentially increase the risk of a serious or fatal fall. Riders self-medicating using NSAIDs could also be putting themselves at an increased risk of long-term health issues. This research reports rider's perceptions and self-reported pain and management options, which may affect the data. So further research is needed to establish the causes of back pain and appropriate management strategies.

Acknowledgements

The authors would like to acknowledge Hartpury College and the organizers of the Hartpury International Horse Trials and those who kindly took the time to participate in the study.

References

1. Anderson, G.B.J. (1999) Epidemilogical features of chronic low-back pain. *Lancet.* 354 581-85.
2. Ariëns, G.A.M., Bongers, P.M., Douwes, M., Miedema, M.C., Hoogendoorn, W.E., Van der Wal, G. Bouter, L. M., Van Mecgelen, W. (2001) Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study *Occupation Environment Medicine.* 58: 200-207.
3. Baker, J. G., Ledddy, J. J., Darling, S. R., Schard, J., Makdissi, M., Willer, B. S. (2016) Gender differences in recovery from sports-related concussion in adolescents. *Clinical Pediatrics* 55 (8) 771-775.
4. Balagué, F., Mannion, A.F., Pellisé, F., Cedraschi, C., (2012) Non-specific low back pain *The Lancet.* 379: 482-91.
5. Ball, C.G., Ball, J.E., Kirkpatrick, A.W. and Mulloy, R.H. (2007) Equestrian injuries: incidence, injury patterns, and risk factors for 10 years of major traumatic injuries. *The American Journal of Surgery.* 193 (5), 636-640.
6. Balyi, I., Way, R., Higgs, C. (2013) Long-term athlete development. Human Kinetics, USA.
7. Ball, J., Ball, C., Mulloy, R., Datta, I., Kirkpatrick, A. (2009) Ten years of major equestrian injury: are we addressing functional outcomes? *Journal of Trauma Management and Outcomes,* 3:2.
8. Berglund, B. and Sundgot-Borgen, J. (2001) Explores the use of medical substances and nutritional supplements (NS) among athletes in the Olympic games in 1996, 1998 and 2000. Types of NS used by athletes; Percentage of athletes who use non-steroid anti-inflammatory drugs (NSAIDS); Benefits of NSAIDS and NS to athletes. *Scandinavian Journal of Medicine and Science in Sports 11 (6) 369-371.*
9. Bjarnason, I., Hayllar, J. Macpherson, A.J., Russell, A.S. (1993) Side Effects of Nonsteroidal Anti-inflammatory Drugs on the Small and Large Intestine in Humans. *Gastoenternology* 104: 1832-1847.
10. Bompa, T. (1999) Periodization training for sport. Human Kinetics, USA.
11. Boschma, A., Smith, G., Lawson, L. (1996) Breast support for the active woman: Relationship to 3D kinematics of running. *Medicine and Science in Sports and Exercise,* 26, s99.
12. British Eventing (2017) Cross-country for eventers_downloadpdf. Available at: https://www.britisheventing.com/training/courses/downloads
13. British Equestrian Federation (2015) Long- term participant development for equestrian riders, drivers and vaulters. Available at: http://www.bef.co.uk/repository/downloads/Riders/RiderDevelopment/LTPD2013v5.pdf

This article has been accepted for publication in Comparative exercise physiology. The original publication is available at https://doi.org/10.3920/CEP180006

14. Bruce, I. (2008) *Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research*. 2^{nd} Edition. London: Kogan Page Limited

15. Burbage, J., Cameron, L., Goater, F., (2016). The effect of breast support on vertical breast displacement and breast pain in female riders across equine simulator gaits. *Journal of Veterinary Behavior: Clinical Applications and Research*, 15: 81.
16. Burbage, J., and Cameron, L. (2017) An investigation into prevalence and impact of breast pain, bra issues and breast size on female horse riders. *Journal of Sport Sciences.* 35 (11) 1091-1097.
17. Chiro trust (2018) 10 facts you should know about whiplash (part 1) Available: https://chiro-trust.org/whiplash/10-facts-know-whiplash-part-1/
18. Clarsen, B., 2015. Overuse injuries in sport: development, validation and application of a new surveillance method. *PhD Thesis.* Available: http://hdl.handle.net/11250/276633 (Last accessed 09/03/16).
19. Clayton, N.K., Pennekamp, P.H., Becker, U., Young, M., Diedrich, O., Luring, C. and Von Falkenhausen, M. (2009). Magnetic Resonance Imaging Findings of the Lumbar Spine in Elite Horseback Riders Correlations With Back Pain, Body Mass Index, Trunk/Leg-Length Coefficient, and Riding Discipline. *The American Journal of Sports Medicine.* 37 (11), 2205-2213.
20. Cook, J.L., Khan, K., Harcourt, P.R., Grant, M., Young, D.A., Bonar, S.F. (1997). A cross sectional study of 100 athletes with jumper's knee managed conservatively and surgically. The Victorian Institute of Sport Tendon Study Group. *British Journal of Sports Medicine.* 31, 332-336.
21. Côté, P., Carroll, L.j., Carragee, E.J., Nordin, M., Guzman, J. (2008) The Burden and Determinants of Neck Pain in Workers. *European Spine Journal* 17 (Suppl 1) S60-S74.
22. Diem, K. G. (2002) A step-by-step guide to developing effective questionnaires and survey procedures for program evaluation and research. *Rutgers-Cook College Resurce centre*. Available at: http://cahnrs.wsu.edu/fs/wp-content/uploads/sites/4/2015/09/A-Step-By-Step-Guide-to-Developing-Effective-Questionnaires.pdf
23. Douglas, J.D., Price, M. and Peters, D.M. (2012) A Systemic Review of Physical Fitness, Physiological Demands and Biomechanical Performance in Equestrian Athletes. *Comparative Exercise Physiology.* 8 (1), pp. 53-62.
24. Edwards, J.C. and Bodle, J.D., (2014). Causes and consequences of sports concussion. *The Journal of Law, Medicine & Ethics*, *42*(2), 128-132.
25. Ekberg, J., Toomas, T., Henrik, R., Lars, V. (2011). Injury rates and risk-factors associated with eventing: a total cohort study of injury events among adult Swedish eventing athletes. *International Journal of Injury Control & Safety Promotion.* Vol. 18 Issue 4, p261-267
26. F.E.I. (2017) FEI Eventing Cross Country Design Guidelines. Available at: https://inside.fei.org/sites/default/files/FEI%20Cross%20Country%20Course%20Design%20Guidelines%202017%2010.11.2017.pdf
27. F.E.I. (2018) Eventing Rules 25^{th} Edition effective 1^{st} January 2018. *Federation Equestre Interantionale*
28. Feucht, C.L. and Patel, D.R. (2010) Analgesics and Anti-inflammatory Medications in Sports: Use and Abuse. *Pediatric Clinics of North America*. 57 (3), 751-774.
29. Fowler, J. (2002) *Survey Research Methods*. 3^{rd} Edition: Sage Publications.
30. Gehlsen, G., & Albohm, M. (1980). Evaluation of sports bras. *Physician and Sportsmedicing*, 8, 89-96.
31. Hasler, R. M., Gysssler, L., Benneker, L., Martinolli, L., Schotzau, A., Zimmermann, H., Exadakylos, A. K. (2011) Protective and risk factors in amateur equestrians and

This article has been accepted for publication in Comparative exercise physiology. The original publication is available at https://doi.org/10.3920/CEP180006

description of injury patterns: A retrospective data analysis and a case - control survey. *Journal of Trauma Management & Outcomes* **5**:4

32. Hobbs, S.J., Baxter, J., Broom, L., Rossell, L., D., Sinclair, J., Clayton, H.M. (2014) Posture, Flexibility and Grip Strength in Horse Riders. *Journal of Human Kinetics* 42: 113-125.
33. Hogg-Johnson, S., Holm, L.W., Guzman, J., Ammendolia, C. Nordin, M. (2008) The Burden and Determinants of Neck Pain in the General Population. *European Spine Journal.* 17 (Suppl 1): S39-S51.
34. Johansson, B., Wentzel, A.P., Andréll, P., Mannheimer, C. and Rönnbäck, L. (2014). May. Evaluation Effects of Methylphenidate on Posttraumatic Brain Injury Symptoms with Focus on Mental Fatigue and Pain. *Brain Injury*. 28, (5-6), 573-573).
35. Johnson, R.S., Provenzano, M.K., Shumaker, L.M., Valovich-McLeod, T.C. and Welch, B.C., (2016). The Effect of Cognitive Rest as Part of Post-Concussion Management for Adolescent Athletes: A Critically Appraised Topic. *Journal of sport rehabilitation*.
36. Jordan, K.P., Kadman, U. T., Hayward, R., Porcheret, M., Young, C., Crroft, P. (2010). Annual consultation prevalence of regional musculoskeletal problems in primary care: an observational study. *BMC Musculoskeletal Disorders* 11:144
37. Kankaanpaa, M. et al. (1998) Back and hip extensor fatigability in chronic low back pain patients and controls. *Archives of Physical Medicine and Rehabilitation.* 79 (4) pp. 412-417.
38. Kasch, H., Stengaard-Pedersen, K., Arendt-Nielsen, L., (2001) Headache, neck pain, and neck mobility after acute whiplash injury. *Spine*Vol. 26 (11) 1246-1251.
39. Kettunen, J. A., Kirst, M., Erkki, A. (2002) Long-Term Prognosis for Jumper's Knee in Male Athletes: Prospective Follow-up Study. *American Journal Of Sports Medicine.* Vol 3 (5).
40. Kraft, C. N., Urban, N., Ilg, A., Wallny, T., Scharfstädt, A., Jäger, M., & Pennekamp, P. H. (2009). Influence of the riding discipline and riding intensity on the incidence of back pain in competitive horseback riders. *Sportverletzung Sportschaden: Organ der Gesellschaft fur Orthopadisch-Traumatologische Sportmedizin*, *21*(1), 29-33.
41. Kraft, C. N., Pennekamp, P. H., Becker, U., Young, M., Diedrich, O., Lüring, C., & von Falkenhausen, M. (2007). Magnetic Resonance Imaging Findings of the Lumbar Spine in Elite Horseback Riders Correlations with Back Pain, Body Mass Index, Trunk/Leg-Length Coefficient, and Riding Discipline. *The American journal of sports medicine*, *37*(11), 2205-2213.
42. Kujala, U.M., Sarna, S., Kaprio, J. (2005). Cumulative incidence of Achilles tendon rupture and tendiopathy in male former elite athletes. *Clinical Journal of Sports Medicine.* 15, 133-135.
43. Lagarde, J., Kelso, J.A., Peham, C., Licka, T., 2005. Coordination dynamics of the horse–rider system. *Journal of Motor Behaviour* . 37 (2), pp. 418–424.
44. Lewis, V. and Kennerley, R. (2017). A preliminary study to investigate the prevelance of pain in elite dressage riders during competition in the United Kingdom. *Journal of Comparative Exercise Physiology,* 13 (4) 259-263.
45. Loder, R. T. (2008) The Demographics of Equestrian-Related Injuries in the United States: Injury Patterns, Orthopedic Specific Injuries, and Avenues for Injury Prevention. *Journal of Trauma and Acute Care Surgery:* 65 (2) 447-460.
46. McGill, S (1997) The biomechanics of lower back pain: Implications on current practice in industry and clinic. *Journal of biomechanics.* 30 (5), pp. 465-475.
47. Maffulli, N. (2005) Equestrian Injuries. *Epidemilogy of Paediatric Sports Injuries.* 48, 8-17.

48. Mayberry, J.C., Pearson, T.E., Wiger, K.J., Diggs, B.S., Mullins, R.J. (2007) Equestrian Injury Prevention Efforts Need More Attention to Novice Riders. *Trauma and Acute Care Surgery*. 62 (3), 735-739.
49. Melzack, R. (1987) The short form McGill Pain Questionnaire. *Pain* 30: 191-197.
50. Moss, P.A., Wan, A. and Whitlock, M.R. (2002) A changing pattern of injuries to horse riders. *Emergency Medicine Journal*. 19 (5), pp. 412-414**.**
51. Munsters, C.C., Visser, K.E., van den Broek, J. and van Oldruitenborgh-Oosterbaan, M.M.S., 2012. The influence of challenging objects and horse-rider matching on heart rate, heart rate variability and behavioural score in riding horses. *The Veterinary Journal*, *192*(1), 75-80.
52. Münz, A., Eckardt, F. and Witte, K. (2014). Horse–rider interaction in dressage riding. *Human movement science*, *33*, 227-237.
53. Murray, J., Singer, E., Saxby, F., French, N. (2004) Factors influencing risk of injury to horses falling during eventing. *Veterinary Record.* 154, 207-208.
54. Murray, J.K., Singer, E.R., Morgan, K.L., Proundman, C.J. and French, N.P. (2006). The risk of a horse-and-rider partnership falling on cross-country phase of eventing competition *Equine Veterinary Journal*, 38 (2), 158-163.
55. Nadler, S.F., Malonga, G. A., DePrince, M., and Feinberg, J. H. (2000) The Relationship Between Lower Extremity Injury, Low Back Pain, and Hip Muscle Strength in Male and Female Collegiate Athletes. *Clinical Journal of Sports Medicine* 10:89-97.
56. Nankervis, K., Dumbell, L., Herbert, L., Winfield, J., Guire, R. and Launder, E., (2015). A comparison of the position of elite and non-elite riders during competitive show jumping. *Comparative Exercise Physiology*, *11*(2), 119-125.
57. Nicholas, M.K. and Blyth, F.M., (2016). Are self-management strategies effective in chronic pain treatment? *Pain management*, *6*(1), 75-88.
58. Norwood, S., McAuley, C., Vallina, V.L., Fernandez, L.G., McLarty, J.W. and Goodfried, G., (2000). Mechanisms and patterns of injuries related to large animals. *Journal of Trauma and Acute Care Surgery*, *48*(4), 740-744.
59. Obelieniene, D., Scrader, H, Bovim, G. *et al.* (1999) Pain after whiplash: A prospective controlled inception cohort study. *J. Neurol Neurosurg Psychiatry.* 66: 279-83
60. O'Brien, D. (2016) Look before you leap: what are the obstacles to risk calculation in the equestrian sport of eventing? *Animals*, *6*(2), p.13.
61. O'Brien, D.; Cripps, R.A. (2008) *Safety for Horses and Riders in Eventing. The SHARE Database*; Rural Industries Research and Development Corporation: Canberra, ACT, AUS, 2008.
62. Patterson, M., Doyle, J., Cahill, E., Caulfield, B. Persson, U.M., (2010) Quanitifying show jumping horse rider expertise using IMUs. In: Proceedings of the Annual International Conference of IEE Engeneeing in Medicine and Biological Society 2010, pp.684-687.
63. Paix, B.R. (1999). Rider injury rates and emergency medical services at equestrian events. *British Journal of Sports Medicine.* 33, 46-48.
64. Petróczi, A., & Naughton, D. P. (2009). Popular drugs in sport: descriptive analysis of the enquiries made via the Drug Information Database (DID). *British journal of sports medicine*, *43*(11), 811-817.
65. Praemer, A., Furnes, S., Rice, D.P. (1992) Musculoskeletal conditions in the United Stats. *AAUS,* 1-99. Cited in: Anderson, G.B.J. (1999) Epidemilogical features of chronic low-back pain. *Lancet.* 354 581-85.

66. Radanov, R. P., Sturzenegger, M., Di Stefano, G. (1996) Long-Term Outcome after Whiplash Injury: A 2-Year Follow-Up Considering Features of Injury Mechanism and Somatic, Radiologic, and Psychosocial Findings *Medicine.* 74 (5) 281-297.
67. Roberts, M., Shearman, J., & Marlin, D. (2009). A comparison of the metabolic cost of the three phases of the one-day event in female collegiate riders. *Comparative Exercise Physiology*, *6*(03), 129-135.
68. Sandiford, N., Buckle, C., Alao, U., Davison, J., Richie, J. (2013). Injuries associated with recreational horse riding and changes over the last 20 years: a review. *JRSM Short Rep* 4 (5).
69. Schmitt, H., Hansmann, H.J., Brocai, D.R., Loew, M. (2001). Long term changes of the throwing arm of former elite javelin throwers. *International Journal of Sports Medicine.* 22, 275-279.
70. Schnur, P. L., Schnur, D. P., Petty, P. M., Weaver, A. l. (1996) Reduction mammoplasty: An outcome study. *Plast Reconstr Surg* 100 (4): 875-883.
71. Scurr, J., White, J., Hedger, W., (2009) Breast displacement in three dimensions during the walking nad running gait cycle. Journal of *Applied Biomechanics,* 25, 322-329.
72. Scurr, J., White, J., Hedger, W., (2010) Supported and unsupported breast displacement in three dimensions across treadmill activity levels. *Journal of Sport Sciences,* 29:1, 55-61.
73. Sorli, J.M., (2000). Equestrian injuries: a five year review of hospital admissions in British Columbia, Canada. *Injury Prevention*. 6, 59–61.
74. Shephard, R.J. (1997) Biology and Medicine in Sailing. *Sports Medicine*. 23 (6), pp. 350-356.
75. Singer, E. R., Saxby, F. French, N. (2003). A retrospective case-control study of horse falls in the sport of horse trials and three-day eventing. *Equine Veterinary Journal, 35 (2) 139-145.*
76. Smartt, P., Chalmers, D. (2009) A new look at horse-related sport and recreational injury in New Zealand *Journal of Science and Medicine in Sport* 12 (3) 376-382.
77. Stokes, K. *et al.* (2015) RFU Community rugby injury and suveillance and prevention project 2014-2015. *English Rugby Union.* Accessed *http://www.englandrugby.com/mm/Document/MyRugby/Players/01/31/71/24/CRISP14-15_Neutral.pdf*
78. Symes, D. and Ellis, R. (2009) A preliminary study into rider asymmetry within equitation. *The Veterinary Journal*. 181 (1), 34-37.
79. Telle, C. (2012) An investigation of the incidence of non-specific low back pain in competitive show jumping horse riders. *Clinical Chiropractic*. 15 (4), 196-197.
80. Terada, K. (2000). Comparison of head movement and EMG activity of muscles between advanced and novice horseback riders at different gaits. *Journal of Equine Science,* 11 (4), 83-90.
81. Terada, K., Mullineaux, D., Lanovaz, J., Kato, K. and Clayton, H., (2004). Electromyographic analysis of the riders muscles at trot. *Equine and Comparative Exercise Physiology 1: 193-198.*
82. Theadom, A., Parag, V., Powell, T., McPherson, K., Starkey, N., Barker-Cotto, S., Jones, K., Amerakunga, S., Feigin, V. (2016) Persistent problems 1 year after mild traumatic brain injury: a longitudinal population study in New Zealand. *British Journal of General Practice.* 66 (642) e16-e23.
83. Thompson, K.; Nesci, C. (2016).Over-riding concerns: Developing safe relations in the high-risk interspecies sport of eventing. *International Review of Sociology in Sport*.
84. Tricker, R. (2000) Painkilling drugs in collegiate athletics. *Journal of Drug Education,* 30:313-24.

85. Wahlström, J., Hagber, M., Toomingas, A. *et al.* (2004) Percieved muscular tension, job strain, physical exposure, associations with neck pain among VDU users; a prospective cohort study. *Occupation an dEnvironment Medicine.* 61: 523-8.
86. Warner, D.C., Schnepf, G., Moilanen, E., *et al.* (2007) Prevalence, attitudes, and behaviors related to the use of nonsteroidal anti-inflammatory drugs (NAIDs) in student athletes. *Journal of Adolescent Health* 20:150-3.
87. Warson, J., and Hendrickson, A. (2007). The rider's pain free back. Trafalgar Square Books, Vermont.
88. Whitlock, M.R. (1999). Injuries to riders in the cross-country phase of eventing: The importance of protective equipment. *British Journal of Sports Medicine*, *33*, 212–214.
89. Wipper, A., 2000. The Partnership: The Horse-Rider Relationship in Eventing. *Symbolic Interaction*, *23*(1), 47-70.
90. Wolframm, I.A., Williams, J. and Marlin, D., (2015). The role of personality in equestrian sports: an investigation. *Comparative Exercise Physiology*, *11*(3), 133-144.
91. Wood, K., Cameron, M., Fitzgerald, K. (2008) Breast size, bra fit and thoracic pain in young women: a correlational study. *Chiropractic and Osteopathy 16 (1).*
92. Ziltener, J. L., Leal, S., Fournier, P. E. (2010) Non-steroidal anti-inflammatory drugs for athletes: An update. *Annals of Physical and Rehabilitation Medicine* 53 (4) 278-288.