Assessing the sport-specific and functional characteristics of back pain in horse riders

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ABBREVIATIONS

ODI: Oswestry Disability Index

FMS: Functional Movement Screen

MC: Motor Control

ADL: Activities of Daily Living

BP: Back Pain

VAS: Visual Analogue Scale

ICC: Intraclass Correlation Coefficient

LRV: Landelijke RijVereniging

ABSTRACT

Objectives: Currently, no standardised screening tools nor established interventions are available to address the characteristics of back pain (BP) specifically in horse riders. Therefore, the aim of this case-control study is to explore sport-specific and functional characteristics of BP in horse riders.

Methods: Sixteen professional and 16 amateur riders (25±7 years) participated in two questionnaires (a sport-specific questionnaire and the Oswestry Disability Index questionnaire) and were examined via the physical functional movement screening (FMS) and Luomajoki's motor control (MC) screening.

Results: The lifetime prevalence of BP was as high as 81%, and spinal discomfort in horse riders was mainly located in the lumbar spine. Professional riders revealed significantly higher prevalence of BP in the last month before assessment ($p = 0.014$) than amateur riders. Compared to horse riders using dressage or multiple saddle types, show jumping riders (n=10) who only use jumping saddles ($p = 0.027$) also revealed higher BP prevalence. Horse riders with lower scores on the FMS and MC screening, and thereby with more movement dysfunctions, were found to experience higher levels of pain ($r = -0.582$, $p = 0.001$; $r = -0.404$, $p = 0.024$, respectively) and disability caused by BP ($r = -0.688$; $p < 0.001$; $r = -0.474$; $p = 0.006$, respectively).

Conclusion: Both physical screening tools are found to be clinically relevant enabling investigators to identify objective functional characteristics related to BP in horse riders. The high prevalence of BP in riders is a clinically important finding that should be explored further to elucidate the causes and subsequently guide occupational health in horse riders.

INTRODUCTION

Equestrian-related injuries are relatively severe compared with injuries incurred in other popular sports (Van Balen *et al.*, 2019). A substantial proportion of these equestrian injuries are acute. Evidence suggests that these can lead to long-term chronic dysfunction (Ball *et al.*, 2009). Physical overloading can also result in chronic pains (Kraft *et al.*, 2009; Lewis and Kennerley, 2017; Lewis and Baldwin, 2018) and overuse injuries account for almost half of the injuries in eventing riders (Ekberg *et al.*, 2011). One of the most common areas of pain in the equestrian population is back pain (BP), with a reported prevalence of 71% - 100% compared to 33% in non-riders (Kraft *et al.*, 2009; Lewis and Baldwin, 2018). Previous stated possible origins of spinal discomfort in horse riders across different equestrian disciplines include the repetitive nature of riding (Lewis *et al.*, 2019), acute traumas, postural defects, asymmetry (Nevison and Timmis, 2013; Hobbs *et al.*, 2014), an insufficient recovery period following a fall and insufficient rehabilitation of previous injuries and monotonous training routines (Ekberg *et al.*, 2011). Furthermore, the level of riding (Hobbs *et al.*, 2014) and the type of saddle (Quinn and Bird, 1996) are stated to possibly be related with BP development and continuity as well.

Equestrian sports science is an emerging field, but evidence-based data on the use of sport-specific screening and their outcomes are still limited in riders. Current research in other non-equestrian sport disciplines, such as football, basketball, running, rowing and cycling, already recommend physical screening of athletes prior to athletic participation (Wingfield *et al.*, 2004; Sanders *et al.*, 2013). The general aim of physical screening is to detect conditions that predispose the athlete to injury or illness and consequently to adapt their training programs accordingly to maximise their health and safety (Mirabelli *et al.*, 2015). Two popular and simple physical screening tools used in many sport disciplines, both with moderate-to-excellent inter- and intra-rater agreement (Luomajoki *et al.*, 2007; Cook *et al.*, 2014), are the Functional Movement Screening (FMS) and the Luomajoki's motor control (MC) screening. The FMS, which has been reported to correlate with injury risk (Kiesel *et al.*, 2007; Cook *et al.*, 2014; Moran *et al.*, 2017), aims to assess the quality of a person's basic functional movements, muscle flexibility, strength, neuromuscular coordination, proprioception, core stability, imbalances and general movement proficiency (Cook *et al.*, 2014). The MC screening was developed to assess movement dysfunctions of the lower back and the quality of a person's movement control of the lumbopelvic complex (Luomajoki *et al.*, 2008) and it is used to distinguish individuals with and without BP (Luomajoki and Moseley, 2011). These screening tools seem suitable for riders, as they assess the characteristics that possibly relate to injury development or continuity in horse riders, such as strength of the core and lower body musculature, balance, quick hand eye co-ordination, flexibility, pelvic stability and the control to dissociate lower limb movement and trunk movement (Douglas, 2017).

In other sports, dynamic and functional capacities such as muscle strength, mobility, stability and neuromuscular control of the spine are related to the prevalence and intensity of BP and the grade of disability caused by BP (Roussel *et al.*, 2012; Stuber *et al.*, 2014; Tayrose *et al.*, 2015; van Dieën *et al.*, 2019). Some evidence in riders suggests the same (Douglas *et al.*, 2012; Hampson and Randle, 2015). The aim of this study was to assess sport-specific and functional capacities related to BP in riders. It was hypothesised that the FMS and MC scores are indicative of BP in riders, and that BP is associated with competition level, riding discipline, and the hours of riding per day.

METHODS

Study design

A case-control study was used to assess the relationship between BP and sport-specific and physical functional characteristics in riders. All participants completed two questionnaires and were examined using two physical performance screening tools. The experimental protocols received Institutional Ethics Committee Approval at the University of Antwerp and informed written consent was obtained from all participants.

Study Participants

Thirty-two riders (10 men, 22 women) average age of 25 (±7) years were recruited by the use of social media and a local advertisement at a national and regional competition of the LRV (Federation of competitive Belgian horse riders). Only riders between 18 and 60 years old, competing within the dressage, show jumping, eventing and/ or Icelandic riding disciplines and without BP or with non-specific BP were included. Non-specific BP can be defined as low BP not attributable to a recognisable and known specific pathology (Balagué *et al.*, 2012). Riders with a known cause for BP, i.e. specific BP, such as previous surgery concerning the spine, congenital scoliosis or scoliosis >25° and BP with a known anatomical cause, were excluded. By excluding participants with specific BP, the non-specific character of the BP under investigation was maintained and risk of selection bias was minimised.

Riding level was defined as per Williams and Tabor (2017): professionals were those whose career was related to their competitive profile and amateurs were those competing at affiliated level at regional competitions. The demographic information of the participants can be found in Table 1.

Testing procedure

A survey was constructed using the principles reported by Diem (2002): it was designed to take no longer than 10 minutes to complete, contained 20 closed-response (e.g. yes/no and Likert scale) and open-response items and a pain Visual Analogue Scale (VAS) score (Jensen, 2003). The survey comprised two sections: the Oswestry Low Back Pain Disability Questionnaire and a self-designed, sport-specific questionnaire. The Oswestry Disability Index (ODI) is a validated patient-reported parameter that measures and categorises the impact of low BP on everyday life by its severity on a scale from 0 (no disability caused by BP at all) to 100 (bedbound due to BP) (Davidson and Keating, 2002; van Hooff *et al.*, 2015; Chiarotto *et al.*, 2016). The self-designed sport-specific questionnaire contained 10 topics: demographic data (age and gender), profession, level of riding, years of riding, the average amount of hours riding per day, discipline, saddle type, incidence of BP, location of pain and the severity of their BP (VAS). This questionnaire was self-designed based on the lack of standardised demographic questionnaires in this population and developed in agreement with both equine professionals and the supervisors of this study with the aim to provide valid and reliable data.

Participants were screened using 14 clinical tests, divided in two sections. The first section was the seven-point FMS protocol, including the deep squat to assess bilateral, symmetrical, and functional mobility of the hips, knees and ankles; the hurdle step to examine the body's stride mechanics during the asymmetrical pattern of a stepping motion; the in-line lunge to assess hip and trunk mobility and stability, quadriceps flexibility, and ankle and knee stability; the shoulder mobility test to assess bilateral shoulder range of motion, scapular mobility, and thoracic spine extension; the active straight leg raise to determine active hamstring and gastroc-soleus flexibility while maintaining a stable pelvis; the trunk stability push-up to examine trunk stability while a symmetrical upper-extremity motion is performed; and the rotary stability test to assess multi-plane trunk stability while the upper and lower extremities are in combined motion. Each FMS movement was scored (0-3 point FMS score) independently by two fifth year-MSc Physiotherapy and Rehabilitation Science students from the University of Antwerp. After the seven different movements were evaluated, a cumulative score out of 21 was recorded, as per the method described by Cook et al. (2014) where 21 is the highest score possible. The second section of the physical screening reported the seven clinical tests of the MC screening, including the waiter's bow, to assess hip flexion and hamstring length with a neutral lumbopelvic complex; pelvic posterior tilt, to examine lumbopelvic flexion; the one leg stance, to assess the lumbopelvic rotation; the sitting knee extension to assess the lower limb extension and hamstring length with a neutral lumbopelvic complex; rocking backward and forward to examine the hip movement with a neutral lumbopelvic complex; and the prone knee flexion to assess the lower limb movement with a neutral lumbopelvic complex. After each MC movement, two scores (0-1 point scale) were independently given to the movement based on specific MC criteria by the same two assessors. After the seven different movements were evaluated, a cumulative score out of seven was recorded, as per the method described by Luomajoki et al. (2007) where 0 indicates the highest level of altered MC and 7 the highest level of functional MC skills.

All screenings and questionnaires were obtained on the same day and none of the riders were familiar with the applied screenings, neither with the questionnaires. The assessors remained blinded for BP and for each other's scores throughout the study procedure.

Statistical analysis

Statistical analyses were conducted using SPSS Statistics 24 (IBM Corp, Armonk, NY, USA). Inter-rater agreement was calculated for both the FMS and MC scores prior to analysis by Kappa correlation. The normality of the data was assessed with the Kolmogorov-Smirnov normality test. As the data were not normally distributed, the Mann-Whitney U test was used to test for differences between the different subcategories of riders. The Pearson's, Spearman's and Chi-Square analyses were used to determine associations between the FMS tests, MC tests, the BP parameters, and the demographic and sport-specific parameters. The significance level was set at 0.05, odd levels of significance are mentioned explicitly.

RESULTS

Twenty-two women (69%) and 10 men (31%) participated in the study. Subjects had been horse riding for an average of 17±7 years and rode 3±3 hours a day on average.

Pain parameters

Eighty-one percent of riders had experienced BP at some time in their life and 35% had experienced BP in the last month before the assessment. Of all riders with spinal discomfort(s), 83% located the discomfort in the lumbar spine, 26% in the thoracic spine and 9% in the cervical spine. The appointed spinal pain localisations are demonstrated in a body chart (Figure 1). Based on the VAS, the intensity of the pain in the riders ranged from no pain to moderate pain (min. VAS=0.00/10; max. VAS=5.70/10; μ=1.91±1.67). The results of the ODI revealed that the average rider experienced no or minimal disability on the day of testing as a result of BP (min. ODI=0.00%; max. ODI=25%; μ=4.59±4.78), meaning the average rider continued their normal lifestyle despite experiencing BP.

Sport-specific parameters

Eighty-eight percent of professional riders had experienced BP at some time in their life and 56% in the last month, which was higher compared to 73% (X^2= 0.963; p>0.05) and 13% (X^2= 6.028; p= 0.014) in the amateur riders. The jumping riders who solely used jumping saddles were more prone to have had BP within the last month before the assessment (60%) compared to the dressage riders (18%) or jumping riders who also used dressage saddles (0%) (X^2=4.894; p= 0.027). No significant differences were found in the intensity of BP or the disability caused by BP between the different levels and disciplines of riding (p>0.05). Parameters that did not influence the pain parameters (the prevalence and intensity of BP and the grade of disability caused by BP) were: gender, age, years of riding and hours of riding per day.

Functional Physical Characteristics

Cohen's Kappa values for inter-rater reliability between the two scorers were 0.982 and 0.981 for the FMS and MC scores, respectively. A significant relationship was found between the experience of BP in the last month or in the lifetime and the in-line lunge test (r= -0.410; p= 0.022); rotary stability test (r= -0.372; p= 0.040); and rocking backwards (r= -0.438; p= 0.014) and forwards (r= -0.416; p= 0.020). This relationship is presented in Figure 2. The mean cumulative FMS score in all riders was 16.30 ±2.02 (min. FMS score= 12.00; max. FMS score= 19.00) and 15.41±2.78 (min. FMS score= 9.00; max. FMS score= 19.00) in the riders that experienced BP within the last month, while the mean cumulative MC score across all riders equalled 4.75±1.81 (min. MC score= 1.00; max. MC score= 7.00) and 4.14±1.82 (min. MC score= 2.00; max. MC score= 7.00) in the riders that experienced BP within the last month (see Table 2). Riders with lower scores on the MC screening and/ or on the FMS, were found to experience higher levels of pain (r= -0.582, p= 0.001; r= -0.404, p= 0.024), to be seen in Figure 3. The ODI was negatively correlated with the results of the MC testing (r= -0.474; p=0.006) and the FMS (r= -0.688; p<0.001), indicating that scoring low on the FMS or MC screening, encountered relatively more limitations during their ADL (see Figure 4). No significant differences were found in the FMS and MC results between the different levels and disciplines of riding, although a trend was seen in lower scores on the MC screening in the professional riders 3.67±1.52 (min. MC score= 1.00; max. MC score= 6.00) compared to the amateur riders 4.98±1.84 (min. MC score= 1.00; max. MC score= 7.00) (U= 59.50; p= 0.061).

DISCUSSION

The aim of this study was to assess sport-specific and functional capacities related to BP in riders. The pain parameters prevalence and intensity of BP and the grade of disability caused by BP showed several significant correlations with the FMS and MC screening scores, as well as the riding level and discipline parameters.

A high incidence of BP was found among riders in this study, particularly in the lumbar back, which is consistent with other studies within this population (Kraft *et al.*, 2009; Lewis and Baldwin, 2018). Similar to results reported by Kraft et al. (2007), this study found no significant correlation between gender, intensity of riding and the pain parameters. However, this study found significant differences in the incidence of BP and intensity of BP between professional and the amateur riders. Hobbs et al. (2014) similarly postulated that the development of BP was related to postural defects and asymmetry in riders and is more likely with an increasing level of horse riding. Due to the repetitive nature of equestrian training (Ekberg *et al.*, 2011), or long-term repeated application of asymmetrical forces in both horse and rider (Quinn and Bird, 1996; Kraft *et al.*, 2009), it is possible that the riding mechanisms might contribute to the increased prevalence of BP in higher level riders.

In contrast with previous research (Kraft *et al.*, 2007), this study found a significant difference in BP parameters between the show jumping riders, the dressage riders and the riders who combine dressage and show jumping in their riding sessions, meaning riding with both jumping and dressage saddle regularly. These results confirm that the type of saddle might be associated with BP in riders, as stated by Quinn and Bird (1996). The saddle seat depth, difference in stirrup length, saddle cushioning, additional support and postural position in the saddle are reported to play a role in the continuity of BP (Quinn and Bird, 1996). However, this study didn't control for the riding activities differing when riding with the different saddle types and only small sample sizes interdisciplinary were presented. Because of the small amount of Icelandic riding and eventing riders, no statistics could be performed to analyse the differences between these disciplines. Further research is required to investigate the influence of the riding discipline and/or the type of saddle on BP.

Despite the high methodological quality of the ODI, it is arguable as to whether the questionnaire is sensitive enough or whether an adapted classification of the disability caused by BP should be recommended for this active population (Davidson and Keating, 2002; Chiarotto *et al.*, 2016). Given that all riders in the selected population were competitive, it might be considered that these athletes work through their pain and aim to prevent the pain to interfere with their daily life or competition commitments and thereby score false negatively on the grading of BP interference (ODI). This consideration is verified by Lewis et al. (2017, 2018) who reported that most riders continue competing with BP, although 71% of the riders with pain felt that their performance was negatively affected through fatigue, decreased range of motion, asymmetry, anxiety and irritability (Lewis *et al.*, 2016).

The results of this study support the utilisation of the FMS and MC screening to predict the susceptibility to BP in riders (Luomajoki *et al.*, 2007; Ko *et al.*, 2016; Bonazza *et al.*, 2017; Moran *et al.*, 2017). Previously, the cut-off value for injury prediction of the FMS was set at ≤14 (Bonazza *et al.*, 2017). The average FMS score in the population of this study was 16 which is above the cut-off value and thereby indicates that the average rider can perform adequate functional movement patterns. As only two of the riders in this study reported clinically relevant BP, based on their ODI score, on the day of the assessment and no other current injuries were reported, this result can be verified. However, on average, riders who experienced BP within the last month before the assessment (n=11) scored 15 on the FMS which indicates a higher level of dysfunctional movement patterns which is related to a higher likelihood of injury development compared to those with higher scores (Bonazza *et al.*, 2017). Furthermore, the findings in this study confirm the association between the MC scores and BP (Salvioli, Pozzi and Testa, 2019) and the cut-off value of 5.5./7 for BP presence found by Luomajoki et al. (2008). As the average score of riders without BP in the last month was 5.8/7 compared to 4.4/7 in riders with BP in the last month, the results of this study agree with the cut-off value of 5.5/7. Out of the 14 clinical tests implemented in the FMS and MC screening, four had a significant relationship with the experience of BP: the in-line lunge test, rocking backward and forward, and the rotary stability test. These specific tests evaluate the dynamics of the hip and pelvis, which are crucial elements for riders. The two lowest scored FMS tests were the push-up and the active straight leg raise. The push-up test screens the symmetric trunk stability in the sagittal plane during a symmetric upper extremity movement and the ability to transfer force symmetrically from the upper extremities to the lower extremities and vice versa (Cook *et al.*, 2014). The active straight leg raise assesses the functional hamstring, gluteal, and iliotibial band flexibility, adequate hip mobility of the opposite leg and pelvic and core stability (Cook *et al.*, 2014). These findings agree with previous findings of low hamstring flexibility, and pelvic and ankle stability in riders (Douglas, 2017). The two lowest scoring tests within the MC screening were the rocking forward and the waiter's bow test. This indicates that riders have difficulty in hip and lumbopelvic dissociation, which indicate a low neuromotor control skills (Luomajoki *et al.*, 2007). The findings of the FMS and MC screening agree with previously published research that found an association between the dynamics of the hip and pelvis, and hip muscle characteristics and BP (Ingber, 1989; Sajko and Stuber, 2009; Fasuyi *et al.*, 2017).

The cumulative FMS scores seen in this study are slightly higher than those found in female collegiate horse riders (Lewis *et al.*, 2019), semi-professional rugby players (Attwood *et al.*, 2019), healthy adults aged 20-39 years (Perry and Koehle, 2013) and long-distance runners (Loudon *et al.*, 2014), similar to the cumulative FMS score seen in young active females of 18-40 years old (Schneiders *et al.*, 2011) and in Gaelic field sports athletes (Attwood *et al.*, 2019), but lower than these of healthy professional football players (Kiesel, Plisky and Voight, 2007). This indicates an adequate quality of basic movement functionality in riders. No assumptions can be made between the FMS scores and performance levels in riders based on current evidence and the non-significant difference found in this study in the FMS scores between the amateur and professional riders. However, it can be hypothesised that the MC scores have a negative association with performance level as stated by Roussel *et al.* (2012) in dancers, as a trend is seen in this study for professional riders to have more MC deficits in comparison with amateur riders. Also in elite soccer players, MC deficits and a high prevalence of BP is prominent and related (Grosdent *et al.*, 2016). It is widely recognised that athletes benefit from training various physical capacities and that physical adaptations are likely to improve performance and decrease the risk of injury (Sajko and Stuber, 2009; Lauersen *et al.*, 2014;

Tayrose *et al.*, 2015). These findings supports the recommendation for unmounted training of riders, including motor control and core stability exercises (Douglas *et al.*, 2012; Hampson and Randle, 2015; Wilson and Collis, 2016).

STUDY LIMITATIONS

The results of this study should be interpreted in light of some methodological concerns. First, the sample size of this study was relatively small. Second, functional asymmetries were not assessed although the relevance of this horse riding related characteristic is emphasised in current research. Finally, the ODI was applied as a BP-specified questionnaire but did not seem to be sensitive enough for this athletic population. Due to these limitations, further research is necessary to investigate the relationships between the functional physical characteristics, as such in the FMS and Luomajoki's MC screening, and BP in riders.

CONCLUSION

The high prevalence of BP in riders is confirmed by this study. Significant differences in the prevalence of BP between professional and amateur riders and show jumping and dressage riders were demonstrated, as well as significant correlations between the prevalence and incidence of and disability caused by BP and the FMS and Luomajoki's MC screening. Both screening tools were found clinically relevant and can therefore be used to objectively measure functional characteristics related to BP in riders. The results of this study can be taken into consideration in the physical management of the rider. Additional research is required to confirm the reported correlations and to determine the sport-specific needs of riders to contribute to their welfare and performance.

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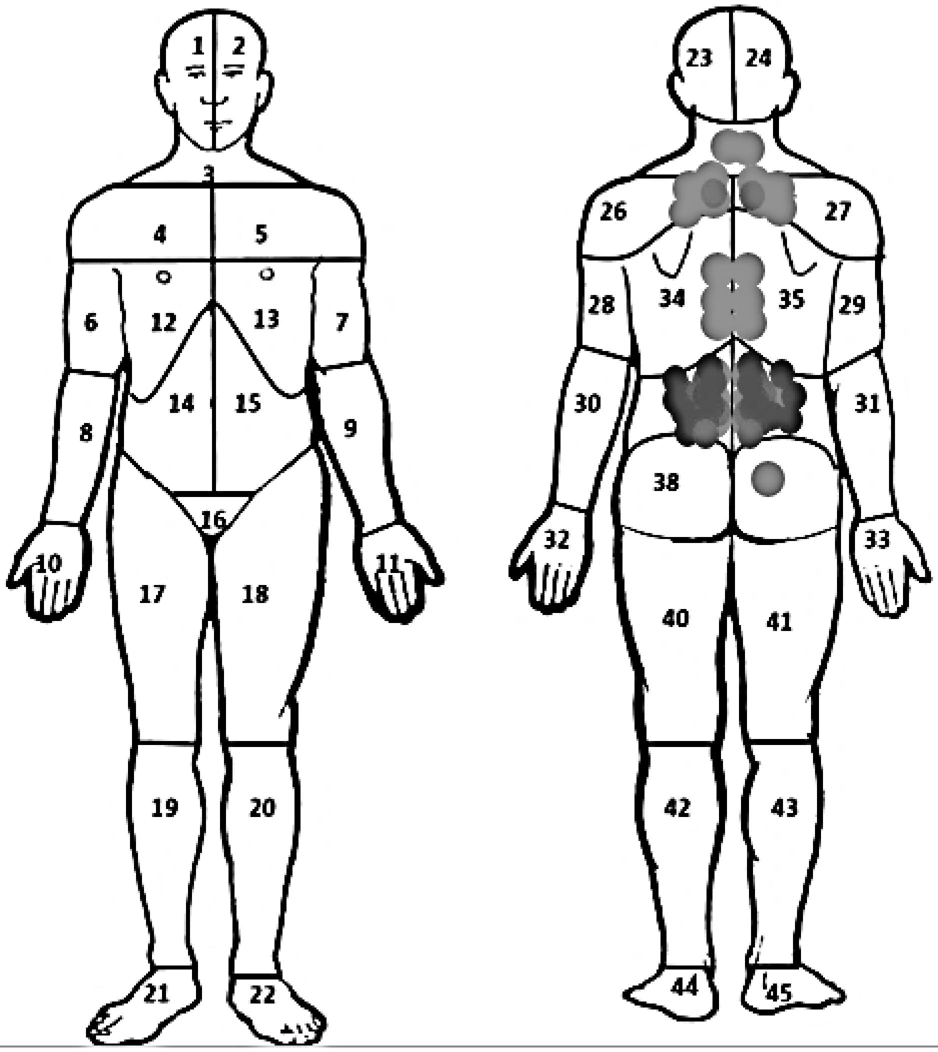


Figure 1: Body chart of the pain location. This figure shows the locations of spinal pain mentioned by the horse riders. The darker areas indicate a higher prevalence of pain.

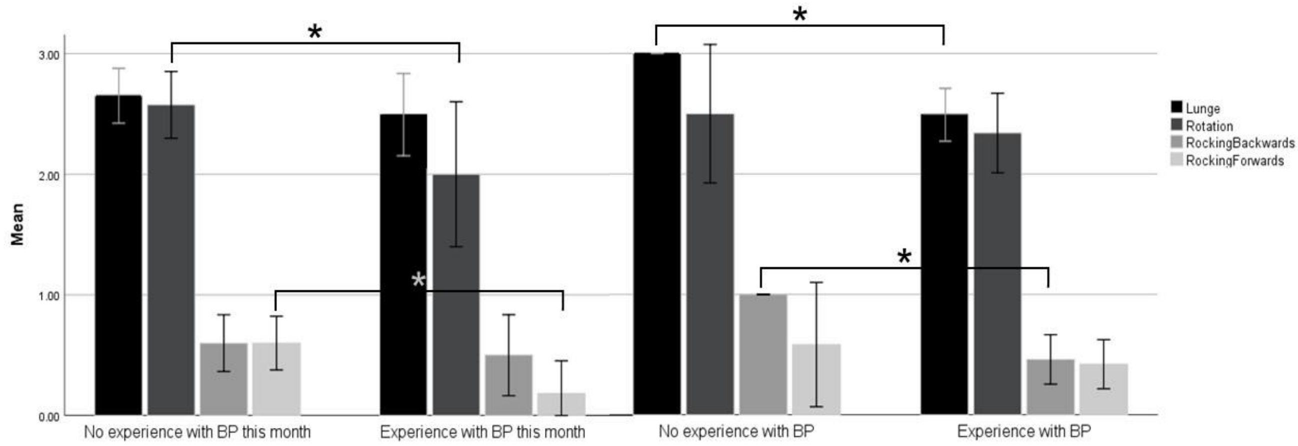
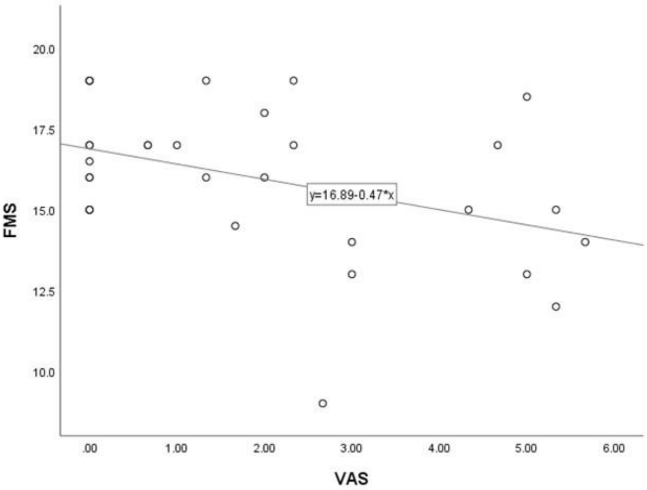


Figure 2: Clustered bar-graph showing the scores of the FMS and MC screen components that significantly correlated to the incidence of BP (*= p<0.05). The two graphs on the left show experience with BP this month, on the right it is represented for BP experienced within a lifetime. The Y-axis depicts the scores on the FMS-subtests (0-3/3) and the MC-subtests (0-1/1). The components included from the FMS are the in-line lunge test and the rotation test. For the MC-screen this are the rocking forwards and backwards tests. Error bars represent 95% CI.



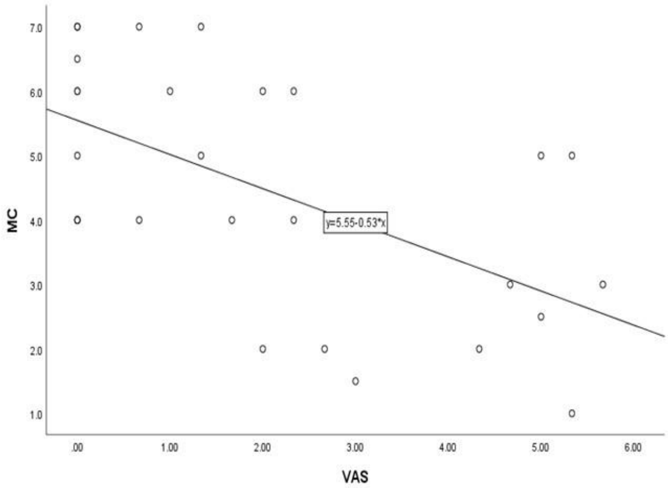


Figure 3: Relation between the VAS-scores and the FMS- and MC-score. The scatterplot on the left shows the relationship and regression of the VAS- and FMS-score, while the scatterplot on the right shows the relationship and regression of the VAS- and MC-score (r= -0.582, p= 0.001; y=16.89-0.47*x; r= -0.404, p= 0.024; y=5.55-0.53*x).

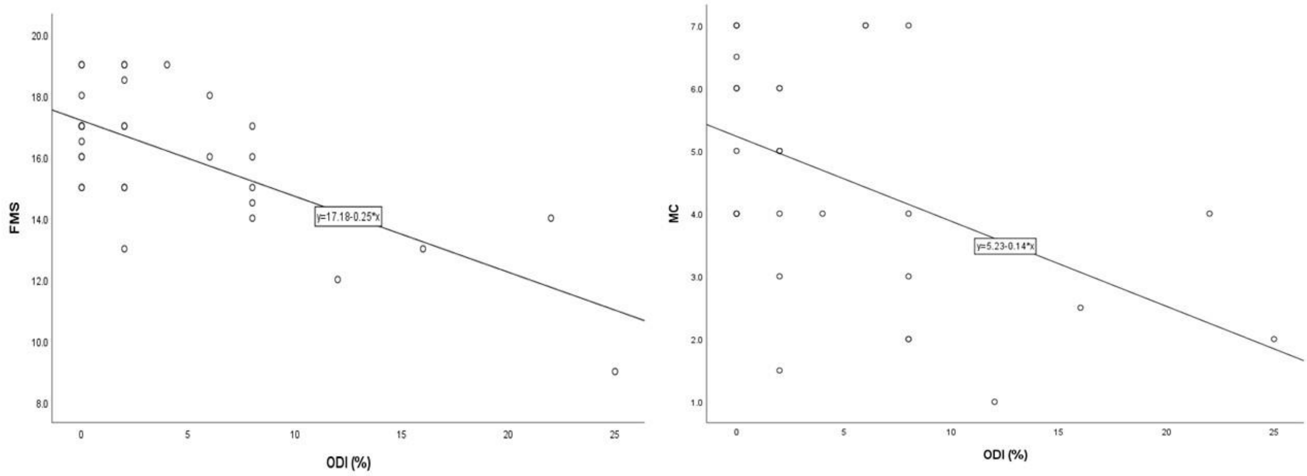


Figure 4: Relation between the ODI-score and the FMS- and MC-score. The scatterplot on the left shows the relationship and regression of the ODI- and FMS-score, while the scatterplot on the right shows the relationship and regression of the ODI- and MC-score (r=-0.688; p<0.001; y=17.18-0.25*x; r=-0.474; p=0.006; y=5.23-0.14*x).

Table 1. The general characteristics of the participants.

	Horse riders (n=32)
Gender	
Female	22
Male	10
Discipline	
Jumping	12
Dressage	10
Jumping and dressage	7
Eventing	2
Icelandic riding	1
Level	
Professional	9
National competition	7
Competitive level	16
Age (years)	25±7
Years of riding	17±7
Hours of riding/ day	3±3

Table 2. A comparison of FMS and MC composite scores between professional and amateur horse riders and between horse riders with BP experience within the last month and horse riders without BP experience within the last month.

	Number of riders (n)	Cumulative MC score	Standard deviation	Range of scores	Number of scores ≤6	Number of scores >6
MC screen						
Higher level	16	4.22	±1.69	1.5-7	14 (87.4%)	2 (12.6%)
Lower level	16	5.00	±1.93	1-7	11 (68.7%)	5 (31.3%)
BP last month	11	4.24	±1.79	1-7	10 (90.9%)	1 (9.1%)
No BP last month	20	5.75	±1.41	4-7	15 (75%)	5 (25%)
FMS						
Higher level	16	15.97	±1.77	13-19	3 (18.8%)	13 (81.2%)
Lower level	16	16.13	±2.80	9-19	3 (18.8%)	13 (81.2%)
BP last month	11	15.41	±2.78	9-19	3 (27.3%)	8 (72.7%)
No BP last month	20	16.30	±2.02	12-19	3 (15%)	17 (85%)