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Original Investigation

Overload knee joint pain in horse riding athletes

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Purpose: Horse riding has been garnering increasing interest in recent years, but it is also recognized as one of the most injury-prone sports. The aim of this study was to identify the specific causes of overload knee joint pain in individuals practicing horse riding.
Methods: The study group consisted of 18 female horse riders (aged 23.72±3.34 years) and the control group consisted of 19 females (aged 23.68±1.00) not engaged in regular horse-riding training. Internal (IR), external (ER) hip joint rotations, hip joint abduction (ABD) and adduction (ADD) were measured. The abductor, adductor and rotator muscle force moments of the knee were measured under isometric conditions.

Results: In the study group, 83% of individuals reported experiencing knee joint pain, both during and after horse riding training. Among those experiencing pain, 77% indicated trotting, and 23% reported galloping as the gaits that provoked the most discomfort. Significant higher values were observed in both active and passive IR ranges in both lower limbs in the study group ($P < .05$). Muscle torque values, normalized to body weight, indicated that the study group had lower adductor muscle torques compared to the control group. Significantly higher muscle strength values were found in both right and left thigh adductor muscles in the study group compared to the control group ($P < .001$).
Conclusions: Overall, the above analysis highlights the importance of strength training for riders, particularly focusing on thigh abductors, including gluteal muscles, to balance muscle strength, reduce knee joint loading, and alleviate spinal pains. Improper joint loading is primarily due to the riding position and resulting imbalance between thigh abducting and adducting muscle strengths. Preventing musculoskeletal pain requires a balanced exercise regimen, focusing on muscle groups that are less utilized in riders' movement techniques.

Keywords: horse riding, muscle strength imbalance, moments of force, range of motion, injury prevention

Introduction

Horse riding, a popular sport enjoyed worldwide, has been garnering increasing interest in recent years[1]. Training in horse riding has been shown to positively affect general health, cardiovascular and respiratory fitness, balance, and mental health, even improving it[2,3]. However, despite its many benefits, horse riding is also recognized as one of the most injury-prone sports[4,5,6].
Injuries can be broadly divided into two types: overload injuries resulting from repetitive microtraumas or pathological movement patterns over time, and accident-related injuries, which may not always dependent on the rider's actions. Riding is divided into seven disciplines: dressage, show jumping, eventing, combined driving, western riding, equestrian vaulting, and endurance riding[6]. Haines et al.[7] investigated that during equestrian events the injury rate was between 0.06% - 1.18% for each discipline. An overall injury rate was 780 per 100,000 athlete exposures. Eventing and hunter–jumper had the highest injury rates. Bone and head injuries were the most common types. Muscles, tendons, joints, and ligaments are most often damaged in dressage and eventing.[7]
Moreover, common complaints among riders include lower back pain, hip joint pain, and muscle pain, particularly in the adductor muscles of the lower limb. These issues predominantly affect experienced riders[5,8]. A study conducted by Lewis et al.[9] found that 62% of professional rider respondents indicated lower back pain as the most common complaint, while 47% reported chronic knee joint pain.
Spinal dysfunctions in professional riders have been extensively documented in the literature[4,5,10,11,12], whereas insufficient research has so far been done on the causes of knee joint pain. The knee joint is one of the largest and most complex joints in the human body, making it often difficult to pinpoint the specific cause of pain experienced by a patient[13,14]. Common sources of damage and pain in the knee joints include cartilage damage[15], which leads to advanced degenerative disease[16] repetitive patellar dislocations causing pain known as Patellofemoral Pain Syndrome (PFPS), abnormal patellar mechanics, hypertrophy of Hoffa's fat pad, tendinopathy, synovial bursitis[17-21]. Other causes of knee joint pain include pathologically altered meniscus – degenerative or traumatically damaged[22,23,24]. Also worth mentioning is Iliotibial Band Syndrome (ITBS), commonly known as "runner's knee," which is the result of friction from the overly tense distal part of the band against the lateral epicondyle of the femur[18]. Apart from structural changes, the causes of knee pain may not be related to purely mechanical damage. Aside from biomechanical dysfunctions, the biopsychosocial model suggests that potential psychosomatic factors may contribute to knee joint pain, such as depression, anxiety, somatization, or low social status[25].
The primary objective of this study was to identify the specific causes of overload knee joint pain in individuals practicing horse riding.

Materials and methods

Participants

The study group consisted of 18 female horse riders (aged: 23.72±3.34 years, weight: 63.68±9.47 kg; height: 168.89±6.83 cm). Inclusion criteria were as follows: age between 18 and 35 years, regular horse-riding training (any equestrian discipline-minimum 3 times a week for at least 5 years), and attainment of at least a bronze-level riding badge. The average length of training experience in the study group was 13 years, with an average of 14 training hours per week. The control group consisted of 19 females (aged 23.68±1.00 years; weight: 62.88±7.09 kg; height: 165.53±5.43 cm) not engaged in regular horse-riding training, but were engaged in various forms of physical activity, were the same age range as study group, and had experience with horse riding at most at recreational level. Participants with past injuries of the lower limbs, such as (e.g., fractures, surgeries sprains) were excluded from this study. All participants were informed about the study's procedures and objectives, and they provided written confirmation of their consent to take part. This study was conducted in accordance with the principles of the Declaration of Helsinki conducted in accordance with the principles of the Declaration of Helsinki and was approved by Ethics Committee of the University of Physical Education in Warsaw (SKE01-42/2022).

Design

This study employed an experimental study design to assess the specific causes of overload knee joint pain in individuals practicing horse riding.

Methods

Participants' anthropometric values (weight and height) were measured using Fawag TP-200/1 equipment and a history of knee joint pain in the study group was collected (whether it occurs; before or after training; in which horse walk; in which discipline). To ensure reliability and reproducibility in range of motion measurements (ROM), a consistent protocol was administered with on all subjects by the same physiotherapist, together with an assistant recording down results and adding stabilization. A standard long-arm goniometer Saehan™ Grip long-arm goniometer (20 cm, accuracy within 1°, range of 360°) was utilized. Moreover, participants were secured to the therapy table with straps to rule out any compensatory or excessive movements. Internal and external hip joint rotations were measured in sitting position, with the participant positioned at the edge of the therapy table, knees and hips flexed at 90°, with the lower leg hanging from the table. The upper limbs were crossed on the chest. The axis of the goniometer was placed at the apex of the patella, with one of the arms of the goniometer parallel to the shin and the other perpendicular to the floor. The value of rotation was taken as the deviation from the zero-starting position.[26,27]

Hip joint abduction and adduction were measured supine position (SuP). During abduction, the unexamined limb hung off the therapy table. During adduction, the contralateral knee was fully flexed to allow heel placement on the table edge. The axis of the goniometer was placed at the superior anterior iliac spine, with one arm towards the opposite anterior superior iliac spine and the movable arm along the femur aimed at apex of the patella.[27] The peak muscle torques of selected muscle groups were measured. The above measurements were taken in accordance with the maximum voluntary contraction method. The abductor, adductor and rotator muscle force moments of the hip were also tested in the sitting position using a JBA Staniak isometric torquemeter under isometric conditions. Participants were stabilized by a close-fitting roller at the level of the anterior iliac spine and in the vicinity of the distal 1/3 of the femur. Limbs were flexed at 90° at the hip and knee joints

Table 1. Differences in Active and Passive Hip Movement Ranges

ROM		Study Group			Control Group			
		Mean±SD	Me	CI 95%	Mean±SD	Me	CI 95%	*P-value*
ABD R	A	32.4±8.1	33	28.38 - 36.4	31.8±6.5	30	28.65 - 34.93	.804
	P	35.4±8.1	36.5	31.4 - 39.49	35.2±6.3	35	32.2 - 38.22	.922
ABD L	A	32.5±6.2	32.5	29.43 - 35.57	31.4±7	30	28.07 - 34.77	.622
	P	34.9±6.2	35	31.86 - 38.03	34.7±7.3	35	31.17 - 38.2	.908
ADD R	A	27.1±5.1	28	24.5 - 29.61	26±5.1	28	23.56 - 28.44	.485
	P	30.3±4.8	30	27.95 - 32.72	29.1±5.2	30	26.56 - 31.55	.441
ADD L	A	25.2±4.2	24	23.1 - 27.23	23.1±5	22	20.66 - 25.44	.162
	P	27.7±4.5	26	25.49 - 29.96	26.6±4.6	25	24.36 - 28.8	.451
IR R	A	32.6±7.9	33	28.61 - 36.5	27±5.9	25	24.18 - 29.82	.02
	P	35.8±7.6	35	32.02 - 39.54	30.1±5.8	30	27.32 - 32.89	.014
IR L	A	35.2±6.7	35	31.84 - 38.49	29.7±6.9	30	26.35 - 33.02	.019
	P	38.6±7	37	35.1 - 42.01	32.4±7.1	32	28.96 - 35.78	.011
ER R	A	28.6±8.2	27	24.51 - 32.71	26.9±4.9	28	24.52 - 29.27	.444
	P	31.5±8.9	29	27.09 - 35.91	30.1±5.5	30	27.41 - 32.7	.915
ER L	A	26.8±6.4	27	23.64 - 30.03	25.3±4	25	23.4 - 27.23	.331
	P	29.2±6.8	29	25.86 - 32.59	28.7±4.4	30	26.63 - 30.84	.796

Legend: ROM – range of motion; A – active range of motion; P – passive range of motion; R – right lower limb; L – left lower limb; ABD – abduction range of motion; ADD – adduction range of motion; IR – internal rotation range of motion; ER – external rotation range of motion; CI – confidence interval; Me – median.

during measurements. The upper limbs were crossed over the chest. The subject's task was to attain the maximum muscle torque values. Each subject performed 2 attempts; the highest value was recorded for statistical analysis. In all cases both right (R) and left (L) limbs were measured.[28]

Statistical analysis

Data were analyzed using STATISTICA 13.0 (StatSoft). The Shapiro–Wilk test assessed the distribution of variables, and Levene's test determined homogeneity of variance. Both the T-test and Mann-Whitney U test were used. The level of significance was set at $P \leq .05$.

Results

In the study group, 83% of individuals reported experiencing knee joint pain, both during and after horse riding training. Among those experiencing pain, 77% indicated trotting (especially the posting trot) and 23% reported galloping as the gaits that provoked the most discomfort. All subjects confirmed experiencing the greatest discomfort during show jumping and dressage.

Statistical analysis showed higher hip ROM values in the study group. Significant higher values ($P < .05$) were observed in both lower limbs in active (right (R): 32.6±7.9; left (L): 35.2±6.7) and passive (R: 35.8±7.6; L: 38.6±7) internal rotation ranges in compared to control group (active: R= 27±5.9; L= 29.7±6.9; passive (R: 30.1±5.8; L: 32.4±7.1). The detailed results of this analysis are presented in Table 1.

Muscle torque values, normalized to body weight ($N \cdot m \cdot kg^{-1}$), indicated that the study group had lower abductor muscle torques (R/L: 1.4±0.3) compared to the control group (R: 1.6±0.4; L: 1.6±0.4). Significantly higher muscle strength values ($P < .001$) were found in both right (2.1±0.4) and left (2.1±0.5) thigh adductor muscles in the study group compared to the control group (R: 1.6±0.4; L: 1.6±0.3). The detailed results of this analysis are shown in Table 2.

To evaluate the effect of asymmetry in hip ranges and muscle strength value distribution, ratios of ROM and strength indexes were calculated: external to internal rotation ROM (ER/IR ROM), muscle torques of external to internal rotators (ER/IR), abduction to adduction ROM (ABD/ADD ROM), and muscle torques of abductors to adductors (ABD/ADD). Significantly lower abductors to adductors ratio values ($P < .001$) in both limbs (R: 0.7±0.1; L: 0.7±0.2) were noted in the study group in compared to control group (R/L: 1.0±0.2). Detailed results of this analysis are shown in Table 3.

Discussion

In competitive sports, musculoskeletal overloading is a common issue due to repetitive movements that engage the same muscle groups. In horse riding, this overloading, coupled with unnatural joint positioning, heightens injury risk. Assessing range of motion (ROM) and muscle torque is vital for improving physical-technical performance and reducing the risk of sports-related injuries[29]. This study hypothesized that knee joint discomfort in riders might be linked to an imbalance of internal (IR) and external rotation (ER) strength in the thigh, along with deficits in abduction (ABD) ROM and a shift in rotation distribution towards IR. Limited ROM is a key modifiable risk factor for prevalent sports injuries, where athletes with restricted ROM have muscle-tendon units potentially unprepared for the high elastic energy generated in intense sports movements[29].

Our study found that 15 out of 18 riders reported chronic knee joint pain, with the posting trot and dressage identified as the most exacerbating factors. Lewis et al.[9] also found that jumping frequently caused chronic spine and knee joint pains. Knee pain is attributed to the load on the knees during eccentric work of the quadriceps femoris muscle, induced by the specific riding position that forces the knee joints into a valgus position. Statistical analysis revealed higher adductor (ADD) thigh muscle strength in riders compared to the control group, likely

Table 2. Differences in Normalized Hip Muscle Torques

Muscle torques		Study Group			Control Group			
		Mean±SD	Me	CI 95%	Mean±SD	Me	CI 95%	*P-value*
ABD-MS	R	1.4±0.3	1.5	1.32 - 1.57	1.6±.4	1.7	1.46 - 1.81	.071
	L	1.4±0.3	1.4	1.27 - 1.58	1.6±.3	1.6	1.44 - 1.75	.119
ADD-MS	R	2.1±0.4	2.0	1.91 - 2.29	1.6±.4	1.6	1.46 - 1.79	.001
	L	2.1±0.5	2.1	1.86 - 2.32	1.6±.3	1.6	1.42 - 1.72	.001
IR-MS	R	1±0.2	0.9	.84 - 1.07	.9±.2	.9	.78 - .96	.23
	L	1±0.2	1	.88 - 1.1	.9±.2	1	.82 - 1.04	.417
ER-MS	R	0.7±0.2	0.7	.64 - .79	.7±.2	.7	.61 - .75	.438
	L	0.7±0.2	0.7	.61 - .76	.6±.2	.6	.57 - 0.71	.361

Legend: R – right lower limb; L – left lower limb; ABD-MS – abductors muscle strength; ADD – adductors muscle strength; IR – internal rotators muscle; ER – external rotators muscle strength; CI – confidence interval; Me – median.

due to the discipline's specific demands[30]. Consistent thigh ADD muscle activity is essential for maintaining proper seat, riding technique, and signaling commands, crucial for safety and injury prevention[5,31].

Our findings also indicate that ADD thigh strength exceeds ABD muscle strength in riders, whereas the control group showed the opposite trend. However, the optimal ratio of these strengths remains unclear[32]. The imbalance between ADD and ABD thigh muscles directly impacts knee joint pain due to uneven joint loading, leading to overloads and anterior knee pain or excessive wear in the lateral compartment[5,8,33,34]. The greatest loads are experienced during posting and landing after a jump, with functional valgus disrupting patella tracking and potentially causing Patellofemoral Pain Syndrome (PFPS)[35]. Ferber et al.[36]

Table 3. Values of the ROM and Muscle Strength Ratios in Both Groups

Ratios		Study Group			Control Group			
		Mean±SD	Me	CI 95%	Mean±SD	Me	CI 95%	*P-value*
ER/IR MS	R	.9±.3	.9	.77 - 1.04	1.0±.3	1	.91 - 1.15	.145
	L	.8±.3	.8	.66 - .91	.9±.3	0.9	.79 - 1.09	.171
ER/IR ROM ACTIVE	R	.9±.3	.8	.77 - 1.05	1.0±.3	1	.9 - 1.18	.165
	L	.8±.3	.8	.66 - .92	.9±.3	0.9	.77 - 1.04	.222
ER/IR ROM PASSIVE	R	1.4±1.3	1.5	1.22 - 1.5	1.3±.3	0.5	1.18 - 1.47	.723
	L	1.5±.4	1.5	1.3 - 1.68	1.5±.3	1.4	1.31 - 1.63	.905
ABD/ADD MS	R	.7±.1	.7	.65 - 0.74	1.0±.2	1	.92 - 1.14	.001
	L	.7±.2	.7	.62 - .8	1.0±.2	1	.92 - 1.15	.001
ABD/ADD ROM ACTIVE	R	1.2±.4	1.1	1.03 - 1.44	1.3±.3	1.3	1.11 - 1.4	.853
	L	1.3±.3	1.3	1.16 - 1.48	1.4±.5	1.4	1.2 - 1.66	.4
ABD/ADD ROM PASSIVE	R	1.2±.3	1.1	1.03 - 1.34	1.2±.3	1.2	1.11 - 1.38	.545
	L	1.3±.3	1.2	1.15 - 1.42	1.3±.4	1.4	1.16 - 1.53	.562

Legend: R – right lower limb; L – left lower limb; ABD/ADD ROM ACTIVE – abduction to adduction active ROM ratio; ABD/ADD ROM PASSIVE – abduction to adduction passive ROM ratio; ABD/ADD MS – abductors to adductors muscle strength ratio; ER/IR ROM ACTIVE – external to internal rotation active ROM ratio; ER/IR ROM PASSIVE – external to internal rotation passive ROM ratio; ER/IR MS – external to internal rotators muscle strength ratio; CI – confidence interval; Me – median.

demonstrated that exercises focusing on strengthening hip joint muscles, particularly ABD and extensors, effectively alleviate PFPS compared to quadriceps-focused protocols.

Further research is needed to assess if knee joint pain in riders is exclusively due to the ADD to ABD thigh strength disparity by measuring flexor and extensor forces of the lower extremities. In the lateral knee joint compartment, structures like the lateral meniscus and articular cartilage are prone to degeneration[22,23,24]. A damaged meniscus causes pain during flexion and compression, particularly during posting and landing on the stirrups. Articular cartilage, lacking nerve endings, does not cause pain in the early stages of degeneration; pain emerges only once degeneration reaches the subchondral bone layer[37]. Confirming this hypothesis requires further diagnostic imaging of these structures.

The imbalance of ADD to ABD forces in the thigh might also result from weakened abducting muscle groups. Previous studies indicate that reduced hip joint muscular strength often correlates with knee pain, as irregularities in these joints directly impact lower segments[38]. In riders, the medium and large gluteal muscles, crucial for abduction and extension, are often weakened[9]. These are postural and stabilizing muscles of the pelvis, so they also participate in maintaining proper position in the saddle. When these muscles show insufficient endurance and strength, the entire workload is taken over by the ADD, which can result in uneven loading of the knee joints, altered biomechanics of the patella, or lumbar spine complaints.

We found no significant disparity in thigh rotator strength, with IR strength comparable to the control group. Although proper saddle position requires IR activation, this is difficult to achieve even for professional riders and is often not given enough importance. Verifying these results would require measurements of larger groups. Limited ABD or ER ROM of the thigh might be another pain source. This study observed greater passive and active IR ROM in riders, but not at the cost of reduced ER. The ranges of rotation are within the generally accepted norms of about 30–45 degrees for both rotations[27], suggesting that prolonged saddle posture, requiring constant ABD and ER of the lower limbs, might cause joint adaptations[5]. Professional equestrians spend several hours a day in this position, and the active and passive structures surrounding the joint must adapt to it over time.

In the hip joint, not only muscles but also ligaments play a significant role, their task being stabilization and guiding movement within a proper range and direction[39]. Healthy ligaments are rigid structures and do not have the ability to stretch significantly and permanently. Repeated actions, prolonged and regular staying in a certain position can cause them to adapt and remain slightly stretched. This, in turn, could justify the greater ROM obtained by the studied group. To determine whether the ligaments have been lengthened through adaptation, the stability of the hip joints in riders should be assessed, which may answer why hip joint pain is often reported by athletes in this discipline[5,8,9].

It is worth mentioning that hormonal changes during the menstrual cycle, especially changes in the concentration of oestrogen and progesterone, can affect physical performance and muscle strength.[41] Oestrogen is a hormone with a putative anabolic function, while progesterone is associated with catabolic pathways[42]. In some women, there is increased muscle strength during the follicular period (the period between menstruation and ovulation), when oestrogen concentrations are higher. During the luteal period (after ovulation), when progesterone concentrations increase, some women may experience reduced muscle strength. Data suggest that the menstrual cycle may alter maximal muscle strength capacity in women who are not using oral contraceptives[43].

Practical Applications

Overall, the above analysis highlights the importance of strength training for riders, particularly focusing on thigh abductors, including gluteal muscles, to balance muscle strength, reduce knee joint loading, and alleviate spinal pains. Strengthening the ABD will help reduce or even eliminate the imbalance between ABD and ADD strength, which affects the proper loading of the knee joints. The gluteal muscles also serve as postural muscles and are responsible for pelvic stabilization, so their strengthening will also alleviate spinal pains. It is also important to maintain proper flexibility of the ADD group and the quadriceps femoris, as shortening of these muscles can compress the patella and cause PFPS. Additionally, strengthening the quadriceps femoris is necessary in the context of preventing knee joint injuries. Given that riders must maintain full balance in the saddle, it is advisable to implement training to strengthen the core muscles, which is often an overlooked element of training. Strengthening the abdominal and back muscles, as well as improving spinal mobility, will reduce spinal complaints, allow for proper pelvic positioning in the saddle, and improve the alignment of the entire lower limb[4,43].

Conclusions

1. Equestrian practitioners are at risk of knee joint overloading, leading to pain in this area.
2. Improper joint loading is primarily due to the riding position and resulting imbalance between thigh abducting and adducting muscle strengths.
3. Preventing musculoskeletal pain requires a balanced exercise regimen, focusing on muscle groups that are less utilized in riders' movement techniques.

Ethical Committee approval

Ethics Committee of the University of Physical Education in Warsaw (SKE01-42/2022).

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Topic

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Author-s contribution

Conceptualization, K.K., M.A.; methodology, P.B, I.W, K.K.; software, P.B, I.W, K.K.; validation, P.B, I.W, K.K.; formal analysis, P.B., I.W.; investigation, P.B., M.A, P.L, .P.; resources, M.A., K.K.; data curation, P.B., I.W., K.K.; writing—original draft preparation, P.B., M.A, P.L., I.W., K.K,; writing—review and editing, P.B., M.A, P.L., I.W., K.K.; visualization, P.B., M.A, P.L., I.W., K.K.; supervision, I.W., K.K.; project administration, A.M., P.L. All authors have read and agreed to the published version of the manuscript.

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