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TEST-RETEST, INTRA- AND INTER-RATER RELIABILITY OF THE REACTIVE BALANCE TEST IN PATIENTS WITH CHRONIC ANKLE INSTABILITY

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Introduction: Chronic ankle instability (CAI) affects 40-45% of those who have had an ankle sprain and leads to recurrent episodes of the ankle "giving way" and neuromuscular deficits[1]. Clinicians use functional performance tests (FPTs) like the star excursion balance test (SEBT) and the Y-balance test (YBT) to identify those at risk of (re)injury and make better-informed return to sport (RTS) decisions[2,3]. However, these tests are limited in on-field sports contexts. To address this, the reactive balance test (RBT) was developed[4,5]. This study aimed to determine the reliability of the RBT in patients with CAI.

Methods: Forty-three eligible patients were screened on the IAC inclusion criteria for CAI. Patients visited the lab three times for familiarization and two experimental trials during which they performed the YBT and RBT on both legs. The test procedures and protocol were identical to the study of Tassignon et al., 2020. The duration and range of the test-retest time frame was chosen to reflect a clinically relevant period and lasted 22 (± 10) days on average. Three raters independently rated the different types of reliability by scoring the RBT outcome measures: accuracy and visuomotor response time (VMRT).

Results: Twenty-seven patients with CAI were included in this study. The ICC measures for the test-retest reliability were similar for accuracy (0.609) and VMRT (0.594). Intra-rater reliability had high correlations and ICCs for accuracy (r=0.816, ICC=0.815) and VMRT (r=0.802, ICC=0.800). Inter-rater reliability had a higher ICC for VMRT (0.868) than for accuracy (0.690).

Conclusion: Test-retest reliability was moderate, intra-rater reliability was good, and inter-rater reliability showed moderate reliability for accuracy and good reliability for VMRT. The data indicates the VMRT performance was more robust than the accuracy measure across the trials. When the Limits of agreement were compared with the minimal detectable change, the data indicates the RBT is more precise and sensitive to changes than the raters' score. Additionally, the RBT shows robust standard error of measurement and mean difference measures.

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THE INFLUENCE OF TIBIAL ROTATION ON HAMSTRING MUSCLES GROUPS' COORDINATION DURING A DYNAMIC KNEE FLEXION ASSESSMENT

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Introduction: Hamstring muscle (HM) strength testing is often used as a helpful means to detect strength weakness and prevent injuries. However, conventional evaluations often fail to provide a detailed understanding of the involvement of the medial (MH) and lateral (LH) hamstring

muscle groups. This might lead to underestimate an abnormal MH/LH recruitment following a persistent deficit [Higashihara et al. 2019; Presland et al. 2021; Schuermans et al. 2014]. Previous research has suggested that MR and LR could increase the activity of MH and LH, respectively [Armour et al. 2004; Beyer et al. 2019]. However, no study has examined the influence of these rotations on HM groups' activity or knee flexion strength during dynamic modalities.

Methods: We aimed to address this research gap by recruiting 36 amateur male athletes and assessed their muscle activity (using Delsys Inc, Natick, MA, USA) of semitendinosus (ST) and biceps femoris long head (BFlh), as well as the knee flexion force (using Cybex; Computer Sports Medicine Inc., Stoughton, MA, USA) during concentric and eccentric contraction modes at different speeds (concentric at 60°/s, 240°/s and eccentric at 30°/s and 120°/s). We compare the EMG and strength curves between LR and MR using two-way repeated-measure ANOVA, and analyzed the data using Statistical Parametric Mapping (SPM 30, v0.4, www.spm1d.org, Matlab).

Results: Our results showed that tibial rotations have a significant effect on knee flexion strength ($p < 0.001$) across most of the different dynamic modalities tested, with lower strength results associated with MR. We observed that lateral rotation consistently increased the recruitment of biceps femoris muscle and conversely (particularly during eccentric contractions). However, rotations did not statistically influence the semitendinosus muscle activity.

Conclusion: Lateral rotation could be employed to specifically target the biceps femoris muscle (and conversely) during dynamic knee flexion strength assessment. However, the validity of tibial rotations should be further investigated in the context of hamstring injury prevention to ensure that a specific HM group deficit is not overlooked. By understanding the influence of tibial rotations on HM groups' activities and strength, clinicians' ability to identify potential weaknesses and develop targeted interventions may be improved to prevent injuries and enhance performance.

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IMPACT OF STRIDE FREQUENCY ON THE MAXIMAL ISOMETRIC FORCES OF THE PLANTAR FLEXOR MUSCLES AND HIP ABDUCTORS MUSCLES DURING AN 156 KM ULTRA-TRAIL

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Introduction: The main objective of this study was to assess the impact of stride frequency on the evolution of the maximal isometric forces of the plantar flexor muscles and hip abductors during an 156 km ultra-trail. A secondary objective was to analyze the evolution of the maximal isometric force of those muscles groups during an ultra-trail.

Methods: The "Trail scientifique de Clécy" took place on November 11, 2021. It was about a 156 km ultra-trail divided into 6 identical loops. Each of 26 km with a total positive elevation of 6,000 m. We collected strength and running biomechanics (stride frequency) data on 55 volunteer ultra-trailers (25 to 70 years old) (1). The measurement of the maximal isometric force for both the plantar flexors and the hip abductors was carried out using a portable dynamometer (2). The running biomechanics data were collected with an Optogait system (3). Based on the stride frequency data, we divided the sample into 2 groups (low stride frequency and high stride frequency). Those measurements were performed on the field, before, during and after the race.

Results: The maximal isometric force of the hip abductors and the plantar flexor muscles decreased significantly between the beginning and the end of the race ($p<0,001$) as well as during the race ($p<0,001$). No significant differences could be observed between the mean value of the variations in the force of the hip abductors ($p=0,722$) nor in the mean

value of the variations in the forces of the plantar flexor muscles (p=0,266) between the 2 groups.

Conclusion: To our knowledge this study is the first to analyze the impact of stride frequency on the variation of the hip abductors force and the plantar flexor force during an ultra-trail. Our results suggest that the stride frequency does not impact the variation of force during such race. However, the maximal isometric force varies throughout the race. This was also reported in other scientific references studies (4) (5). Therefore, it would be interesting to take the strength into account in the arising of the tiredness and the injuries and in the performance.

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HIGHER KNEE JOINT WORK IS A RISK FACTOR FOR THE DEVELOPMENT OF PATELLAR TENDINOPATHY IN VOLLEYBALL: A PROSPECTIVE STUDY

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Introduction: Patellar tendinopathy (PT) is a common injury in sports with repetitive landing tasks such as volleyball. Impaired landing biomechanics might play a role in the development of this overuse injury. Therefore, the aim of the study was to investigate biomechanical risk factors for PT in volleyball players during sport-specific jump-landing tasks.

Methods: In this prospective study, 82 healthy male volleyball players were evaluated during the season 2021-2022. Pre-season, three-dimensional full-body kinematics and kinetics of the push-off phase preceding the actual jump were collected during three different jump-landing tasks (spike jump, block jump and drop vertical jump). During follow-up, injury data were collected by using a weekly questionnaire and a 3-montly retrospective control questionnaire. Univariate cox regression with competing risk analysis was used to identify significant contributors to the development of PT ($p<0.05$).

Results: Of the 82 volleyball players, 10 developed PT during the follow-up period of one season (12%). The results of the study identified that increased concentric knee joint work during all jump-landing tasks (block jump p=0.01, spike jump p=0.03, drop vertical jump p=0.04) and increased eccentric knee joint work during block jump (p=0.04) are predictive parameters to develop PT in male volleyball athletes.

Conclusion: The results of this study indicate that volleyball players with higher concentric knee joint work during different jump-landing tasks and higher eccentric knee joint work during block jump are prone to develop PT. Less knee joint work during jump-landing tasks might be beneficial for injury prevention.

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WHAT DO UPPER-EXTREMITY PHYSICAL PERFORMANCE TESTS ACTUALLY MEASURE? INSIGHTS FROM AN ELECTROMYOGRAPHICAL STUDY.

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Introduction: Shoulder injuries are common in overhead athletes with prevalence rates up to 42%. (1) When sustaining an injury, the treatment approach must be based on the results of the clinical examination, including thorough analysis of possible functional impairments. In this view, physical performance tests (PPTs) focus on multijoint evaluations in which the athlete performs an activity that represents some aspects of athletic function.(2) Evaluating the electromyographical (EMG) demands of those PPTs enables clinicians to select appropriate PPTs for their athletes. (3)

Methods: Thirty asymptomatic overhead athletes participated in this descriptive laboratory study. Four upper-extremity PPTs (Y-Balance Test - Upper Quarter (YBT-UQ), Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST), Upper Limb Rotation Test (ULRT) and Shoulder Endurance Test (SET))(4)(5) were evaluated using surface EMG on both dominant and non-dominant sides to measure muscle activity in upper (UT), middle (MT), and lower (LT) trapezius, serratus anterior (SA), infraspinatus (IS) and, posterior deltoid (PD).

Results: During YBT-UQ performance on both sides, the supporting hand showed high SA activity levels (range: 51 – 94%MVIC) during all reach directions while IS was most active when supporting the superolateral reach (range: 92 – 129%MVIC). For the reaching hand, SA was most active (range: 46 – 83%MVIC). During the CKCUEST, all muscles were moderately to highly active, with SA (range: 64 – 87%MVIC) and IS (range: 42 – 85%MVIC) being the most active ones in both moving and supporting hand. Moderate to high activity was recorded for all muscles on both sides during the ULRT. For the SET, muscle activity progressively increased with increasing speed for both dominant and non-dominant performance.

Conclusion: Our results provide specific EMG based information which allows clinicians to better understand PPT performance, enhancing selection of appropriate PPTs that match their patients' needs to return to sport.

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IS THERE AN ASSOCIATION BETWEEN THE JUMP-LANDING PROFILE OF VOLLEYBALL PLAYERS AND THE VISCOELASTIC PROPERTIES OF THE PATELLAR TENDON?

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Introduction: Patellar tendinopathy is highly prevalent in male volleyball players due to the repetitive jump-landing tasks. Landing kinematics have been denoted as a risk factor for the development of patellar tendinopathy. However, it is unknown whether these landing kinematics have an influence on the tendons' structural parameters such as stiffness. Previous studies showed that the viscoelastic properties of the patellar tendon are related to the injury susceptibility. Therefore, the aim of this study was to investigate a possible association between the jump-landing pattern of volleyball players and patellar tendon stiffness.

Methods: Thirty-three male volleyball players, without a history of patellar tendon injuries and without any present lower extremity complaints, underwent a three-dimensional kinematic motion analyses of the jump-characteristics complemented by stiffness (shear wave elastography) and thickness (ultrasonography) measurements of the patellar tendon. The effect of the landing kinematics on the dominant patellar tendon stiffness was investigated with linear mixed models. The level of significance was set at α=0.05.

Results: The results of the study showed a significant association between knee flexion range of motion and ten-

don stiffness (p=0.022). The lower the knee flexion range of motion, the higher the tendon stiffness.

Conclusion: This study was the first to show an association between the jump-landing pattern of volleyball players and the stiffness of the patellar tendon. More specifically, the lower the knee flexion range of motion during landing, the higher the patellar tendon stiffness. These results suggest that the specific jump-landing pattern of volleyball players impacts the patellar tendon structure, co-determining the injury predisposition.

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DOES BASELINE COGNITIVE PERFORMANCE PREDICT THE RESPONSE TO MENTAL FATIGUE IN HEALTHY INDIVIDUALS?

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Introduction: Mental fatigue (MF), a psychobiological state induced by prolonged demanding cognitive activity, is implied to cause an increased injury risk in a healthy population (1-3). However, the level of emergence of MF is highly variable between different subjects, making it difficult to screen which people are more sensitive to its effects (4). Meanwhile, almost no factors have reliably been identified that can predict the response to MF (5). Since cognitive processes, such as attention and decision-making, are crucial for physical activities, this study aimed to investigate the link between cognitive abilities and the response to mental fatigue.

Methods: We employed a randomized single-blinded placebo-controlled counter-balanced cross-over design. First, participants completed three cognitive tests (sustained attention to response task, psychomotor vigilance task, and N-BACK task) to measure attention, working memory, and response inhibition. During the experimental and control trial, participants completed either a 45-minute modified Stroop task or watched a documentary of the same duration. Before and after the experimental and control trial, all 48 participants were asked to rate their feeling of MF on a visual analogue scale (M-VAS). After the Stroop task/documentary, participants performed a Go-NoGo task and a 15-minute time trial to assess cognitive and physical performance. Linear regression was used to evaluate the relationship between cognitive performance and MF effects.

Results: Baseline cognitive functions did not significantly relate to differences between scores on the M-VAS (F=2.126; p=.094). No significant relationship was found between baseline cognitive functions and the extent to which MF affects physical performance (F=1.315, p=.286). Finally, a marginally significant relationship was found between baseline cognitive performance and accuracy scores on the Go stimuli of the Go-NoGo task when participants are mentally fatigued (F=2.485; p=.063) but not for reaction time (F=.664; p=.621) or accuracy on the NoGo stimuli (F=.629; p=.646).

Conclusion: It is of the utmost importance to identify athletes who are more susceptible to MF, as this could help us in developing effective injury prevention strategies. The present study revealed no significant relationship between baseline cognitive performance and susceptibility to MF. More research is needed to fully elucidate the individual response to MF.

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THE ADDITIONAL VALUE OF ISCHEMIC PRECONDITIONING DURING WARM-UP ON ISOKINETIC STRENGTH AND ENDUANCE

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Introduction: Ischemic preconditioning (IPC) has become an upcoming topic within blood flow restriction (BFR) literature. A positive effect of IPC on muscle strength has already been suggested by several studies, but there is yet no conclusive evidence concerning the effect of IPC on isolated strength parameters compared to regular warm-up in a larger population.

Methods: Thirty-three healthy participants attended two sessions of performing a maximal isokinetic strength test with a different warm-up. The control session comprised a five-minute warm-up on a stationary bike, whereas in the intervention session two bouts of five minutes of IPC preceded the strength test. Readiness to perform (RTP) was questioned after the warm-up. Quadriceps and hamstring strength parameters, including average and maximum peak torque/body weight (PT/BW) and work fatigue (WF), as well as rate of perceived exertion (RPE) and rate of perceived discomfort (RPD) were obtained after each test. The presence of delayed-onset muscle soreness (DOMS) was questioned 24 hours post-session.

Results: The average and maximum PT/BW were significantly lower in the IPC-session for both the quadriceps ($p = 0,024$; $p = 0,005$, respectively) and hamstrings ($p = 0,015$; $p = 0,007$, respectively). Significantly lower scores were also found for RTP before, and DOMS after the IPC-session ($p < 0,001$). No significant differences between IPC and control were found for WF, RPE and RPD.

Conclusion: Passive BFR applied as IPC does not appear to enhance muscle strength or endurance in terms of peak torque or work fatigue, on the contrary. Two 5-minute bouts of IPC-application 10 minutes prior to a maximal isokinetic strength test reduced the average and peak torque while simultaneously reducing the readiness to perform compared to a conventional cycling warm up.

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COUNTERMOVEMENT JUMP MAY DETERMINE PERFORMANCE ALTERATIONS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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Introduction: The main objective was to examine countermovement jump (CMJ) measures to identify which parameters can best distinguish between anterior cruciate ligament reconstruction (ACLR) and control participants. The secondary objective was to determine whether performance alterations between operated and non-operated limb exist during vertical two-legged activities after ACLR.

Methods: This case control study included 67 patients with hamstring graft at 6 postoperative months (203.5 days ± 32.2) and 47 healthy athletes with no knee injury history. Two groups were formed, an ACLR group (n=67) and a control group (n=47). An evaluation of CMJ by force plate was performed, to calculate vertical ground reaction force (vGRF), maximal power (MP) and eccentric rate force development (RFDe) during landing and limb symmetry index (LSI). (1–3) First analysis compared LSI vGRF, LSI MP and LSI RFDe between both groups during CMJ. Secondary analysis compared vGRF, MP and RFDe between operated/non-operated limb in the ACLR group and dominant/non-dominant limb in the control group.

Results: CMJ measures in the ACLR group were significantly reduced compared to the control group for LSI vGRF (85.9% ± 9.6 vs 94.6% ± 5.3, $p < 0,001$, respectively), LSI MP (84.8% ± 8.4 vs 95.6% ± 4.1 , $p < 0,001$, respectively) and LSI

RFDe (68.0% ± 23.1 vs 76.7% ± 17.2, p < 0,001, respectively). Secondary analysis showed no significant result in control group between dominant/non-dominant limb. ACLR group showed significant results between operated / non-operated limb for PT (9.4 $N.kg^{-1}$± 0.1 vs 10.8 $N.kg^{-1}$± 0.13, p < 0,001, respectively), MP (17.7 $W.kg^{-1}$± 4.0 vs 20.3 $W.kg^{-1}$± 4.1, p < 0,001, respectively) and RFDe (825.2 $N.s^{-1}$± 62.0 vs 1200.5 $N.s^{-1}$± 87.8, p < 0,01, respectively).

Conclusion: The results indicate significant torque, power and landing deficits and performance alterations on the non-operated limb during CMJ at time to return to sport after ACLR. The results may be too preliminary to draw definitive conclusions but double legged assessment should be considered in return to sport decision making after ACLR.

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EARLY OPEN KINETIC CHAIN IMPROVES STRENGTH RECOVERY AND RETURN TO SPORT AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITHOUT GRAFT LAXITY INCREASING

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Introduction: The main objective was to determine whether the early associated use of open kinetic chain (OKC) and closed kinetic chain (CKC) improved quadriceps and hamstring strength in the rehabilitation after anterior cruciate ligament reconstruction (ACLR). The secondary objective was to assess whether the early use of OKC had an influence on graft laxity at 3 and 6 postoperative months.

Methods: This study included 103 patients with hamstring graft. Two groups were formed OKC+CKC group (n = 51) vs CKC group (n = 52). OKC protocol which included exercises for quadriceps and hamstrings muscles, were introduced at 4 weeks after ACLR (31,4 days ± 7,6). (1,2) At 3 months (101,9 days ± 18,4) and 6 postoperative months (199,2 days ± 28,1), an evaluation of muscle strength by isokinetic dynamometer was performed, to calculate peak torque-to-body weight ratio (PT/BW) for the quadriceps and hamstrings. The laxity measurement was performed by comparative measurements performed by GNRB.

Results: At 3 and 6 postoperative months, quadriceps strength in the OKC+CKC group was higher than in CKC group for LSI (76,1 % ± 0,21 vs 46,9 % ± 0,21, p < 0,001 and 91 % ± 0,17 vs 61,8 % ± 0,26, p < 0,001, respectively) and PT/BW (1,81 $Nm.kg^{-1}$ ± 0,75 vs 0,85 $Nm.kg^{-1}$ ± 0,50, p < 0,001 and 2,40 Nm.kg-1 ± 0,73 vs 1,39 Nm.kg-1 ± 0,70, p < 0,001, respectively). There were similar findings for the hamstring strength: LSI (86,1 % ± 0,21 vs 64,3 % ± 0,24, p < 0,001 and 91,9 % ± 0,17 vs 82,4 % ± 0,24, p < 0,001, respectively) and PT/BW (1,09 $Nm.kg^{-1}$ ± 0,36 vs 0,69 $Nm.kg^{-1}$ ± 0,39, p < 0,001 and 1,41 $Nm.kg^{-1}$ ± 0,41 vs 1,06 $Nm.kg^{-1}$ ± 0,39, p < 0,001, respectively). At 3 months no difference was observed for laxity between OKC+CKC and CKC group (p = 0,48). At 6 months the laxity was greater in CKC group (p = 0,31).

Conclusion: The results indicate that early associated use of OKC and CKC allow for enhanced correction of quadriceps and hamstrings strength deficits and readiness to return to sport without increasing graft laxity.

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GASTROCNEMIUS MUSCLES ACTIVITY INCREASING MAY IMPAIR RUNNING SPATIO-TEMPORAL PARAMETERS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A PILOT STUDY

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Introduction: The main objective of this study was to evaluate whether running after anterior cruciate ligament reconstruction (ACLR) resulted in increased muscular activity of the gastrocnemius medialis and gastrocnemius lateralis compared to running in healthy participants. The secondary objective was to assess whether these changes in muscular activity correspond to changes in cadence, vertical stiffness, flight time and ground contact time while running.

Methods: This pilot case-control study included 7 patients with hamstring graft at 6 postoperative months (208.7 days ± 34.6) and 8 healthy athletes with no knee injury history. Two groups were formed, an ACLR group (n=7) and a control group (n=8). After maximal voluntary isometric contraction (MVIC) assessment, both groups performed treadmill running assessment with Optogait®. After a 6 minutes warm up on a treadmill at 10 $km.h^{-1}$, (1) 30 sec were recorded to measure the surface electromyographical activity (EMG) of the GM and GL. (2,3) After root mean square (RMS) treatment of the raw signal, RMS EMG results were normalized by MVIC activity to allow inter-subject comparability.

Results: Between-group analyses showed a significant increase in RMS EMG for the ACLR group compared to the control group for the GM (34.7%MVIC ± 11.0 vs 25.5%MVIC ± 13.0, p = 0.05, Effect Size = 0.52) and the GL (32.8%MVIC ± 10.6 vs 17.2%MVIC ± 6.30, p < 0.01, Effect Size = 0.78). Significant correlations were observed in the ACLR group with GL RMS EMG for ground contact time (r = 0.84; p = 0.02). However, there were no significant correlations with cadence (r = 0.50; p = 0.27), vertical stiffness (r = 0.50; p = 0.27) and flight time (r = 0.02; p = 0.97). No significant correlations were observed in the ACLR group with GM RMS EMG.

Conclusion: These findings indicate that ACLR subjects presented with higher GM and GL activity while running compared to the control group. The overuse of these muscles may play a role in the alteration of spatiotemporal parameters of running after ACLR.

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SUPERIOR FOOT & ANKLE MUSCLE STRENGTH IN NON-REARFOOT ENDURANCE RUNNERS COMPARED WITH REARFOOT RUNNERS: IMPLICATIONS FOR THE MANAGEMENT OF RUNNING-RELATED KNEE INJURIES.

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Introduction: Transitioning to a forefoot strike pattern can be used as a component of a gait retraining intervention to manage running-related knee injuries (1). However, adopting a non-rearfoot strike induces a higher load on foot and ankle structures than rearfoot strike (2)(3). In response to these biomechanical differences, non-rearfoot runners (NRF) appear to have a superior ankle plantar flexor strength and Achilles tendon cross-area compared with rearfoot runners (RF) (4). Sufficient foot muscle strength is also necessary to prevent excessive longitudinal arch (LA) deformation when running with non-rearfoot strike (5). The aim of this study was to investigate the difference in foot-ankle muscle strength between RF and NRF.

Methods: Forty RF and forty NRF were recruited. A navicular drop, a foot posture index and the maximal voluntary isometric strength (MVIS) of six foot-ankle muscles were measured. The footstrike pattern was determined using a high-speed camera during a self-paced run on a treadmill.

Results: NRF had higher MVIS for ankle plantar flexor (+12.5%, p = 0.015), ankle dorsiflexor (+17.7%, p = 0.01), hallux flexor (+11%, p = 0.04) and lesser toe flexor (+20.8%, p = 0.0031). NRF also had stiffer plantar arches (p = 0.04) and less pronated feet (p = 0.02). There is a small positive correlation between MVIS of ankle plantar flexor with MVIS of ankle invertor (r = 0.22; p-value = 0.04), hallux flexor (r = 0.26; p-value = 0.01) and lesser toe flexor (r = 0.28; p-value = 0.01).

Conclusion: The main finding of this research is the higher MVIS of hallux and lesser toe flexor in NRF compared with RF, despite a wide range of values. NRF also have a higher MVIS of ankle plantar flexor and dorsiflexor than RF. There is only a small correlation between ankle plantar flexor and foot muscle strength. Consequently, clinicians who practice gait retraining interventions including transition to a forefoot strike pattern should assess foot and ankle muscle strength separately. Then, they should implement, if necessary, a foot strengthening program to prevent excessive LA deformation.

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NEUROCOGNITIVE DEFICITS RELATED TO LIGAMENTOUS ANKLE INJURIES AND CHRONIC ANKLE INSTABILITY

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Introduction: The ankle is the most commonly injured body part in sports and is often subject to recurrent injury, especially ligament sprains (1). Up to 40% of ankle sprains may develop chronic ankle instability (CAI) (2). Despite growing evidence that altering neurocognitive demands can affect lower limb biomechanics in individuals with CAI, the underlying mechanisms remain unclear. The aim of this systematic review was to summarise the current literature on the neurocognitive deficits linked with ligamentous ankle injuries and CAI.

Methods: Five electronic databases were used, including PubMed, Web of Science, Scopus, PsychInfo and SPORTDiscus from their inception to February 22nd, 2023. Articles were eligible if they (1) were published in English, (2) were original research and (3) investigated neurocognitive functioning in 18-year-old or older patients with CAI or who experienced a lateral ankle sprain. The methodology followed the PRISMA guidelines. We grouped the neurocognitive functions into eight domains: executive functions, information processing speed, inhibitory control, attention, reaction time, visual spatial perception, motor control, and memory.

Results: A total of 1221 results were identified, of which 18 studies met the inclusion criteria. The risk of bias assessment indicated an overall high risk of bias in the studies. Among these included studies, 335 individuals with CAI were included, 244 healthy controls, and 68 copers. Three studies highlighted that reaction time was significantly worse within individuals with CAI compared to copers and healthy controls. Regarding attention, three out of six studies suggest that these cognitive functions may be impaired in individuals with CAI. Also for memory, three out of six studies found deficits in individuals with CAI. The remaining five neurocognitive domains showed either inconclusive or no results in individuals with CAI.

Conclusion: Overall, individuals with CAI appear to have neurocognitive deficits in reaction time, attention and memory, while other neurocognitive domains do not seem to be affected. Nevertheless, there are still few studies on the different neurocognitive subdomains in this population which highlights the need for further research to better map and understand this phenomenon and its underlying mechanisms.

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PEAK PATELLAR TENDON FORCE DURING HEAVY LOAD SINGLE-LEG SQUATTING IS INFLUENCED BY A DECLINE BOARD BUT NOT BY THE EXTERNAL WEIGHT'S MASS

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Introduction: Heavy slow resistance training is an important stage in progressive exercise programs for the rehabilitation of patellar tendinopathy(1,2). An exercise frequently included this training, is the single-leg squat either on level ground or on a decline board(3). Unfortunately, the impact of variations of the heavy load single-leg squat on the peak patellar tendon force (PTF) has not yet been objectively quantified. The objective of this study was therefore to investigate the influence of the mass of an external weight and the use of a decline board on the peak PTF during a heavy load single-leg squat.

Methods: Twelve healthy participants with at least one year of strength training experience were included. The participants performed single-leg back squats on a decline board and on level ground with external weights of 70%, 80% and 90% of their respective one-repetition maximum. Three-dimensional kinematics were collected using a passive marker-based motion capture system (100Hz; Vicon, Oxford, UK) and ground reaction forces were measured using a ground-embedded force plate (1000Hz; AMTI, Watertown, USA). Peak PTF was calculated in OpenSim (Stanford, USA)(4) using the Catelli model(5) and a static optimisation approach. A two-way repeated measures ANOVA determined the main effect for the mass of the external weight, the main effect for the surface, as well as for their interaction effect on the peak PTF.

Results: Peak PTF values were significantly higher on the decline board compared to level ground ($p_{surface}$=0.025). Neither on the decline board nor on level ground did an increase in the mass of the external weight result in a significant increase of the peak PTF (p_{mass}=0.100; $p_{mass*surface}$=0.090).

Conclusion: Progression in peak PTF during a single-leg squat can be obtained with a decline board. Increasing the mass of the external weight from 70% to 90% of the one-repetition maximum will not result in a higher peak PTF on either surface. Therefore, it can be concluded that it is possible to expose patients with patellar tendinopathy to high peak PTF loads during rehabilitation, even at lower heavy weights, simply by performing the single-leg squats on a decline board.

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PHYSIOTHERAPISTS AND PHYSIOTHERAPY STUDENTS ESTIMATE PATELLAR TENDON FORCES DURING REHABILITATION EXERCISES EQUALLY WELL

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Introduction: Exercise therapy with gradual progression of patellar tendon load is key for the rehabilitation of patellar tendinopathy(1,2). Unfortunately, objective quantification of patellar tendon forces (PTF) in clinical practice is impossible(3). Therefore, physiotherapists rely on clinical reasoning to estimate PTF for individual patients. The objective of this study was to examine whether physiotherapists and graduating physiotherapy students, specialised in musculoskeletal rehabilitation, can accurately estimate PTF during rehabilitation exercises.

Methods: One healthy individual performed 19 rehabilitation exercises twice. Exercises included gait, squats, lunges, steps, calfraises, single-leg Romanian deadlift and jumps. The first time, marker-based motion capture data (100Hz; Vicon, Oxford, UK) and ground reaction forces (1000Hz; AMTI, Watertown, USA) were collected. PTF was calculated in OpenSim (Stanford, USA)(4). The second time, videos of the exercises were recorded in a clinical setting. These videos were implemented in an online survey. Here, participants were asked to score each exercise on a 100-point numerical rating scale ranging from "absolutely no PTF" to "maximal PTF over all exercises". The survey was completed by 50 physiotherapists and 50 second-master students. Two statistical analyses were performed. First, the differences between the participants' scores and the objective scores were calculated. Both the average difference over all exercises and the difference for each individual exercise were analysed using one-sample t-tests (critical p-value=0.01). Next, the scores were reduced to rankings, representing a more basic level of clinical reasoning. The correlation between the participants' rankings and the objective rankings was analysed using Kendall's tau coefficient.

Results: In both groups, the overall difference between subjective and objective PTF scores was not significantly different from zero (both p>0.01). At the level of individual exercises, both groups estimated eight exercises correctly, underestimated five exercises and overestimated six exercises. Except for one exercise, the same exercises were over- or underestimated. Regarding the rankings, both physiotherapists (tau=0.626, p<0.001) and students (tau=0.614, p<0.001) had moderate to good correlations with the objective PTF rankings.

Conclusion: Physiotherapists and physiotherapy students have a moderate to good capacity to estimate PTF

during rehabilitation exercises. The capacity to estimate PTF is not influenced by clinical experience as both groups scored equally well.

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DOES SLEEP QUALITY PREDICT VO_2 MAX IN HEALTHY ADULTS?

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Introduction: It has previously been discovered that the amount of daily vigorous activity is associated with an increased VO2max in adults.[1] Additionally, a relation was found between increased physical activity and overall sleep quality.[2] However, only a limited amount of studies have explored how VO2max affects sleep quality. This present study intends to builds upon these findings by investigating whether VO2Max predicts sleep quality, and whether sleep quality is affected by physical performance level in healthy adults.

Methods: Sixty-seven healthy adults (33 males and 34 females) aged 31.39 ± 8.92 years old, with a VO2max of 47.29 ± 8.42 ml/kg^-1/min^-1, and performance level of 2,10 ± 0,82 were included in this study. Subjects performed a maximal incremental exercise test on a cycling ergometer, starting at a power output of 80W and increasing by 30W every three minutes. The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality. This questionnaire evaluates 19 self-reported items divided in seven subcategories: 1. Subjective sleep quality, 2. Sleep latency, 3. Sleep duration, 4. Habitual sleep efficiency, 5. Sleep disturbances, 6. Use of sleeping medication, and 7. Daytime dysfunction. A simple linear regression was performed to investigate whether VO2max significantly predicted sleep quality and a one-way ANOVA for investigating whether there were any differences in sleep quality depending on performance level.

Results: The fitted regression model (Sleep quality = 0.017 * VO2max + 15,821) found no significant results (R2 = 0.004, F = 0.258, p = 0.613) when investigating whether VO2max predicts sleep quality. Additionally, no differences in sleep quality were found for groups of different performance levels (F = 0.043, p = 0.988).

Conclusion: This research shows that VO2max does not predict sleep quality and that other factors will be more decisive at determining sleep quality. These findings further contribute to the understanding of factors determining sleep quality in healthy adults.

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HAMSTRING MUSCLE FIBRE TYPE DISTRIBUTION IN FOOTBALL PLAYERS HAVING SUFFERED AN ANTERIOR CRUCIATE LIGAMENT INJURY: HARDER, BETTER, FASTER, STRONGER? A CASE-CONTROL STUDY USING MR SPECTROSCOPY.

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Introduction: Anterior Cruciate Ligament (ACL) Injuries are one of the most common acute sports injuries in football. Amongst others, architectural features as bone morphology, knee joint configuration and lower limb alignment have been associated with the ACL injury risk. Recently, the role of muscle fibre type distribution in the light of both athletic performance and hamstring muscle injury risk, has gained popularity in sports medicine research. As the ACL is a biomechanical synergist of the hamstring muscle unit and football players with a history of ACL injury are more prone to hamstring injuries and vice versa, this study intended to verify to what extent hamstring muscle fibre type distribution is related to the risk of ACL injury in foot-

ball players, by conducting a case control study using Magnetic Resonance Spectroscopy (MRS).

Methods: 21 amateur football players with a recent history of ACL injury and 45 matched controls were submitted to a MRS evaluation. The Semitendinosus muscle of the non-injured leg was used for carnosine content calculations in the ACL history group. In the control group dominant and non-dominant legs were chosen randomly based on respective distribution in the ACL history group. Muscle fibre type distribution was estimated based on the relative carnosine content (expressed in Arbitrary Units (AU)), and the associated Z-scores were used to classify participants having mostly Fast Twitch (FT), Intermediate Type (IT) or Slow Twitch (ST) fibre presence.

Results: Mixed models analysis revealed that carnosine contents did not differ significantly based on ACL history presence, with average carnosine contents of 0.19 ± 0.054 and 0.17 ± 0.051 AU in the ACL injury and control groups, respectively (p = 0.145). FT, IT and ST dominances was found in 38%, 29% and 33% of participants in the ACL group and 24%, 40% and 36% in the control group, respectively.

Conclusion: ACL injuries do not present any association with hamstring muscle fibre type. Nonetheless, given the large range and high variability in fibre distribution in this population, recovery needs might differ essentially, making certain players more prone to overload and fatigue related injuries than others.

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FATIGUE-INDUCED BIOMECHANICAL RISK FACTORS FOR PATELLAR TENDINOPATHY IN VOLLEYBALL: A PROSPECTIVE STUDY

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Introduction: Patellar tendinopathy (PT) is a highly prevalent overuse injury in volleyball. However, little is known about whether and how fatigue may increase the risk for developing PT through biomechanical alterations during repetitive jump-landing activities in volleyball. Therefore, the objective of this study was to identify fatigue-induced biomechanical risk factors for PT in volleyball during a spike jump-landing.

Methods: Eighty-two male volleyball players were tested pre-season in 2021 with subsequent prospective follow-up for one season. At baseline, three-dimensional full-body kinematics and kinetics were collected while performing a spike jump before and after a volleyball-specific fatigue protocol. Univariate cox regression with competing risk analysis was performed to identify significant predictors for the development of PT ($p<0.05$).

Results: During follow-up, 13 of the 82 players developed PT (16%). For the fatigued biomechanical variables, decreased hip flexion (-7.8°, p=0.026, HR=1.057), increased patellar tendon loading rate (+6.2 x body weight/s, p=0.043, HR=1.049) and increased length of the rectus femoris (+1.3 cm, p=0.005, HR=1.826) and vastus lateralis muscle-tendon unit (+0.3 cm, p=0.048, HR=4.034) were significant contributors for developing PT.

Conclusion: The results of this prospective study suggest that players who utilize a stiffer landing at the hip after fatigue may have an increased risk for developing PT due to the accumulation of tensile forces acting on the patellar tendon.

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DEFICITS IN NEUROCOGNITIVE PERFORMANCE IN PATIENTS WITH CAI PERFORMING A DYNAMIC BALANCE TASK

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Introduction: While the majority of patients recover from an initial lateral ankle sprain and become copers, approximately 40% develop chronic ankle instability (CAI), which includes a recurrent feeling of giving way[1]. Central adaptations have been suggested to partly explain the aetiology and chronic character of CAI[2]. Consequently, deficits in neurocognitive ability may impact musculoskeletal injury incidence rates[3]. Balance tests, which are routinely utilised in clinical practice for injury prevention and return to sport decision-making, lack neurocognitive load seen in the sports context. Therefore, the primary aim was to assess neurocognitive function and balancing ability using the reactive balance test (RBT)[4].

Methods: Patients and healthy controls in this study visited the lab twice. During the first visit, they familiarized themselves with the Y-balance test (YBT) and RBT test procedures. During the second visit, the YBT and RBT were performed on each leg using the same procedures as the first visit. The randomisation used for the Fitlight colours and inter-stimulus time during the RBT differed between the two trials to avoid recall bias and minimise possible learning effects. The inclusion criteria followed the IAC recommendations[5].

Results: This study included 27 patients with CAI and 22 healthy controls. Patients with CAI had similar YBT test scores regardless of stance limb or axis tested compared to healthy controls ($p = 0.455$; composite scores; CAI – most affected side: 87.23cm, CAI – contralateral side: 87.86cm, CON: 84.00cm). The RBT revealed deficits in accuracy in the patient group. However, there were no side-to-side differences for either RBT outcomes (accuracy and visuomotor reaction time) in the patient group ($p = 0.538$; most affected side: 83.12% ± 8.04%, contralateral side: 81.48% ± 8.65%). There were no significant changes between groups for VMRT (CAI - CON: 776.03ms ± 107.77ms, 739.47ms ± 98.43ms, $p = 0.584$).

Conclusion: This study found that patients with CAI performed less accurately than healthy controls during a neurocognitive balance task but maintained similar VMRTs. Also, in this study, patients performed the YBT as well as healthy controls. Based on these findings, neurocognitive stimuli should be added to rehabilitation programs for patients with CAI.

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SCREENING ASSESSMENT, PERCEIVED TRAINING LOAD AND INJURY INCIDENCE IN A YOUNG AND PRESELECTED VOLLEYBALL POPULATION: RESULTS FROM A 10-MONTH OBSERVATION PERIOD USING A RETROSPECTIVE DESIGN

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Introduction: Screening for injury prediction in team sports has been questioned in adult populations, but there is limited research on the relationship between screening and injury incidence in youth volleyball athletes. Additionally, the relationship between perceived training load and injury incidence in this population is unexamined.

Methods: This retrospective study analyzed data from a routine, standardized screening assessment in 46 youth elite athletes aged 12-16 years. Injuries, training partici-

pation, and perceived training load using Borg scores were recorded by the medical team during a 10-month follow-up period. Differences in screening tests between a group with chronic overuse injuries and a group without chronic overuse injuries were explored using a Mann-Whitney U test.

Results: Of the 46 athletes, 29 (63.0%) reported a chronic injury. The injured group scored significantly lower ($p < 0.05$) on the Biering-Sørensen test for both absolute and relative values, but had significantly higher values on various isometric strength tests, including flexion for the left and right leg, and extension for the right leg. These higher values were observed for absolute but not relative values. No significant differences were observed between the groups for perceived training load.

Conclusion: Our findings show equivocal results regarding differences in screening tests between injured and non-injured youth athletes in this population, which is consistent with earlier research in adult athletes. Therefore, screening information at the group level cannot be used to predict future injuries. In addition, perceived training load does not indicate injury susceptibility. Other approaches, such as multifactorial analysis methods or personalized approaches, should be explored to better understand the complex and dynamic nature of injuries.

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UPPER LIMB FUNCTIONAL TESTING: NORMATIVE DATA IN OVERHEAD AND NON-OVERHEAD ATHLETES

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Introduction: Upper limb functional testing has become more and more popular over the last years for its reasonable cost, its speed of implementation and its close links with the sporting gesture. However, there is a lack of normative value for most of the tests described in literature. Therefore, the first objective of this study was to provide normative data for upper limb functional testing in handball and rugby players. The second objective was to determine the influence of age and sport (handball vs rugby) on the results obtained.

Methods: A total of 81 healthy sportspeople (17.8 ± 3 years; 178.7 ± 7.7 centimeters; 77.2 ± 15.2 kilo's) were recruited. They were classified in two categories according to their age (14-18 years or 18- 25 years) and their sport (handball or rugby). They performed a battery of upper limb functional tests, including the *Single Arm Medicine Ball Throw* (SAMBT), the Modified-*Athletic Shoulder Test* (M-AST), the *Upper Limb Rotation Test* (ULRT), the *Closed Kinetic Chain Upper Extremity Stability Test* (CKCUEST) and the *Countermovement push-up* (CMPU). Isometric shoulder rotators strength was also measured in a supine position, shoulder at 90° of abduction, with a handheld dynamometer.

Results: Significant differences were highlighted in upper limb performance according to the sport practiced ($p<0.05$) and the age category ($p<0.05$). High and significant correlations were found between isometric shoulder rotators strength and the SAMBT ($r= 0.71$) ($p<0.05$) in adolescent handball players or the M-AST ($r = 0.68$-0.87) ($p<0.05$)

in all athletes. No correlation was observed between the other tests and isometric shoulder rotators strength as well as between the functional tests themselves.

Conclusion: Normative data and cut-offs were provided for the different functional tests in both populations (handball and rugby) and age groups (14-18 and 18-25 years). These data will help clinicians in interpreting the values in an objective of performance, primary prevention or return to play decision.

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THE EFFECT OF BLOOD FLOW RESTRICTION TRAINING ON QUADRICEPS ACTIVITY AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRCUTION.

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Introduction: The main objective of this study was to evaluate whether quadriceps strengthening with low load blood flow restriction (BFR) improves electromyographic (EMG) activity of the vastus medialis, vastus lateralis, and rectus femoris similarly to quadriceps strengthening using heavy load. The secondary objective was to assess within-quadriceps regional EMG differences among the three muscle heads.

Methods: This case-control study included 27 patients with a primary non-contact anterior cruciate ligament injury reconstructed with hamstring graft 3 months after surgery (101.9 ± 18.4 days). The control group (n = 14) performed heavy load knee extensions at 80% of maximal voluntary isometric contraction (MVIC), while the experimental group (n = 13) performed the same exercise with low load (30% MVIC) combined with BFR with 80% of limb occlusion pressure. (1,2) Patients performed one set of 12 knee extension repetitions to measure surface EMG activity of the vastus medialis, vastus lateralis, and rectus femoris After root mean square (RMS) treatment of the raw signal, RMS EMG results were normalized by MVIC activity to allow inter-subject comparability, and are thus shown as %MVIC.

Results: Univariate between-group analysis showed a significantly increase in RMS EMG for the control group compared to the BFR group for the rectus femoris (50.5%MVIC ± 14.6 vs 36.7%MVIC ± 17.4, p = 0.01, Cohen's d = 0.87),the vastus medialis (56.3%MVIC ± 19.1 vs 31.0%MVIC ± 18.1, p = 0.002, Cohen's d = 0.87), and the vastus lateralis (59.8%MVIC ± 23.0 vs 29.5%MVIC ± 19.1, p = 0.002, Cohen's d = 1.35). No significant differences were observed between rectus femoris and vasti muscles in both the BFR (p = 0.89) and the control group (p = 0.12).

Conclusion: These findings indicate that high load resistance training increased significantly quadriceps RMS EMG amplitude in all the three examined muscle heads, as compared to the low load BFR group. The results may be too preliminary to draw definitive conclusions about BFR and quadriceps activity after ACLR.

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BICEPS FEMORIS PROXIMAL MYOTENDINOUS JUNCTION SIZE IS ASSOCIATED WITH HAMSTRING STRAIN INJURY HISTORY AND HAMSTRING ENDURANCE IN MALE SOCCER PLAYERS – A CASE CONTROL STUDY USING MAGNETIC RESONANCE IMAGING

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Introduction: Hamstring strain injuries (HSI) are very common in athletes exposed to repeated high speed running. Previous research established that architectural features might play a crucial role in the muscle's injury risk. Most muscle lesions occur at level of the Biceps Femoris Long Head's (BF_{LH}) proximal myotendinous junction (MTJ), which has never been subject of morphological research in the light of HSI or athletic performance capacity before. This study intended to explore the role of the BF_{LH}'s proximal MTJ size in hamstring injury susceptibility and athletic performance by means of a case control study.

Methods: 15 male soccer players with a history of hamstring strain injury (HSI) and 16 matched controls were submitted to a comprehensive assessment protocol consisting of Magnetic Resonance Imaging (MRI; T1 sequences) to evaluate the morphology of the proximal MTJ of the BF_{LH} and a hamstring strength analysis (isokinetic hamstring strength and hamstring endurance (Single Leg Hamstring Bridge test (SLHB) and isokinetic strength).

Results: Athletes with a HSI history (HSIH) presented significantly smaller MTJ widths (6.90mm ± 0.89mm) compared to the controls (9.94 mm ± 0.93mm) ($p = 0.042$). HSIH was also associated with weaker bilateral strength endurance (26 versus 38 SLHB repetitions, $p = 0.019$), whereas no isokinetic strength differences could be identified based on HSIH. The athlete's SLHB score presented a significant positive correlation with the BF_{LH}'s Proximal MTJ geometry ($p=0.014$, Spearman's $Rho=0.456$), whereas no association with isokinetic strength was found.

Conclusion: HSIH is associated with smaller proximal MTJ size in the BF_{LH} and hamstring endurance deficits, potentially highlighting the importance of the magnitude of the MTJ's muscle-tendon contact surface, possibly providing the BF_{LH} with more passive stiffness and strength contribution capacity, protecting it against HSI. The SLHB seems to be a valuable functional test and should be promoted in prevention.

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