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Examination of Hamstring Eccentric Muscle Strength and Limb Asymmetry with Nordbord Device

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Abstract

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Aim: The aim of this study was to investigate the hamstring eccentric muscle strength and limb asymmetry in young football players.
Materials and Methods: 30 licensed healthy players who competed in the U17 and U19 Elite academy league of Istanbul Başakşehir Football Club participated in the study. Eccentric hamstring strength and limb asymmetry values were assessed while performing nordic hamstring exercise using NordBord device (Vald Performance, Newstead, Australia).
Results: Right hamstring eccentric force ($r = -0.007$, $p = 0.971$) and mean force ($r = -0.195$, $p = 0.303$) have low and non-significant correlations with asymmetry. Left hamstring strength ($r = -0.381$, $p = 0.038$) has significant but negative correlations with asymmetry. There is no correlation between torque and asymmetry ($p > 0.05$).
Conclusion: One of the factors that reduces injury in eccentric knee flexor muscle groups is the absence of strength imbalance between the legs. Although there is no consensus on an ideal minimum value for asymmetry, some experts suggest that it should be below 15%. In our study, the asymmetry values of U17 and U19 football players (30 males) were found well below the value (8,55 ± 5,13) recommended by the experts. The low correlation results between right muscle strength and asymmetry in our study indicate that right hamstring muscle strength does not notably effect the asymmetry of the players. In contrast, it was found to have an effect on asymmetry for the left hamstring muscle group strength.

Nordbord Cihazı ile Hamstring Eksantrik Kas Kuvveti ve Ekstremite Asimetrisinin İncelenmesi

Özet

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Anahtar Kelimeler:
Futbol, Nordic Curl, Hamstring, Asimetri, Eksantrik Kuvvet.

Amaç: Çalışmada genç futbol oyuncularında hamstring eksantrik kas kuvveti ve ekstremite asimetrisi arasındaki ilişkinin gösterilmesi amaçlanmıştır.
Gereç ve Yöntemler: İstanbul Başakşehir Futbol Kulübü'nün U17 ve U19 Elit akademi liginde mücadele eden, gerekli sağlık kontrollerinden geçmiş sağlıklı 30 lisanslı oyuncu çalışmaya katılmıştır. NordBord cihazı (Vald Performans, Newstead, Australia) kullanılarak nordik hamstring egzersizi ile eksantrik hamstring kas kuvvetine ve ekstremite asimetri değerlerine bakılmıştır.
Bulgular: Sağ hamstring eksantrik kuvveti ($r = -0.007$, $p = 0.971$) ile asimetri ve ortalama kuvvet ($r = -0.195$, $p = 0.303$) ile asimetri düşük ve anlamlı olmayan korelasyonlara sahiptir. Sol hamstring kuvveti ($r = -0.381$, $p = 0.038$) ile asimetri arasında ise anlamlı fakat negatif yönlü korelasyon vardır. Torque değerleri ile asimetri arasında bir korelasyon bulunmamıştır ($p > 0.05$).
Sonuç: Diz fleksör kas gruplarında yaralanmayı azaltan faktörlerden biri bacaklar arasında kuvvet dengesizliğinin olmamasıdır. Asimetri için ideal bir minimum değer üzerinde fikir birliği olmamasına rağmen, bazı uzmanlar %15'in altında olması gerektiğini önermektedir. Bizim çalışmamızda futbolcuların (30 erkek) ortalama asimetri değerleri, bazı uzmanlar tarafından önerilen değerin oldukça altında (8,55 ± 5,13) bulunmuştur. Çalışmamızda sağ hamstring kas kuvveti ile asitmetri arasındaki düşük korelasyon sonuçları, hamstring sağ kas kuvvetinin asimetri üzerinde belirgin bir etkisi olmadığını göstermektedir. Buna karşılık sol hamstring kas grubu kuvvetinin asimetriye negatif etkisi olduğu görülmüştür.

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Introduction

The importance of the hamstring muscles strength in daily and sports activities has long been recognized. Knee flexor and extensor strength rates as the hamstring/ quadriceps ratios plays a crucial role in stability. The hamstring/quadriceps ratios differ for professional athletes in various sports but are less open to interpretation in terms of the hamstring muscles (Kellis, Sahinis ve Baltzopoulos, 2023). Measurement of hamstring muscle strength with isokinetic muscle strength devices is considered as the gold standard. Isokinetic devices are used to measure various parameters such as angular velocity, active or passive muscle movements, range of motion, limb to limb differences in muscle strength and contraction quality. Knee muscle strength could be evaluated during the eccentric Nordic Hamstring exercise (NHE) with the test method for isokinetic dynamometers. Eccentric muscle strength training regimes are of great clinical importance in terms of preventing possible injuries that may occur during sports or daily life. Furthermore research aimed at reducing the risk of injury by improving eccentric muscle strength are common in recent years especially for after anterior cruciate ligaments injuries (Da Silva, Maior, 2022; Diker et al., 2022).

Isokinetic dynamometry tests are considered reliable and commonly employed technique for muscle strength measurements (Dvir et al., 2019). It's widely used due to it's consistant measurements for both eccentric and concentric force production. There are studies which have included both isokinetic devices and constant angular velocity/resistance tools and many of them have explored the relationships between eccentric, consentric force and other determinants of muscle performance and strength characteristics. Devices capable of assessing metrics like force-length dynamics have contributed to both laboratory and field-based scientific inquiry.

The Nordic Board device is a validated tool to assess the eccentric strength of hamstring derived from isometric contractions. It's accepted as a realiable method to test eccentric muscle strength of knee flexors in athletes. Being a portable and costeffective device which provide accurete measurements is an advantage for field tests (Opar et al., 2013). Additionaly Nordic Board assessments can be integrated more evaluation protocols for other muscle groups as needed (Claudino, Filho, Bittencourt et al., 2021). Strength assessments were acquired via a static muscle model across the full range of motion providing data with an angle sensor and pad contact forces. (Horst et al., 2015; Attar et al., 2017).

Sprints in football are intermitent and involve rapid accelaration. The ability of sprinting capabilities are essential for the effective execution of both offensive and defensive strategies. Football heavily relies on sprinting which is a crucial movement during games, demanding robust lower limb muscles. The hamstring muscle groups exhibits a critical biomechanical engagement during accelaration phase of sprinting. Periodic assessment of hamstring muscles in young football players facilitates talent recognation and implement progressive developmental interventions. The literature provides a substantial body of research which addressed the subject of eccentric muscle strength but hamstring muscle strength topic remains highly prominent within current academic researches (Diker et al., 2022 ; Penailillo et al., 2016).

All limb muscles should interplay a synergetics to ensure precise movements during football games. This harmonious interaction would benefit both for performance and to reduce the risk of injury. The

literature demonstrates that eccentric exercise regimens generate exercise induced muscle damage in young populations as those observed in adults (Deli et al., 2017). Hence, trainings prioritizing resistive exercise protocols reveals a restricted influence on pain attenuation. One dimensional muscular resistance fail adequately for athletic pursuits involving dynamic and prolonged patterns. Implementation of eccentric biased training is imperative to avert the development of muscle weakness. Although the established benefits of resistance training, investigations into eccentric muscle contractions remain limited. Despite the extensive research available on eccentric hamstring training,

A significant amount of research has explored eccentric hamstring strength on athletes participating in various sports disciplines and non-injured subjects (Claudino et al., 2021; Gürühan, 2018; Ercan, 2018). The distribution of muscle forces within the hamstring musculature during contraction has been a foundational aspect of planning eccentric training protocols. The incidence of hamstring strain injuries is highest among non-contact injuries, which constitues 12% of all injuries (Ekstrand et al., 2011). The long head of the biceps femoris muscle is identified as the highest incidence of injury and subject to peak levels of mechanical stress during sports within atletic populations. Hamstring strain injuries (HSI) occur predominantly during high velocity sprints in football matches with a percentage of 60-80% (Timmins et al., 2016; Woods et al., 2004). Hence, intrinsic risk factors are crucial determinants of hamstring strain injuries. In terms of alterable risk factors, musculoskeletal imbalance is reported as one of the three risk factor for non-contact injuries by professionals engaged with elite football clubs (McCall et al., 2015; Meurer et al., 2017). Despite musculoskeletal imbalance is a comprehensive concept, the imbalance of force production between knee flexor and extensor muscles has served as the principle subject of hamstring strain injuries (Ishøi et al., 2021; Fritsch et al., 2023). The continuous assessment of strength imbalances, along with other modifiable factors, throughout the competitive season could enhanced insights into the linkage between H:Q ratio and injury (Kellis et al., 2021)

Common parameters for quantifying eccentric strength are typically peak force, average force, peak torque and average torque (Rhodes et al. 2018). In particular, further research needed to explore how asymmetry effects loading in hamstring muscles. The evaluation of asymmetry and hamstring strength in football players which is associated with the performance and injury highlight the importance of this research. It's critical to address the knowledge gaps for enhancing a players performance while preventing injury risk. Therefore a new perspective to the literature in this issue which analyze the correlations between asymmetry and strength and torque would be beneficial. In this current study hamstring muscle strength, bilateral limb asymmetry and torque of young football players were investigated with a Nordboard device during Nordic curl movement. The objective of this research is to define the correlation between hamstring eccentric muscle strength and limb asymmetry among regularly training young football players.

Methods

Participants:

This study included 30 licenced healthy football player of İstanbul Başakşehir Football Club U17-U19 Elite League (age: 17,3 ± 0,53 years, height: 179,6 ± 7,62 cm, weight: 71,44 ± 6,60 kg). Any player who reported an injury, any known chronic diseases or musculoskeletal disorders was excluded from the study.

All players were training five days per week in the elite league. This study was conducted with the approval of the Ethical Review Committee of Marmara University (Ethics approval number: 09.2024.284 and date 09.02.2024). 28 of 30 participants dominant limb were right in the study. Study procedures were explained to the participants, and each participant provided a written informed consent before participation in the study.

Data Collection Process

All measurements were collected before the morning training. Participants performed warm-ups consisting of 5 min light running and 5 min mobility exercises (side shuffles, high knees, butt-kicks, skipping, and front-back and side-side leg swings and jumps). Before the measurement the nordic hamstring exercise explained to participants and the participants attended a familiarization session. A single set of three hamstring strength tests was performed for data collection.

Height and body mass were obtained by a meter and Tanita MC 780 MA bioimpedance analyzer. Force output scores (N) and asymmetry (limb strength imbalances during the lowering eccentric phase of nordic hamstring exercise) were measured with NordBord device (Vald Performance, Newstead, Australia) while each participant was placed in a kneeling position on the device. Participants were instructed to maintain a neutral position of the hip and spine while gradually leaning forward toward the ground at the slowest possible speed, with their hands held across their chest. The players were required to perform one set of three repetitions of the Nordic Hamstring Exercise. The force data were recorded with the NordBord application (Software from Vald Performance NordBord) at the 50 Hz sample rate. The peak bilateral force output (N) scores which was the highest force, from the three repetitions, were analyzed.

Data analysis

Normal distribution of the data were tested with Kolmogorov-Smirnov and Shapiro-Wilk test. Significance level was set at $p<0.05$. Pearson's correlation coefficient was applied to research data to measure the degree of association between force, torque and asymmetry. Datas analyzed in SPSS 18 (IBM Corp., Armonk, NY) and Microsoft Office Excel Softwares.

Results

30 Football players completed all the tests. Participants demographic data presented in Table 1. All data are given in mean and standard deviation.

Table 1. Descriptive data of the participants. Presented as mean with standart deviations

Variable	Mean ± SD
Age (years)	17,3 ± 0,52
Height (cm)	179,76 ± 7,62
Body Mass (kg)	71,44 ± 6,60
Body Mass Index (kg/m²)	22,08 ± 1,12

SD: Standad Deviation, cm: centimeter, kg:kilogram, kg/m²:kilogram/square meter

Peak force of right/left hamstring, peak bilateral force (N) and mean force of right/left hamstring, mean bilateral force (N) scores are presented in Table 2.

Table 2. Hamstring strength for limbs and asymmetry, represented mean and standart deviations

Variable	Mean ± SD
Hamstring Peak Force Right (N)	344,22 ± 67,69
Hamstring Peak Force Left (N)	324,85 ± 63,95
Hamstring Peak Force avg (N)	335,29 ± 63,75
Hamstring Asymmetry (%)	8,55 ± 5,13
Hamstring mean Force Right (N)	328,06 ± 75,07
Hamstring mean Force Left (N)	302,06 ± 65,74
Hamstring Mean (N)	305,57 ± 85,88

SD: Standad Deviation, N:Newton

Table 3 shows the Pearson's correlations between force, torque and asymmetry on each test scores. Right hamstring strength had positive correlations with left hamstring strength ($r = .903$, $p < .001$), and mean force ($r = .977$, $p < .001$) as well as with Torque-Right ($r = .874$, $p < .001$), Torque-Left ($r = .788$, $p < .001$) and Torque-mean ($r = .856$, $p < .001$). There is no significant correlation between hamstring right peak force and asymmetry .

Table 3. Correlations between hamstring strength, torque and asymmetry

	Hamstring Peak Force Right (N)	Hamstring Peak Force Left (N)	Hamstring Peak Force-mean	Hamstring Asymmetry (%)	Torque-Right (NM)	Torque-Left (NM)	Torque - mean (NM)
Hamstring Peak Force-Right	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Hamstring Peak Force-Left	.903** <.001	-- --	-- --	-- --	-- --	-- --	-- --
Hamstring Peak Force-mean	.977** <.001	.974** <.001	-- --	-- --	-- --	-- --	-- --
Hamstring Asymmetry (%)	-0,007 0,971	-.381* **0,038**	-0,195 0,303	-- --	-- --	-- --	-- --
Torque- Right (NM)	.874** <.001	.759** <.001	.839** <.001	0,112 0,555	-- --	-- --	-- --
Torque-Left (NM)	.788** <.001	.876** <.001	.852** <.001	-0,286 0,126	.892** <.001	-- --	-- --
Torque - mean (NM)	.856** <.001	.840** <.001	.869** <.001	-0,084 0,659	.974** <.001	.971** <.001	-- --

r: Pearson Correlation, p: Sig. (2-tailed), N: Newton, NM: Newton Meter, %: Percent

Left hamstring strength had high positive correlations with right hamstring strength ($r = .903$, $p<.001$) and mean strength ($r = .974$, $p < .001$) as well as Torque-Right ($r = .759$, $p < .001$), Torque- Left ($r=.876$, $p < .001$) and Torque mean ($r = .840$, $p < .001$). Asymmetry was significantly but negatively correlated with left leg strength ($r = -0.381$, $p = 0.038$).This finding suggests that left leg hamstring strength also has an important role on asymmetry. No significant correlation was seen with right leg strength ($r = -0.007$, $p = 0.971$) and mean force ($r=-0.195$, $p = 0.303$) $p> 0,05$. Torque-Right ($r = 0.112$, $p = 0.555$) had non-significant correlations with Torque-Left ($r = -0.286$, $p = 0.126$) and Torque-mean ($r = -0.084$, $p = 0.659$).

Discussion and Conclusion

Football involves high intensity activities, like sprinting, jumping and rapid turns which subjects the hamstring to high level of stress. Studies have shown potential links between asymmetry and sports performance like jumping, agility and running (Parkinson 2021, Bishop 2022). The Nordboard test provides a reliable measurement to examine both strength and extremity asymmetry (Markovic et al., 2021). Comparing peak force between each limb plays a critical role in balance and symmetry analysis. In this

current study there is no significant difference between the extremities for eccentric hamstring strengths. The hamstring strength results measured during Nordic exercise in our study are consistent with a previous study in young soccer players (Ferguson 2024).

Previous studies investigated strength asymmetry between limbs and the impact on the sports performance (Parkinson, 2021, Bishop, 2022). While some of the studies in the literature did not find a relationship between lower extremity asymmetry and hamstring strength, in a study conducted in soccer players, it was reported that strength imbalances dramatically elevates the chances of hamstring injury (Croisier et al., 2008). One of the factors that reduce injury in eccentric knee flexor muscle groups is the lack of power imbalance between the legs. Although there is no consensus on an ideal minimum value for asymmetry, a recent prospective study by Bourne et al. in rugby union demonstrated that Nordic hamstring test imbalances greater than 15% correlated with increased hamstring injury incidence (Bourne et al., 2015). In our study, it was determined that the asymmetry values in U17 and U19 soccer players (N=30) were low (8,55 ± 5,13). This finding reveals that developing similar scores of strength in both legs is effective in reducing asymmetry.

A deficiency in eccentric knee flexor strength as assessed through the Nordic hamstring exercise found to be a factor for increased hamstring strain injury in elite soccer players (Timmins et al., 2016). In terms of injury prevention, identifying muscle strength and performance asymmetries is recognised as and effective approach to predict increased injury risk. The study by Sýkora (2024) aimed to analyze the incidence of eccentric and isometric hamstring strength asymmetries among U19 elite youth soccer players in Slovakia that findings revealed a high prevalence of hamstring strength asymmetries. Specifically 47% of the players exhibited more than 10% strength imbalance between their limbs at least one of the tests. Given that a strength difference exceeding 10% in the tests is considered as a risk factor for sports-related injuries. The results suggest that physical training interventions focused on to reduce inter limb differences for athletes with high asymmetry scores may be an important part of injury preventon strategies (Sýkora, 2024). Contrary to prior research, it's been reported in literature that strength imbalance was not considered as a risk factor for future injury (Timmins et al., 2016).

The findings of the current study showed a negative correlation between left hamstring muscle strength and asymmetry. Soccer players often prefer to utilize their dominant limb as the primary for ball manipulation, such as kicking and passing. However the non-dominant limb provides a supportive role for postural stability (Wong et al.2007). The correlation between left hamstring strength and asymmetry in this study may be due to the players dominant limb is mostly right limb.

More studies are needed to elucidate the underlying causes of asymmetry in strength and torque. Schache et al. concluded that regular assessment of isometric maximal voluntary contraction asymmetry would help to detect symptoms related to the presence of hamstring strains due to the effect of training loads (Schache, 2012). With this approach, the potential risk of injury will be eliminated before it occurs. According to the results of this study, it can be suggested that coaches should add leg strength training to the traning programs specifally to the weaker limb of the players since less asymmetry is desirable condition to decrease future injury risk for professional players.

It's been demonstrated that athletes showing muscle imbalances have a significant reduction in peak concentric and eccentric hamstring torque (Ardern et al. 2015). We have tested players' peak torque and findings demonstrated that right peak torque has significantly correlated with right and left hamstring peak force. Hence there is no correlation between torque and asymmetry. In this study, the level of imbalance in strength is well below that can generate a decrement in torque. It can be due to all players has the same level of physical activity and same training regime for at least six months duration. More studies are needed to demonstrate the training effect on asymmetry with higher populations and same training with longer durations.

The findings of the current study will provide data for the coaches to guide the improvement of the training regimens on the hamstring strength performance. Initially the peak force scores of our study augment descriptive data to the existing literature about professional young football players. Additionally this research emphasize the importance of tracking the direction of asymmetry between extremities. Identifying the persistent limb asymmetries enables coaches for targeted trainings of the weaker limbs.

Limitations :

- We included only one football team in the study.
- The positional differences of the players couldn't be examined to analyse the limb asymmetries.
- The age and playing level related increases in hamstring imbalance couldn't be established due to same age and playing level of participants included in the study.

Suggestions

- Long term follow up studies can be conducted on the muscle strength and the asymmetry to better understand how changes occur over time.
- Researches comparing the effects of different training programs on hamstring eccentric muscle strength and asymmetry would be helpfull to determine the more effectice training programs.
- Including larger populations and participants in various physical fitness levels in this area of research would increase the validation of the results.

References

Ardern CL, Pizzari T, Wollin MR, Webster KE. Hamstrings strength imbalance in professional football (soccer) players in Australia. (2015). Journal of Strength and Conditioning Research. Apr;29 (4):997-1002. doi: 10.1519/JSC.0000000000000747. PMID: 25426513.

Attar, W.S.A.A, Soomro, N., Sinclair, P.J., Pappas, E., Sanders, R.H. (2017). Effect of Injury Prevention Programs that Include the Nordic Hamstring Exercise on Hamstring Injury Rates in Soccer Players: A Systematic Review and Meta-Analysis. National Library of Medicine; 47(5):907-916.

Bishop ,C., Manuel, J., Drury, B., Beato, M., Turner, A. (2022). Assessing Eccentric Hamstring Strength Using the NordBord: Between-Session Reliability and Interlimb Asymmetries in Professional Soccer Players. Journal of strength and conditioning research. Jun 27, 2022. Epub Jun 27, 2022. DOI: 10.1519/JSC.00000000000004303

Bishop, C., Read, P., McCubbine, J., and Turner, A. (2021). Vertical and horizontal asymmetries are related to slower sprinting and jump performance in elite youth female soccer players. Journal of Strength and Conditioning Research 35 (1), 56–63. doi:10.1519/JSC. 0000000000002544

Bourne MN, Opar DA, Williams MD, Shield AJ. Eccentric Knee Flexor Strength and Risk of Hamstring Injuries in Rugby Union: A Prospective Study. The American Journal of Sports Medicine. (2015). 43(11):2663-2670. doi:10.1177/0363546515599633

Claudino, J. G., Filho, C. A. C., Netto Bittencourt, N.F., Gonçalves, L.G., Couto, C.R., Quintão, R.C., Reis, G.F., Oliveira Júnior,O., Amadio, C.A., Boullosa, D., Júlio Cerca Serrão,J.C. (2021). Eccentric Strength Assessment of Hamstring Muscles with New Technologies: a Systematic Review of Current Methods and Clinical Implications. Sports Medicine- Open. 7(1):10 . Doi. 10.1186/s40798-021-00298-7

Croisier, J. L., Ganteaume, S., Binet, J., Genty, M., & Ferret, J. M. (2008). Strength imbalances and prevention of hamstring injury in professional soccer players: A prospective study. The American journal of sports medicine, 36(8), 1469–1475. https://doi.org/10.1177/0363546508316764

Da Silva, G. H., & Maior, A. S. (2022). An assessment of isometric muscle strength and the hamstring: quadriceps ratio among males trained with free weights vs. Machines. Baltic Journal of Health and Physical Activity, 14(2), 6, https://doi.org/10.29359/BJHPA.

Deli CK, Fatouros IG, Paschalis V, Avloniti A. (2017). A comparison ofexercise-induced muscle damage following maximal eccentriccontractions in men and boys. Pediatric exercise science.;29:316-326.

Diker, G., Struzik, A., Ön, S., & Zileli, R. (2022). The relationship between the hamstring-to-quadriceps ratio and jumping and sprinting abilities of young male soccer players. International Journal of Environmental Research and Public Health, 19(12), 7471.

Dvir, Z.; Müller, S. (2019). Multiple-Joint Isokinetic Dynamometry: A Critical Review. Journal of Strength and Conditioning Research, *00*, 1–15.

Ercan, A. (2018). Hamstring Kası Yaralanması Geçirmiş Olan Profesyonel Futbolcularda FMS ve Nordbord Skorlarının Karşılaştırılması. Yüksek Lisans Tezi. İstanbul. Bahçeşehir Üniversitesi. Sağlık Bilimleri Enstitüsü.

Ekstrand J, Hägglund M, Waldén M. (2011). Epidemiology of Muscle Injuries in Professional Football (Soccer) The American Journal of Sports Medicine.;39(6):1226-1232.

Ferguson, J., Gibson, N. V., Weston, M., & McCunn, R. (2024). Reliability of Measures of Lower-Body Strength and Speed in Academy Male Adolescent Soccer Players. The Journal of Strength & Conditioning Research, 38(3), e96-e103.

Fritsch, C. G., Dornelles, M. P., Oliveira, G. D. S., & Baroni, B. M. (2023). Poor hamstrings-to-quadriceps torque ratios in male soccer players: weak hamstrings, strong quadriceps, or both?. Sports Biomechanics, 22(7), 811-821.

Gürühan, S. (2018). Sağlıklı Bireylerde Farklı Eksentrik Hamstring Egzersizleri Sırasındaki Kassal Aktivasyonların İncelenmesi. (Yayımlanmamış Yüksek Lisans Tezi). Ankara. Gazi Üniversitesi, Sağlık Bilimleri Enstitüsü.

Horst, N.V., Smits D.W., Petersen, J., Goedhart, E.A., Backx, F.JG, (2015). The preventive effect of the nordic hamstring exercise on hamstring injuries in amateur soccer players: a randomized controlled trial. The American Journal of Sports Medicine. 43(6):1316-23.

Ishøi, L., Krommes, K., Nielsen, M. F., Thornton, K. B., Hölmich, P., Aagaard, P., Penalver Juan J.J, Thorborg, K. (2021). Hamstring and quadriceps muscle strength in youth to senior elite soccer: a cross-sectional study including 125 players. International Journal of Sports Physiology and Performance, 16(10), 1538-1544.

Kellis, E., Sahinis, C., & Baltzopoulos, V. (2023). Is hamstrings-to-quadriceps torque ratio useful for predicting anterior cruciate ligament and hamstring injuries? A systematic and critical review. Journal of Sport and Health Science, 12(3), 343-358.

Kellis, E., Sahinis, C., Dafkou, K., Ellinoudis, A., & Galanis, N. (2021). Hamstring to quadriceps strength ratio and cross-sectional area of the quadriceps and hamstrings muscles assessed using extended field-of-view ultrasonography. Research in Sports Medicine, 29(1), 25-42.

Markovic, G.; Sarabon, N.; Boban, F.; Zoric, I.; Jelcic, M.; Sos, K.; Scappaticci, M. Nordic Hamstring Strength of Highly Trained Youth Football Players and Its Relation to Sprint Performance. Journal Strength Conditioning and Research, 2020, 34, 800–807.

Mccall, A., Carling, C., Davison, M., Nedelec, M.L.E., Gall, F, Berthoın, S., & Dupont, G. (2015). Injury Risk Factors Screening Tests and Preventative Strategies: A Systematic Review of The Evidence That Underpins the Perceptions and Practices of 44 Football (Soccer) Teams from Various Premier Leagues. British Journal of Sports Medicine, 49(9), 583-589. http://dx.doi.org/10.1136/bjsports-2014-094104

Meurer, M. C., Silva, M. F., & Baroni, B. M. (2017). Strategies for injury prevention in Brazilian football: Perceptions of physiotherapists and practices of premier league teams. Physical Therapy in Sport, 28,1–8. doi:10.1016/j.ptsp.2017.07.004

Opar, DA, Piatkowski, T, Williams, MD, and Shield, AJ. (2013). A novel device using the Nordic hamstring exercise to assess eccentric knee flexor strength: A reliability and retrospective injury study. The Journal of Orthopaedic & Sports Physical Therapy. 43: 636–640.

Rhodes, D., McNaughton, L., Greig, M. (2018). The temporal pattern of recovery in eccentric hamstring strength post-soccer specific fatigue. Research in Sports Medicine, 27 (3), 339–350.

Parkinson, A.O., Apps, C.L., Morris J.G., Cleveland T. B., Lewis M.G.C. (2021) The Calculation, Thresholds and Reporting of Inter-Limb Strength Asymmetry: A Systematic Review. Journal of Sports Science and Medicine (20), 594 - 617. https://doi.org/10.52082/jssm.2021.594

Penailillo, L., Espildora, F., Jannas-Vela, Sebastian, Mujika, I., Zbinden-Foncea, H. (2016). Muscle Strength and Speed Performance in Youth Soccer Players. Journal of human kinetics PMCID: PMC5260655 PMID: 28149358

Sýkora, J. (2025). The incidence of eccentric and isometric hamstring strength asymmetries among U19 youth elite soccer players in Slovakia. Slovak Journal of Sport Science - Vol. 9, Iss: suppl.,124-131

Schache, A.G.; Dorn, T.W.; Blanch, P.D.; Brown, N.A.; Pandy, M.G.(2012) Mechanics of the human hamstring muscles during sprinting. Medicine & Science in Sports & Exercise, 44, 647–658

Timmins, R.G.; Bourne, M.N.; Shield, A.J.; Williams, M.D.; Lorenzen, C.; Opar, D.A.(2016) Short biceps femoris fascicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): A prospective cohort study. British journal of sports medicine., 50, 1524–1535

Woods, C., Hawkins, R. D., Maltby, S., Hulse, M., Thomas, A., & Hodson, A., & Football Association Medical Research, P. (2004). The Football Association Medical Research Programme: An audit of injuries in professional football–analysis of hamstring injuries. British Journal of Sports Medicine, 38,36–41. doi:10.1136/BJSM.2002.002352

Wong, P.-L., Chamari, K., Chaouachi, A., Mao De, W., Wisloff, U., & Hong, Y. (2007). Difference in plantar pressure between the preferred and non-preferred feet in four soccer-related movements. British Journal of Sports Medicine, 41(2), 84–92. doi:10.1136/ bjsm.2006.030908

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