

Technology For Screening Potency Risk Hamstring Strain Injury (HIS) Through Muscle Strength Test: Systematic Review

Tecnología para la detección del riesgo de lesión por distensión del tendón de la corva (HIS) a través de la prueba de fuerza muscular: revisión sistemática

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Abstract. Athlete own risk more injuries many compared to common people. The hamstring muscle is part important body used for running, jumping, and kicking. Required a technology that can measure hamstring strength and help the rehabilitation process. Nordbord is one of the technology available measure strength maximal, average, hamstring asymmetry with accurate and objective. Purpose from use Nordbord as test hamstring muscles for measure, improve, train, and prevent potency risk hamstring injury. Study this use method *Preferred Reporting Items for Systematic Review and Meta-Analysis* (PRISMA). Search the resources needed using an electronic site search program as Spingerlink, Emerald, Google Scholar, PubMed, and ScienceDirect with time rise with range 6 years time last (2016 – 2022). Criteria inclusion, study about screening potency risk injury ACLs and HIS with Nordbord. and criteria exclusion, only abstract, articles that do not published in a journal scientific. The result of this study is the Nordbord muscle strength test could be used to measure the power of the Nordic hamstring (eccentric) in a maximum manner with the formula $(N) = 4 \times BM \text{ (kg)} + 26.1$ and isometric, the more asymmetry results in a high potential injury risk.

Keywords: Hamstring, asymmetry, muscle strength test, eccentric.

Resumen. El propio atleta corre el riesgo de sufrir más lesiones en comparación con la gente común. El músculo isquiotibial es una parte importante del cuerpo que se usa para correr, saltar y patear. Se requiere una tecnología que pueda medir la fuerza de los isquiotibiales y ayudar en el proceso de rehabilitación. Nordbord es una de las tecnologías disponibles para medir la fuerza máxima, promedio, asimetría de los isquiotibiales con precisión y objetividad. Propósito de usar Nordbord como prueba de los músculos isquiotibiales para medir, mejorar, entrenar y prevenir lesiones en los isquiotibiales de riesgo de potencia. Estudie este método de uso *Preferred Reporting Items for Systematic Review and Meta-Analysis* (PRISMA). Busque los recursos necesarios utilizando un programa de búsqueda de sitios electrónicos como Spingerlink, Emerald, Google Scholar, PubMed y ScienceDirect con un aumento de tiempo con un rango de 6 años por última vez (2016 - 2022). Criterios de inclusión, estudio sobre cribado de LCA y HIS con riesgo de lesión de potencia con Nordbord. y criterios de exclusión, solo resumen, artículos que no estén publicados en una revista científica. Resultado del estudio, esta es la prueba de fuerza muscular que Nordbord podría usar para medir la potencia de los isquiotibiales nórdicos (excéntricos) de una manera máxima con la fórmula $(N) = 4 \times BM \text{ (kg)} + 26.1$ e isométrica, cuanto mayor sea la asimetría, mayor será el riesgo potencial de lesión.

Palabras clave: isquiotibiales, asimetría, prueba de fuerza muscular, excéntrico.

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Introduction

Physical exercise has many benefits for improving health and fitness (Ayubi., et al. 2023; Kusnanik et al., 2023; Handayani et al., 2023). But on the other side, athletes have a greater risk of injury compared to ordinary people (Komaini et al., 2021). Good conditions become demands or stress experienced an athlete, fine in a manner physical at the time of practice or competition, and pressure or in a manner psychology not only could influence the performance athlete but also can influence condition health and risk for happening injury (Kurniawan et al., 2021). Hamstring injuries most often occur in sports that involve rapid movement, stretching, or acceleration, especially when the hamstring muscle is contracted eccentrically (when the muscle lengthens while contracting). Several sports that are often associated with hamstring injuries are football, basketball, rugby, swimming, tennis and running. Activity in sports own level risk very high injury and become frequent cases found, injured sport (Sport Injury) all type injuries incurred, both at the time practice nor at time exercise (competition) or after do competition

(Akbar et al., 2021). Injury to athletes often raises consequence negative, fine in a manner physical nor psychologically, a lot competition sports held every he year, demanded the athletes for Keep going practice, with risk more injuries tall than normal sportsmen (Ambarani et al., 2021). Nordbord technology is a device developed to measure muscle strength and provide accurate and objective data on muscle performance. Norbord works by using sensors or tools that are placed on the participant's hamstring muscles (Ogborn et al., 2021). This sensor measures muscle strength in real-time when participants perform hamstring muscle strength tests, such as isometric tests (static muscle strength) or isotonic tests (muscle strength during movement) (Lodge et al., 2020). The data generated by Norbord technology includes information about muscle strength, recovery time, and the presence of muscle strength imbalances between the hamstring muscles on the right and left sides of the body (Ogborn et al., 2021). The use of Norbord technology in this study provides several advantages. First, this technology provides an objective and accurate measurement of hamstring muscle strength, reducing the potential for bias in the measurement

results. Second, the data generated in real-time allows researchers to observe muscle response in real-time, aiding in a more precise and in-depth analysis of the risk of hamstring injury. Third, this technology could allow more in-depth analysis of changes in muscle strength over time and provide important information for rehabilitation and injury prevention programs (Ogborn et al., 2021). Reason injury no only caused contact physical, however forces that occur in the muscle moment do activity too causing injury (Okta et al., 2022).

On joints knee there is a number of functioning ligaments as stabilizer knee movement namely the Anterior Cruciate Ligament (ACL) (Perdana Kusuma et al., 2022). The ACL is one of the important ligaments in the knee that connects bone thigh to the tibia (Pristianto et al., 2021). ACL ligaments have important function for guard stability on the knee and prevent happening translation tibia towards the anterior or prevent translational femur towards the back (Herman et al., 2022). on condition injury acute on ACL, moment incident injury raises sound *popping* ones then quick followed very severe pain, so no capable do activity, loss room motion joints happen instability (Dilla Maralisa, et al., 2020). Extension flex hips and knees that occur is function important in the hamstring muscles. The hamstring muscles inhibit extension knee During cycle gait, before attack heel, to consume energy kinetic and protect joints hips and knees (Khattak et al., 2021). Muscle strength could be influenced by factors such as nervous activity and morphology as well as mechanical characteristics of muscles and tendons. Acute hamstring injury with accompanying structural damage with contraction fluid, which gradually leads to formation of a wound used in the area of injury (Kellis & Sahinis., 2022). Injury hamstring stretch consists from percentage substantial from resulting acute musculoskeletal injuries during activity sport going on (Patel & Barot., 2022).

On some article study before, author not yet find study for do screening potency ACL injuries and HSI through technology nordbord. Besides that, this research is expected to give understanding to coaches and more athletes objective about screening potential ACL and HIS injuries through technology cardboard.

Method

This research is a type of systematic review research. Analysis structure used in study this in line with a number of studies bibliometric done on the topic other. Amount obtained books and articles is 83, published from 2016 to 2022. Methods library data collection or research whose object study explored through various source information bibliography (books, journals scientific). Population or problem to be happen analyzed in paper scientific about Technology for Screening Potency risk ACL and HIS injuries via Nordbord.

Search and selection strategy studies

Method study systematically used with PRISMA (*Preferred Reporting Items for Systematic Review and Meta Analysis*) stages consisting of from identification, screening, inclusion and eligibility found articles then analyzed. Search source using an electronic site as Spingerlink, Emerald, Google Scholar, Pub-Med, and ScienceDirect, by keyword screening potency ACL and HIS injuries through nordbord. A number of obtained articles selected based on time rise with range 6 years time last published (2016 - 2022) in language England. Articles will reviewed for look technology screening potency athlete injuries through nordbord with fulfilling article criteria. All found information in publication about technology screening potency athlete injuries through nordbord will recorded and presented with explanation in shape narration. Conclusions are drawn after the data is obtained.

Table 1. Search strategy of each database

Id	Database	Search Strategy
1.	Google Scholar	("Technology For Screening Potency Risk Hamstring Strain Injury" AND "Muscle Strength Test")
2.	Pubmed	("Technology For Screening Potency Risk Hamstring Strain Injury" OR "HIS") AND ("Muscle Strength Test" OR "Muscular Strength Testing")
3.	EbscoHost	("Technology For Screening Potency Risk Hamstring Strain Injury") AND ("Muscle Strength Test")
4.	Springerlink	("Technology For Screening Potency Risk Hamstring Strain Injury" AND "Muscle Strength Test")
5.	Emerald	("Technology For Screening Potency Risk Hamstring Strain Injury" AND "Muscle Strength Test")

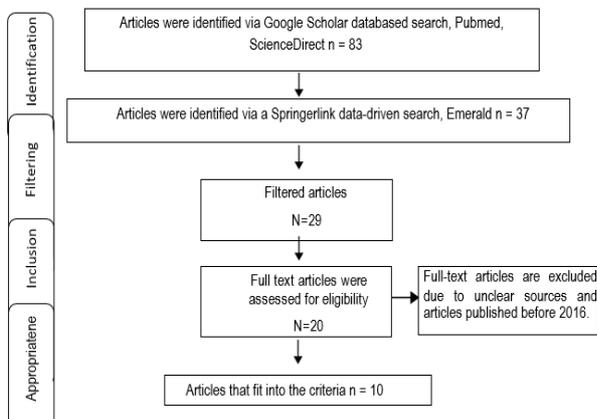


Figure 1. Technology Flowchart for Screening Potential Risks of Anterior Cruciate Ligament (ACL) and Hamstring Strain Injury (HSI) Through Nordbord.

Criteria inclusion and exclusion

Studies this in line with a number of research conducted on the topic other. Obtained articles are 10 published articles from 2016 to with year 2022. Using device soft management reference (Mendeley), criteria inclusion, study about screening potency risk injury ACLs and HIS with Nordbord, participants who are sportingly active and engaged in activities that involve hamstring movement, Participants who can fully participate in a hamstring muscle strength test using Nordbord technology, and criteria exclusion, only abstract , articles that do not published in a journal scientific, journal that has one or more from each criterion item inclusion and theme technology screening for

potency ACL and HIS injuries with Norbord, then reviewed. Journal selected criteria for reviewed is journal appropriate research with inclusion criteria.

Results

The results of the research used in the systematic review are as follows (table 2).

Table 2. Research on Technology for Screening Potency Risk Anterior Cruciate Ligament (ACL) Injury and Hamstring Strain Injury (HIS) Through Nordbord

No	Author, Year, Title	Sample Characteristics	Publisher	Study Design	Conclusion
1	Martin Buchheit, Yannick Cholley, Mark Nagel, and Nicholas Poulos, (2016), "The Effect of Body Mass on Eccentric Knee-Flexor Strength Assessed With an Instrumented Nordic Hamstring Device (Nordbord) in Football Players"	81 soccer players (U17, U19, U21, senior 4 th French Division and Professionals) and 41 Australian Football League (AFL) player.	International Journals of Sports Physiology and Performance	Crossover studies	Eccentric knee flexor strength, as assessed with the Nordbord, is largely BM dependent. To control for this effect, practitioners may compare actual test performance with the expected strength for a given BM, using the following predictive equation: Eccentric strength (N) = 4 x BM (kg) + 26.1. Professional soccer players with specific knee-flexor-training history and enhanced neuromuscular performance may show higher than expected values.
2	Anil Isik, Gurcan Unlu, Omer Batin Gozubuyuk, Turgay Aslanyurek, (2017), "Can Boreceli The Relationship between Previous Lower Extremity Injury, Body Weight and Bilateral Eccentric Hamstring Strength Balance in Young Soccer Players"	22 (25%) out of 88 players reported LE injuries in the previous two years (injured players (IP)), the rest of them (75%) did not report any LE injuries (non-injured players (NP))	Monten. J. Sports Sci. med.	Crossover studies.	Hamstring muscle strength imbalances are not affected by lower extremity injuries, and body weight, too, is a factor that can contribute to strength imbalances.
3	Ben Macdonald, (2017), "An Investigation Into The Immediate Effects Of Pelvic Taping On Hamstring Eccentric Force In An Elite Male Sprinter – A Case Report"	A 25 years old elite sprinter who has competed for Great Britain at both the 2012 and 2016 olympic games as part of the 4 x 100 m relay team, and the individual 200m and with history of hamstring injury.	Elsevier/ Journal of Physical Therapy in Sport	Experimental study	Application of the nordbord to measure eccentric hamstring strength, and its relationship to musculoskeletal and lumbar hip motor control tests. After a period of failed intervention strength training. This suggests that hip stability plays a role in hamstring muscle function.
4	Sam Halley, Tim Massard, Ric Lovell, Jason Siegler, Paul Marshall1 & Tony Wignell, (2018), "Eccentric Knee Flexor Strength Assessed Via Nordbord Should Be Scaled For Weight And Age In Youth Athletes"	124 Westfields Sports High School Athletes Soccer: n=63, League: n=61 (mean ± S.D [range]) (Age: 15.0 ± 1.3 [6]), Body Mass: 72.6 ± 18.9 [100])	Journal of Australian Strength and Conditioning	Crossover studies.	Maximal EHS values obtained via the use of a Nordbord should be allometrically scaled for both body mass and also age in youth athletes when assessing within/between individual differences. When assessing Nordbord scores between individuals in a single group or tracking the longitudinal developmental changes of a single individual, values should be scaled for both body mass and age. Appropriate scaling is therefore required to assess if strength differences are real or if they may be attributed to differences in age/body mass.
5	Parsons, J.L, Coen, SE, and Bekker, S. (2021), "The effect of Nordic hamstring exercise training volume on biceps femoris long head architectural adaptation"	Girls/women has not changed in over 20 years, and they remain 3–6 times more likely to experience injury compared with boys/men.	Brother J Sports Med.	Experimental Study	Over 20 years of research failed to reduce the difference in ACL injury rates between men and women. Including gender in the study of ACL injuries will increase the influence of non-biological elements and inform effective approaches to the prevention and treatment of ACL injuries.
6	Glenn Madison, Stephen David Patterson, Paul Read, Louis Howe, And Mark Waldron, (2018), "Effects Of Small-Sided Game Variations On Changes In Hamstring Strength"	Ten male semi-professional soccer players (mean 6 SD: age 23 6 5 years [age range: 18–29 years]; stature 178 6 7 cm; and body mass 73.4 6 10.6 kg)	Journal of Strength and Conditioning Research	Experimental study	The amount of acceleration done in a session, can increase the likelihood of hamstring fatigue, and is controlled by the relative throwing area.
7	Italo Sannicandro, Paolo Traficante, Giacomo Cofano, (2019), "Hamstring injury prevention: the strength assessment in young soccer players"	Male young soccer players Under 17 (n=14, 16,6±0,5 years, 175,8±7,1cm and 70,9±9,1 kg).	MOJ Sports Med.	Crossover studies	The difference between the two tests revealed the effect of fatigue on the hamstring muscles based on the reps required, and showed a difference between the hamstrings of the lower legs of young players.
8	Spieß J, Meyer S, Wyss T, Hübner K, Bruhin B, Luomajoki H, (2019), "Strength deficits of the hamstrings following surgery on the anterior cruciate ligament: a case-control study of elite alpine ski racers"	Athletes who had undergone surgery on the anterior cruciate ligament 49 ± 41 months previously and healthy ski racers. The total eccentric strength of both legs measured in the hamstrings supporting the ACL (n=18) was compared with the healthy group (n=70); the strength of the operated leg was also compared with the healthy leg and with the mean for the healthy group.	Swiss Sports & Exercise Medicine	A case-control study was performed with athletes	More attention should be paid during rehabilitation to hamstring strength, measurement using the Nordbord system is suitable for routine monitoring of eccentric strength, then there is a need to understand the effect of hamstring strength in cruciate ligament injuries
9	Drury, B et al. (2021), "Different Interest Rest Intervals During the Nordic Hamstrings Exercise in Young Male Athletes"	Ten well-trained, young, male, team-sport athletes (age ¼ 20.7 6 2.3 years, height ¼ 179.4 6 5.5 cm, mass ¼ 83.9 6 12.4 kg)	Journal of Athletic Training	Crossover studies.	In trained athletes, a 1-minute ISRI is sufficient to maintain quality interlimb asymmetry and force production, between sets during NHE. The practitioner should be aware of the potential reduction in peak strength production that may occur.
10	Hordberg, J, et. al., (2022), "Persistent knee flexor strength deficits identified through the Nordbord eccentric test not seen with "gold standard" isokinetic concentric testing during the first year after ACL reconstruction with a hamstring tendon autograft"	127 Patients (45% women, mean age 24,9± 8.1 years) were extracted from a rehabilitation outcome registry at 10 weeks and 4,8,12 month after ACL reconstruction with hamstring tendon autograft.	Elsevier Journal of Physical Therapy in Sport	Crossover studies	The Nordbord test can identify deficits in knee flexor strength that are not identified by isokinetic testing, during the first year among patients with ACL reconstruction problems, ie by using a hamstring tendon autograft.

From several journal described above, explained that with do screening potency risk Anterior Cruciate Ligament

(ACL) and Hamstring Strain Injury (HIS) injuries technology sport or Nordbord, deliver results in a manner *real data*

and become guide for do handling or the rehabilitation process at the stage next.

Discussion

Activity in sports own level risk very high injury and become frequent cases found, injured sport (Sport Injury) ie all type injuries incurred, both at the time practice nor at time exercise (competition) or after do competition (Akbar et al., 2021). Injury to athletes often raises consequence negative, fine in a manner physical nor psychologically, a lot competition sports held every he year, demanded the athletes for keep going practice with risk more injuries tall than normal athletes. The player who get the HIS nee 30 days of for recovery (Fuentes et al., 2014). For resolve solution there is technology sport that is *Nordbord*, tool for screening potency injury, mainly risk potential in Anterior Cruciate Ligament (ACL) and Hamstring Strain Injury (HIS).

Researcher leading others around the world continue use Nord Bord for measure, improve, and understand hamstring strength and risk injury, maybe professional perform tall for get more many score from NordBords they from time to time along with the knowledge base collective We the more in. A number of articles has use Nordbord as a tool to analyze and evaluate, following explanation from each – each article, this research supports the hypothesis that imbalance strength of hamstring muscles is not affected by injury to lower extremity and body weight is possible factor influence strength imbalance (Buchheit et al., 2016; Isik et al., 2018; Sannicandro, 2019; Wik et al., 2019). Studies case this explain impact positive EPC on production eccentric hamstring style in male sprinters elite, discuss application Nordbord for measure eccentric hamstring strength, and how results from this could interpreted in relationship with general musculoskeletal used, and lumbar hip tests motor control (Macdonald et al., 2017). Maximum EHS value obtained through use Nordbord must scaled in a manner allometric for mass body and also age in athlete young moment rate in / between difference individual. More from 20 years study has fail reduce difference level intermediate ACL injuries man and woman. Including gender in studies ACL injury will increase influence non- biological and informing elements effective approach for prevention and treatment ACL injury. Moment evaluate Nordbord score Among individuals in one group or track change longitudinal development of one individual, value must be scaled for body mass and age. (Parsons et al., 2018; Van Dyk et al., 2019).

Observation this give outlook new about effects of training volume and reduction training on BFLH architecture and can give guide for the implementation of the NHE program, SSG relatively more areas big raises internal and external loads biggest, produce decline hamstring strength. Measurement use System Nordbord suitable for monitoring routine strength eccentric. Studies more carry on needed for increase understanding about influence hamstring strength in cruciate ligament injuries (Wik et al., 2019).

Our findings show that 1 minute enough for maintain quality production strength and interlimb asymmetry between sets during NHE in trained athletes. Although so, practitioner must realize potency decline big in production strength peak that possible happen (Bourne et al., 2017; Évaluation et al., 2017).

Test The eccentric Nordbord is capable of identifying relevant deficit in a manner clinical in symmetry strength flexor knees that don't identified by testing concentric isokinetic standard gold During year first among treated patients with ACL reconstruction using hamstring tendon autograft. With fast, easy, accurate, and reliable system for monitor hamstring strength and imbalance or knee. Incorporating advanced sensors, time data visualization real, and cloud analytics, NordBord is system comprehensive for measure and monitor athlete 's hamstring strength and imbalance in a manner accurate.

Conclusion

Activity in sports own level risk very high injury and become frequent cases Found, Cause injury no only caused contact physical, however there is forces that occur in the muscles moment do activity, got risky causing injury, screening potency risk Anterior Cruciate Ligament (ACL) and Hamstring Strain Injury (HIS) injuries through Nordbord, providing results in a manner accurate and objective. It could become a guide for enhancing muscle strength or the rehabilitation process at the next stage. It is recommended to carry out more studies regarding training programs for increased physical and rehabilitation after measuring hamstring strength.

Using Nordbord's technology, this study provides an opportunity to gain a deeper understanding of hamstring injuries and the different potential risks in men and women. This information can form the basis for practical recommendations for sports medicine professionals, coaches, and athletes in managing the risk of hamstring injury by sex.

Previously, it was possible to assess the risk of hamstring injury by subjective means, such as visual observation or manual assessment by medical personnel. However, with the presence of Nordbord technology, this research succeeded in creating a more measurable and objective approach in identifying potential risks of injury.

It is hoped that this method will provide more in-depth and more accurate information for sports health professionals, coaches and athletes to identify individuals at high risk of hamstring injuries. That way, preventive or intervention measures can be taken more timely and effectively to reduce the incidence of hamstring injuries and improve overall sports performance.

Indicate limitation

In conducting a systematic review and meta-analysis, the researcher faced several limitations. First, the limited number of relevant studies on the use of technology to

screen for hamstring injury risk may lead to an underrepresentational analysis and focus on a small sample. In addition, the different methodologies and quality of studies may affect the accuracy and validity of the conclusions drawn from the meta-analysis. There is potential for selection bias, in which researchers may tend to select studies with positive or significant results, while ignoring studies with negative or insignificant results. Data heterogeneity caused by variations in design, technology, or population characteristics in the included studies can also affect the validity of the conclusions. In addition, potential publication bias could affect the results of the meta-analysis, because studies with positive results are more likely to be published than studies with negative results. Generalization of the results also needs to be considered, because the conclusions from systematic reviews and meta-analyses may only apply to certain populations or contexts. The language barrier in this study can also be an obstacle, if you only consider studies in one particular language and ignore relevant literature in other languages. Finally, limitations of the technology used to screen for hamstring injury risk, such as its availability, accuracy, or validity, must also be considered in the interpretation of the results of this meta-analysis.

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