



Correlation between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk in amateur male beach volleyball players

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Abstract

In recent years, there has been increasing interest in understanding sports injuries, particularly in high-intensity disciplines such as beach volleyball. Key factors like muscle strength, jump performance, and balance play a critical role in both athletic performance and injury prevention. However, the relationship between these factors and injury risk in beach volleyball, especially among amateur players, remains underexplored. This study aims to investigate the correlations between muscle strength, jump height, dynamic balance, and injury risk among male amateur beach volleyball players. Twenty-four injury-free participants from high-level amateur competitions were assessed using isokinetic strength testing, a drop jump test for jump height, the Y Balance Test for dynamic balance, and the Functional Movement Screen (FMS). While no significant correlations were found between strength, balance, and injury risk, several tendencies emerged. The FMS highlighted issues with shoulder mobility and trunk stability, which may contribute to both performance limitations and increased injury risk. Additionally, the drop jump test revealed that higher muscle strength was associated with better jump performance, while the Y Balance Test indicated flexibility and strength imbalances in the non-dominant leg. These findings suggest that targeted interventions to improve shoulder mobility, trunk stability, and address imbalances could help reduce injury risk and optimize performance. Future research should involve larger sample sizes and explore alternative testing methods to further understand injury prevention and performance optimization in beach volleyball.

Keywords/tags

Beach volleyball; isokinetic muscle strength; drop-jump; dynamic balance; injury risk;

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1 Introduction

In recent years, there has been a growing emphasis on understanding the multifactorial nature of sports injuries, particularly in disciplines like volleyball where repetitive movements and high-intensity actions are common. Studies have shown that muscle strength, jump performance, and balance play pivotal roles in athletic performance and injury prevention across various sports (Puga & Dias, 2020). However, the specific relationship between these factors and injury risk in beach volleyball, particularly among amateur players, remains relatively unexplored.

Within the broader framework of sports science and medicine, there's a burgeoning interest in identifying comprehensive injury prevention strategies tailored to specific sports and athlete demographics. This interest stems from the recognition that preventing injuries not only enhances athlete performance but also contributes to the long-term sustainability of sports participation and overall well-being.

The thesis aims to investigate the correlation between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk among amateur male beach volleyball players. This research is crucial as it addresses the intersection of various physical attributes and their potential influence on injury susceptibility within a specific athletic population.

The results of the thesis have practical significance in the context of beach volleyball, providing valuable insights for injury prevention, performance optimization, and the development of tailored training programs for male beach volleyball players. Physiotherapists, coaches, athletes, and sports medicine professionals can better understand the factors that influence performance and risk of injury in the sport.

Additionally, research contributes to the field of sports science, potentially inspiring further training and innovation in training methods and sports medicine practice. The thesis will focus on amateur male beach volleyball players, acknowledging that injury risk factors and training needs may vary between genders and competitive levels.

By narrowing the scope to this specific demographic, the research can delve deeper into the unique physiological demands and injury patterns characteristic of amateur male beach volleyball. This focused approach examines correlations between muscle strength, jump performance, dynamic balance, and injury risk within this population, offering insights that may guide injury prevention strategies and performance optimization. Additionally, focusing on amateur athletes recognizes the importance of injury prevention at grassroots levels, where resources and support for comprehensive sports medicine interventions may be limited compared to elite levels.

2 Beach volleyball specifics

2.1 Performance specific and injury risks

Volleyball stands tall as one of the world's premier sports, ranking among the top five most cherished athletic pursuits globally. As of 2022, the International Volleyball Federation (FIVB) oversees a vast network of 222 affiliated national federations, fostering a community that boasts over 800 million participants worldwide. This sport encompasses two main variants: indoor volleyball and beach volleyball. While both share a fundamental skill set, they diverge in court dimensions, playing surfaces, and player counts. Volleyball, widely regarded for its minimal contact and commendable safety record, demonstrates a low incidence of injuries. However, its dynamic pace and reliance on repetitive overhead and jumping motions predispose athletes to both acute and overuse injuries, particularly affecting the upper and lower extremities. The net zone, a focal point for close-quarters action, often sees injuries to the head, face, hands, and ankles (Busca et al., 2015).

The power generated during serving and spiking, integral aspects of volleyball, is considerable. Spiking, executed in various forms such as straight-ahead, cross-body, and the finesse-oriented roll shot, alongside serving techniques like the jump serve and float serve, involve significant force and torque. These actions follow a structured motor pattern, encompassing approach, take-off, arm cocking, arm acceleration, and follow-through phases. The dominant shoulder plays a crucial role, undergoing maximal external rotation before swiftly recoiling to impart maximum force onto a volleyball weighing between nine to ten ounces. Spikes can propel the ball at speeds nearing 28 m/s, reaching receivers at the baseline within a fraction of a second. Nonetheless, the repetitive nature of these forceful overhead motions exposes athletes to overuse injuries akin to those seen

in other overhead sports like baseball and tennis, including rotator cuff tendinopathy, biceps tendinitis and tears, glenoid labrum tears, shoulder instability, impingement syndrome, scapular dysfunction, and nerve injuries (Young et al., 2023).

Moreover, the cyclic jumping and landing actions inherent in volleyball can lead to overuse injuries in the lower extremities. The stress during jumping and landing is influenced by technique and playing surface, with sand surfaces dampening ground reaction forces compared to rigid surfaces. Gender, court position, and the type of spike or serve further influence landing techniques. Notably, differences in tactical approaches between beach and indoor volleyball, alongside situational variations in attacking and blocking, contribute to injury patterns. Common lower extremity injuries include patellar tendon tendinopathy, anterior cruciate ligament (ACL) tears, meniscus tears, stress fractures, and ankle sprains.

With a mean frequency of up to 38 jumps per set (~145 per game), depending on the player, the jumping ability is, therefore, a key component of competitive success in indoor and beach volleyball. Jumping higher allows the server to play the ball with a straighter initial projection angle, enables the setter to pace the time between the set and the attack, allows the blocker to increase effectiveness by projecting more over the net, and permits the attacker to spike over or with the block. It is also important to remember that the landing technique plays a fundamental role in volleyball biomechanics, as for each jump (action), there is a reaction, which will result in forces transmitted to the athletes' joints and tendons. Upper limb overuse lesions are associated with the need to perform fast movements resulting in high loads in the shoulder complex (SC) (Young et al., 2023; Puga & Dias, 2020).

According to the study conducted to assess injuries in beach volleyball players the distribution of acute injuries by body region is depicted in Figure 1. Knee injuries (30%, 7 of 23), ankle injuries (17%, 4 of 23), and finger injuries (17%, 4 of 23) collectively constituted more than half of all acute time-loss injuries in the retrospective survey, with a similar pattern observed in the prospective study. Severity assessment of the reported acute time-loss injuries indicated mildness, as evidenced by the duration of absence from matches or training. Specifically, only one injury resulted in an absence of more than 3 weeks, while four injuries led to 8 to 21 days of absence, and 18 injuries resulted in an absence of 1 to 7 days (Chéron et al. 2017; Bahr & Reeser, 2003).

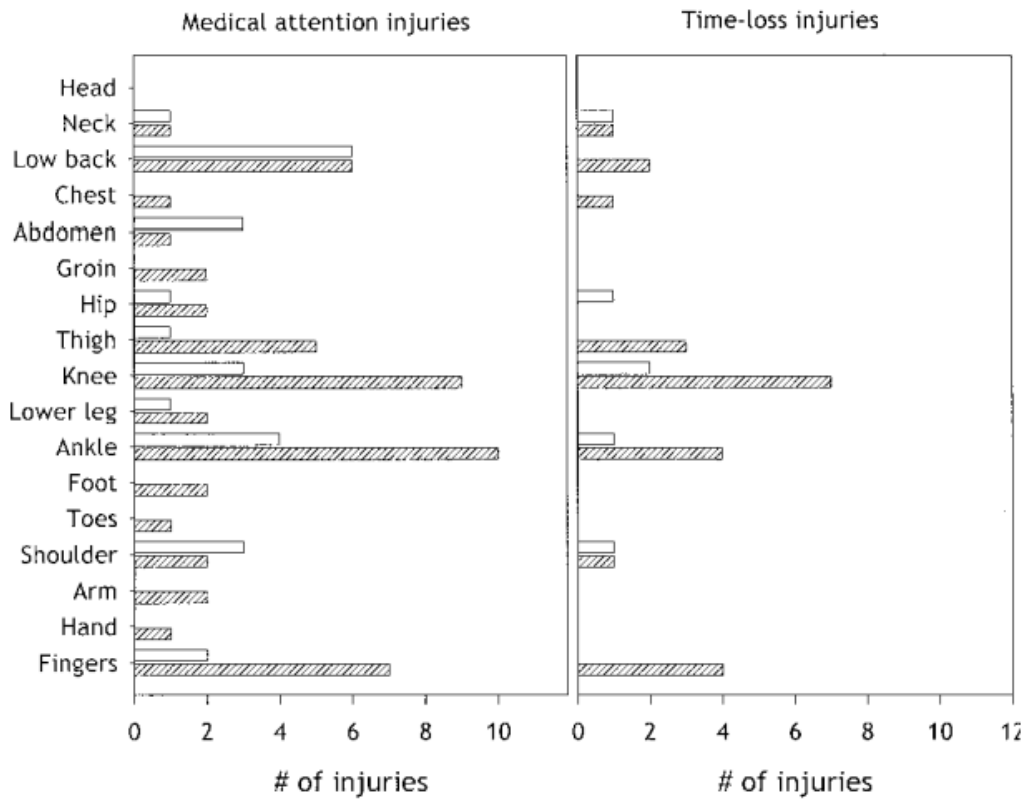


Figure 1. Distribution of acute injuries by body region(Bahr & Reeser, 2003)

Despite the popularity and relatively low injury rate of beach volleyball, studies indicate that over one-third of professional players seek medical attention for overuse injuries. Knee injuries are prevalent, followed by ankle and shoulder issues. The professional beach volleyball injury rate remains low, with approximately three time-loss injuries per 1000 hours of competition (see Figure 2). However, medical consultations for overuse injuries are prevalent among players, predominantly concerning knee, shoulder, and low back discomfort (Bahr & Reeser, 2003).

Group	No. of matches	Match exposure (hours)	No. of injuries	Incidence ^a
Men	378	1040	4	3.8 ± 1.9
Women	217	536	0	0.0 ± 0.0
Total	595	1576	4	2.5 ± 1.3

^a Reported as the number of injuries per 1000 hours of exposure.

Figure 2. Number of injuries during matches and injury incidence for time-loss injuries (Bahr & Reeser, 2003).

Despite volleyball typically having a lower incidence of injuries compared to other sports, the importance of proactive injury prevention strategies cannot be overstated, particularly in beach volleyball where the physical demands and potential for injury remain significant. Effective injury prevention strategies in beach volleyball often involve targeted conditioning exercises aimed at bolstering the muscles responsible for absorbing impacts, rectifying technical imperfections, and addressing underlying imbalances in strength and flexibility. Given the high-impact nature of beach volleyball and the repetitive stress placed on the body during matches and training sessions, proactive prevention measures are essential for safeguarding athletes' health and longevity in the sport. By prioritizing injury prevention, athletes can not only minimize the risk of acute injuries but also mitigate the development of chronic conditions that may compromise their ability to compete at their best. Moreover, a focus on prevention fosters a culture of proactive self-care and injury awareness among athletes, empowering them to take an active role in maintaining their physical well-being throughout their careers. Testing athletes' physical condition serves as an integral component of injury prevention, aiding in the identification of potential risk factors and informing targeted conditioning programs to optimize performance and minimize the likelihood of injuries in beach volleyball.

2.2 Beach volleyball athletes' assessment

In contrast to some other sports, beach volleyball lacks standardized assessment protocols for evaluating athlete performance and injury risk. Despite the sport's growing popularity and the increasing recognition of its physical demands, there remains a dearth of evidence-based research on performance testing specifically tailored to beach volleyball athletes (Bahr & Reeser 2003; Puga & Dias 2020). This absence of standardized assessment tools poses significant challenges for coaches, trainers, and sports scientists seeking to optimize athlete preparation and mitigate injury risk. Without robust data and established benchmarks, identifying individual strengths and weaknesses becomes a formidable task, hindering the development of targeted training interventions and injury prevention strategies. However, the imperative to assess beach volleyball athletes cannot be overstated. Given the sport's dynamic nature and the unique demands imposed by sand surfaces, precise evaluation of athletes' physical capabilities is essential for fostering optimal performance and reducing the risk of injuries (Puga & Dias 2020). By implementing systematic performance testing protocols, coaches and trainers can gain invaluable insights into athletes' strengths, weaknesses, and injury vulnerabilities, enabling them to tailor training regimens and interventions

that enhance athletic performance while minimizing the likelihood of injuries. As such, there exists a pressing need for further research and the development of standardized assessment protocols specific to beach volleyball, aimed at providing coaches and athletes with the tools they need to thrive in this exhilarating sport (Juhan et al., 2021; Jiménez-Olmedo et al., 2018)

As such, investing in the development of evidence-based assessment protocols tailored to beach volleyball is not only imperative for optimizing athlete performance but also indispensable for safeguarding athlete well-being and longevity in the sport. By rigorously testing parameters such as muscle power, jump performance, dynamic balance, and injury risk, coaches and trainers can effectively tailor training programs and injury prevention strategies, thereby enhancing athletes' competitive edge while minimizing the risk of debilitating injuries (Puga & Dias2020).

2.2.1 Isokinetic muscle strength

Isokinetic testing has been a cornerstone in both assessment and rehabilitation practices for the past six decades. Initially employed primarily in evaluating musculoskeletal injuries at the knee due to their prevalence and the ease of testing, recent investigations in the 2020s have uncovered a concerning trend: many patients, post-injury or surgery, exhibit lingering strength and power deficits that impede their return to previous levels of performance. Consequently, there's been a resurgence in the utilization of objective isokinetic testing, complemented by a battery of functional tests, to gauge the performance capabilities of associated muscle groups. This resurgence is driven by the pressing need to address the challenges associated with returning to unrestricted participation. The efficacy of isokinetic, coupled with the substantial number of patients unable to regain pre-injury activity levels due to significant strength, power, and endurance deficits, underscores the importance of adopting a "Test, Don't Guess!" approach. Isokinetic testing serves two crucial imperatives: it provides objective data to guide progression through rehabilitation programs, particularly in advanced phases, and aids in assessing readiness for discharge, crucial for a successful return to sport. This commentary focuses on muscle strength, power, and endurance testing, particularly using the knee as a model. Various methods including manual muscle testing, handheld dynamometry, and isotonic progressive resistive exercise testing can be utilized, but isokinetic offers unique advantages. It can be employed for pre-participation screening to identify potential deficits, monitor patient progress during rehabilitation, and inform the development of criteria-based treatment plans. Isokinetic testing not only aids in rehabilitation but also offers

immense value for athletes in monitoring their performance and evaluating potential risks of muscle power deficiencies and injuries (Thompson et al., 2023; Urhausen et al., 2022; Wilk et al., 2024). By regularly incorporating isokinetic assessments into athletes' training regimens, coaches and sports medicine professionals can track changes in muscle strength and power over time, identifying any declines or imbalances that may predispose athletes to injury. Additionally, isokinetic testing provides valuable insights into the effectiveness of training interventions, enabling adjustments to be made to optimize performance and mitigate injury risk. This proactive approach to athlete management not only enhances performance potential but also minimizes the likelihood of setbacks due to undetected weaknesses or imbalances in muscle function. Despite a recent shift away from isokinetic testing, it remains the "Gold Standard" for measuring dynamic muscle performance, supported by its reliability, validity, and correlation with functional skills (Urhausen et al., 2022; Wilk et al., 2024).

The advantages of isokinetic testing, as elucidated by Dabis et al. (2018), encompass several critical factors. Isokinetic testing provides reliable and objective documentation of dynamic muscle performance, offering efficiency by loading a dynamically contracting muscle to its maximum capability throughout the entire range of motion. The accommodating resistance characteristic of isokinetic testing allows muscles to be challenged to their maximal capability, enabling isolation of muscle groups for precise testing and rehabilitation. Furthermore, the inherent safety of isokinetic testing in managing pain and fatigue is highlighted, along with its validity, supported by correlations with other functional tests. Concentric isokinetic exercises are noted for their minimal post-exercise delayed-onset muscle soreness, while the ability to exercise at different angular velocities facilitates the recruitment of fast-twitch muscle fibers critical for functional activities. Additionally, isokinetic testing contributes to decreasing reciprocal innervation time, joint compressive forces, and anterior tibial translation. The inclusion of computerized feedback enhances torque control accuracy and provides real-time motivation to patients during exercises, further emphasizing the multifaceted benefits of isokinetic testing in rehabilitation and performance enhancement.

According to Wilk et al. (2024), the key parameters for isokinetic testing to assess muscle performance, especially in determining readiness to return to sport (RTS). Parameters include quadriceps torque/body weight ratio at 180°/second, hamstring/quadriceps ratios, bilateral comparisons using the Limb Symmetry Index (LSI), acceleration rate during knee extension at 0.2 seconds, and

endurance values for quadriceps and hamstrings. These parameters are crucial for RTS assessment, as detailed in Figure 3. Additionally, certain parameters such as the T-shuttle run, hop testing, force plate data, and neurocognitive reactive functional testing are highlighted for their usefulness in a comprehensive assessment.

- Quadriceps Peak Torques to Body Weight Ratio:
 - Males 180 deg/sec 60-65%
 - Females 180 deg/sec 50-55%
- Hamstring/Quadriceps Ratio:
 - Males 180 deg/sec 66-75%
 - Females 180 deg/sec 75%>
- Bilateral Quadriceps Peak Torque Comparison:
 - Males: 85%>
 - Females: 85%
- Hamstring Bilateral Peak Torque Comparison:
 - Males: 90%>
 - Females: 100%>
- Acceleration Rates at 0.2 sec
 - $\geq 90\%$ Quadriceps
- Endurance Values:
 - Quadriceps work fatigue ratio 12% decrease or less.

Figure 3 Isokinetic testing criteria (Wilk et al., 2018)

2.2.2 Drop jump performance in volleyball

The Drop Jump, characterized by an explosive leap following a descent from a specified height, mirrors the mechanics of block and repetitive jumps seen in volleyball. In vertical axis jump protocols, such as dropping in a predefined area, successful execution entails a series of movements. This includes planning the trajectory for the body's centre of mass, maintaining control of body position during the jump phase, and ensuring postural stability upon ground contact (landing) (Peng et al., 2019; Makaraciv et al., 2021).

The Drop Jump (DJ) test involves stepping off a box at a fixed height, landing on the floor, and immediately rebounding vertically to minimize ground contact time and maximize jump height. It as-

esses an athlete's ability to execute the stretch-shortening cycle (SSC), often measured by the reactive strength index (RSI), calculated as jump height divided by ground contact time (Costley et al, 2018; Bishop et al., 2022)

According to Xu et al, 2023, the limitations of this systematic review revolve around the insufficient number of studies focusing on jump height calculation during the Drop Jump test, with only two included in the review. This scarcity hinders definitive conclusions on optimal methods or equipment for determining jump height during the drop jump. Additionally, no studies utilizing linear position transducers met the inclusion criteria, making it challenging to assess their effectiveness in quantifying jump height. Future research should explore various devices to investigate the reliability of jump height calculation methods during both Countermovement Jump and drop jump. Given the diverse equipment used, careful consideration of factors such as sampling frequencies and calculation definitions is crucial to minimize discrepancies in jump height values. Recommendations for practitioners include the double integration method via force plates for jump height-1 measurement and the instantaneous method for jump height-2 estimation. Despite methodological differences, the findings underscore the need for further investigation into the reliability of each calculation method across different equipment settings. Recommendations table compiled by the author to estimate the jump height (see Figure 4)

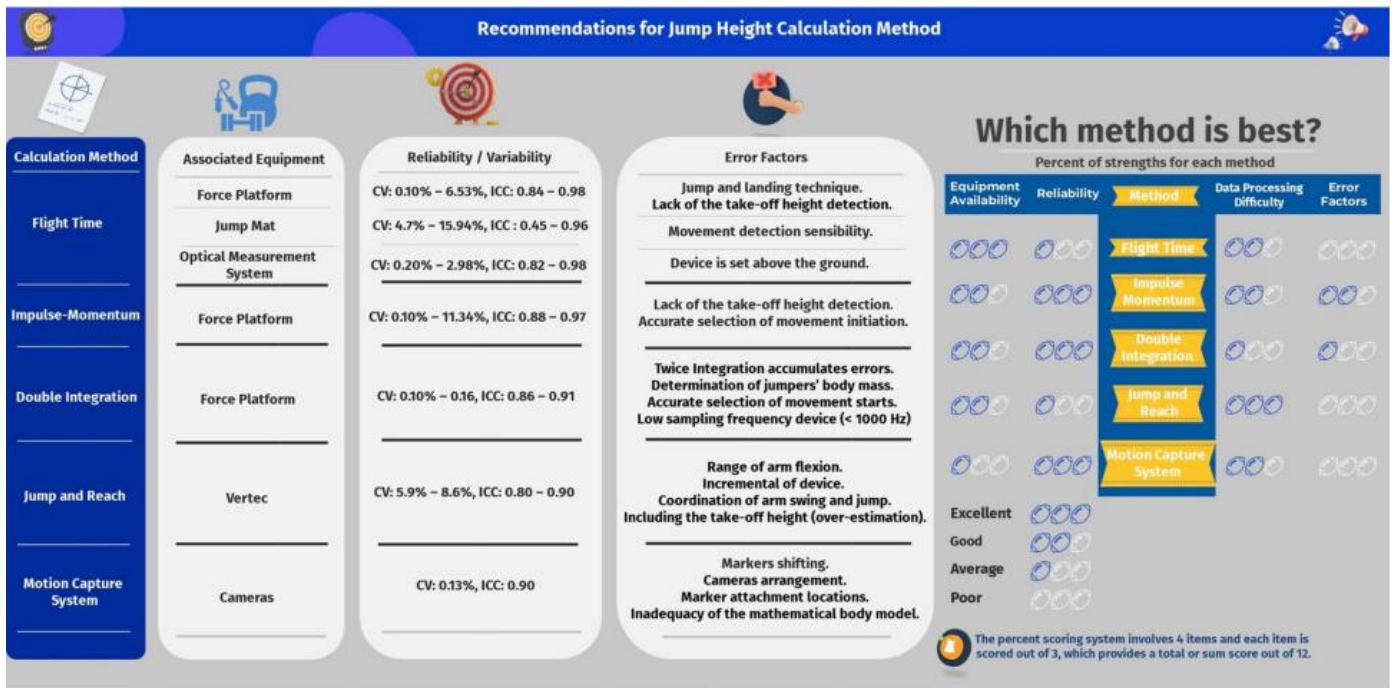


Figure 4. Recommendations for jump height calculation method (Xu et al, 2023)

2.2.3 Dynamic balance

The Star Excursion Balance Test (SEBT) and Y-Balance Test Lower Quarter (YBT-LQ) have garnered considerable attention within the realm of sport physiotherapy, serving as pivotal tools in assessing physical readiness, pinpointing injury risks, facilitating return-to-sport evaluations, and gauging the efficacy of interventions. Extensive research and practical application have highlighted the reliability, validity, and responsiveness of the SEBT, particularly in the context of dynamic neuromuscular control training among both injured and healthy athletic cohorts. Notably, these tests excel in probing neuromuscular control boundaries, thereby enhancing the detection and amplification of subtle deficits and asymmetries. (Alnahdi et al., 2015; Gribble et al., 2012).

The Star Excursion Balance Test (SEBT) has been widely utilized in sport physiotherapy for assessing physical readiness, injury risks, return-to-sport evaluations, and intervention effectiveness. Its reliability, validity, and responsiveness have been well-established, particularly in dynamic neuromuscular control training among athletic populations. However, to improve the SEBT's reliability and practicality, the Y-Balance Test Lower Quarter (YBT-LQ) was developed, streamlining the test to focus on the three most reliable reach directions (Alnahdi et al., 2015; Gribble et al., 2012; Plisky et al., 2021).

While both tests assess dynamic neuromuscular control at stability limits, they differ in methodology. The YBT-LQ utilizes a standardized approach facilitated by a testing kit and revised protocol, aimed at enhancing reliability and expediting testing procedures. Notable protocol adjustments include allowing the heel of the stance foot to raise, prohibiting touch down with the reaching limb, and implementing a standard reach height off the ground. Recommendations for test performance accuracy by Plisky et al., 2009 (see Figure 5).

Recommendation	Rationale
Shoes off	Individuals attend testing in a variety of footwear so it is difficult to standardize.
Six practice trials	Learning effect.
Video instruction	Increases efficiency of testing protocol and standardizes instruction.
Standard testing order	Minimize fatigue by alternating stance limbs. Improves consistency in administration of test.
Stance foot aligned at most distal aspect of toes	Keeps starting point in a uniform and reproducible position to which the reach foot can be referenced.
Stance foot movement is allowed	Difficult to reliably determine if heel/forefoot is lifted from the surface.
Body movement allowed under control	Difficult to standardize amount of movement allowed.
Normalized to limb length	Normalization standardizes measurement to each individual.
Standard reach height	Allows reach height to be uniform.

Figure 5. Recommendations for standardized protocol with the provided rationale for the recommendation (Plisky et al., 2009).

Research indicates moderate to high-quality evidence supporting the YBT-LQ's reliability as a dynamic neuromuscular control test. However, variations based on sex and sport were observed, suggesting the necessity of population-specific considerations, especially in injury risk assessment (Butler et al., 2012). Notably, generalized cut points may not reliably predict injury, necessitating tailored interpretations based on clinical population specifics, such as age, sex, and activity level (Plisky et al., 2009).

In sports, unilateral balance and dynamic neuromuscular control are paramount. Identifying dysfunctional unilateral stances prospectively highlights injury risks in sports settings. Recent literature underscores the significance of assessing dynamic neuromuscular control through body-relative movement testing, particularly emphasizing the anterior, posteromedial, and posterolateral directions for identifying chronic ankle instability and lower extremity injury risks (Lehr et al., 2013). Also, according to Guirelli et al., (2012), a moderate correlation was discerned between knee extensor strength and the anterior direction, alongside a similar correlation between hip extensor strength and the posterolateral direction in the Y Balance Test. This suggests that there may be a relationship between the strength of knee and hip extensors and the performance outcomes of the YBT among adolescent volleyball players. However, it is important to note that correlation does not imply causation, and further research is needed to establish any causal link.

Additionally, advancements such as the Y Balance Test™, an instrumented adaptation of SEBT components, seek to enhance measurement repeatability and standardize test performance. Utilizing anterior, posteromedial, and posterolateral components of SEBT, this device and its protocol address potential measurement errors and methodological variations, ensuring reliable and comparable results among studies and clinicians (Lehr et al., 2013; Plisky et al., 2012).

Several limitations warrant consideration in this study. Potential errors might have arisen from factors such as fatigue, practice effects, and conducting remeasurements on the same day as the initial testing. Subsequent investigations should consider conducting assessments with participants barefoot, as many athletes attend pre-participation physicals and rehabilitation sessions wearing various types of footwear, which may not be conducive to sport-specific movements. Moreover, future studies should adopt a consistent, standardized testing protocol to facilitate cross-study comparisons of results. Furthermore, it's noteworthy that only the right limb was assessed twice by the initial rater (Plisky et al., 2009).

Butler et al. (2013) conducted a study examining the mean composite Y Balance Test (YBT) scores among healthy adult recreational athletes. The findings revealed the following mean scores:

- Anterior reach: 94.5% of leg length
- Posteromedial reach: 95.5% of leg length
- Posterolateral reach: 96.5% of leg length
- Composite score: 95.5% of leg length

Gribble et al. (2012) conducted a study investigating the mean composite Y Balance Test (YBT) scores among healthy adult non-athletes. The study reported the following mean scores:

- Anterior reach: 80.4% of leg length
- Posteromedial reach: 78.2% of leg length
- Posterolateral reach: 83.2% of leg length
- Composite score: 80.6% of leg length

It is crucial to acknowledge that normative data may differ based on factors such as the tested population, testing protocols, and equipment utilized. Thus, it is advisable to utilize normative data that closely aligns with the characteristics of the tested population and to approach result interpretation with care.

2.2.4 FMS in beach volleyball

The Functional Movement Screen (FMS) serves as a screening tool designed to identify movement deficiencies that could potentially predispose an otherwise healthy individual to injuries during physical activity. While preparticipation examinations have traditionally assessed an individual's immediate ability to engage in physical activity safely, no existing screening test has demonstrated the ability to predict an individual's risk of injury during future activities (Bonazza et al., 2017). However, Kiesel et al. (2007) were pioneers in exploring the predictive value of the FMS. In their study, they discovered that lower FMS scores correlated with a significantly heightened risk of injury among professional football players.

FMS application spans a wide spectrum in the literature, encompassing usage among diverse demographics including young, active individuals, middle-aged adults, elite athletes, collegiate players, professionals, military personnel, and firefighters. Notably, lower FMS scores have been correlated with higher body mass index (BMI), advanced age, and reduced levels of physical activity (Mitchell et al., 2016).

The cut-off score of ≤ 14 on the Functional Movement Screen (FMS) is employed to identify individuals at increased risk of injury. Those scoring below 14 points on the FMS screening are at higher odds of sustaining injuries. However, current research remains constrained, leaving uncertainties regarding the specific sports or occupations wherein FMS proves optimal for predicting injury risks. Additionally, the validity of the original cut-off score of ≤ 14 across various populations remains unclear (Kiesel et al., 2007; Teyhen et al. 2012). Several studies have confirmed the high reliability of the Functional Movement Screen (Parenteau et al., 2014; Teyhen et al. 2012) A recent investigation conducted by Teyhen et al. showed that even with minimal training (4 hours), novice raters achieved moderate to good levels of inter-rater and intra-rater reliability when administering the FMS.

In summary, the Functional Movement Screen (FMS) is a valuable tool for identifying movement deficiencies linked to increased injury risk during physical activity. Its application spans diverse demographics, with lower scores associated with higher injury risk, particularly among athletes. While its reliability is high, uncertainties remain regarding its optimal use across different sports and occupations, as well as the universal validity of its established cut-off score. Further research

is needed to refine its predictive capabilities and establish tailored guidelines for specific populations.

3 Purpose and objective of the thesis

Purpose of the thesis: To elucidate the relationship between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk in amateur male beach volleyball players.

Objective of the thesis: By achieving this aim, the research aims to benefit the volleyball community by providing valuable insights into injury prevention strategies tailored to this specific demographic. These insights can inform the development of targeted training programs, improve player performance, and reduce the incidence of injuries, thereby contributing to the long-term sustainability of beach volleyball participation.

4 Implementation

4.1 Method of the development assignment

The target group consists of 24 amateur male beach volleyball players participating in the highest-level amateur competitions, all of whom are free from injuries. These players represent the primary focus of the study, as the research aims to directly benefit their performance and well-being in competitive settings. By understanding the relationships between physical attributes and injury risk among this specific demographic of injury-free athletes, the research can inform tailored training programs and injury prevention strategies to support the health and performance goals of these athletes.

The participants for the study will be chosen through a survey (Appendix 2), from which we will gather pertinent data including volleyball experience, history of injuries, and willingness to participate in examination sessions. The dominant side of all participants is the right side. The tests will take place at a private clinic, specifically at Hila Rehabilitation and Sports Medicine Centre in Lithuania, where I am employed. Approval for the study will be obtained from the clinic.

The testing sessions were conducted over four consecutive days, with a 24-hour interval between each session. The detailed schedule was as follows:

- Day 1: The objectives and methodological procedures of the study were explained to the athletes, and they signed the informed consent forms. Following this, body mass and height measurements of the players were taken.
- Day 2: The jump height test was conducted using the Drop Jump method. Additionally, the Functional Movement Screen (FMS®) was administered to assess the injury risk for all players.
- Day 3: The isokinetic strength test for the knee muscle groups was performed using an isokinetic dynamometer.
- Day 4: Balance measurements were taken using the Y Balance Test.

Each session was carefully organized to ensure accurate data collection and minimize the risk of fatigue affecting performance in subsequent tests.

4.1.1 Isokinetic muscle strength testing

The isokinetic strength assessment of the concentric hamstrings and quadriceps was performed using the Biodex System 3 device (Biodex Medical Systems, Inc., Shirley, NY, USA) at an angular velocity of 60°/s. The testing protocol was as follows:

- **Test Type:** Isokinetic bilateral
- **Pattern:** Extension/flexion
- **Mode:** Isokinetic
- **Contraction Type:** Concentric
- **Series and Angular Velocities:**
 - 60°/s: 3 repetitions (warmup)
 - 60°/s: 5 repetitions

During the test, participants were seated in an optimally positioned Biodex chair, secured with stabilization straps at the trunk, hips, and thigh, while holding their arms across their chest. The knee joint rotation axis was aligned with the rotation axis of the dynamometer (see Figure 6).

Participants, specifically beach volleyball players, underwent a 10-minute warmup that included stretching movements targeting the lower extremities before the test. Male participants performed maximal concentric knee flexion and extension for both their dominant and non-dominant lower extremities within an angular range of motion from 90° (flexion) to 0° (extension).

Rest periods were incorporated as follows: 3 minutes between testing each leg and 60 seconds between each angular velocity. The dynamometer was calibrated before each test session according to the manufacturer's standard protocol.

The mean peak torque (PT) values for the flexors and extensors of each leg were normalized by body mass for analysis. The hamstring to quadriceps (HQ) ratio was calculated by dividing the concentric peak torque of the hamstrings by that of the quadriceps at the same contraction speed (Lockie et al., 2012).



Figure 6. Isokinetic muscle strength testing procedure

4.1.2 Drop jump test

The Drop Jump (DJ) test was conducted to evaluate the participants' jump height. The procedure was as follows: participants stood on a 40 cm high box with their feet shoulder-width apart (see Figure 7). They were then instructed to drop off the box, land with each foot on a separate force plate, and immediately jump as high as possible upon landing. Prior to data collection, participants received detailed instructions on performing the DJ and completed several warm-up jumps. Three successful trials were recorded for each athlete.

The DJ was captured using a three-dimensional motion analysis system comprising 12 cameras (250 frames/s; Qualisys, Sweden) and two force plates (BP400600-OP, AMTI force and motion, USA). For each athlete, three-dimensional kinematic, kinetic, and ground reaction force (GRF) data were assessed bilaterally from initial contact (IC) to take-off (TO). Movements were recorded using Qualisys Track Manager Software. To calculate biomechanical parameters, including jump height, Visual 3D (C-motion Company, Rockville, MD) was employed.



Figure 7. Drop Jump testing

4.1.3 Dynamic balance test

Athletes performed a 5-minute dynamic warm-up consisting of the following lower extremity movements: forward lunging, backward lunging, heel walking, tiptoe walking, marching, and toy soldiers. After the dynamic warm-up, a site-specific investigator provided instructions for the YBT-LQ performance. Each athlete then completed six warm-up trials. The YBT-LQ involves an instrumented device with three pipes extending from a weight-bearing platform in a "Y" shape.

The athletes were instructed to stand barefoot on the weight-bearing platform with their right lower extremity, positioning their toes behind the red indicator line. They then used their non-weight-bearing lower extremity to "reach" in one of three directions (anterior, posteromedial, and

posterolateral) by sliding the reach indicator (movable platforms associated with each arm of the Y). The testing protocol included three anterior reach trials on the right limb (right limb stance with left limb non-weight-bearing), followed by three trials on the left limb. After completing the anterior reach trials, three trials per lower extremity (right followed by left) were performed in the posteromedial direction and finally the posterolateral direction. Any failed reach trials were repeated until correctly performed. Common errors included:

- pushing or flicking the reach indicator (instead of sliding it under control),
- applying pressure outside the red target area,
- losing balance, and stepping onto the non-weight-bearing limb.

The investigator recorded the distance reached for each successful trial (i.e., no errors).

After completing the YBT-LQ, each athlete's limb length was measured, while they were in a supine position. Limb length was measured using a cloth measuring tape, from the anterior superior iliac spine to the distal aspect of the ipsilateral medial malleolus. Reach distances were normalized to limb length (see Statistical Analysis section) (Brumitt et al., 2021; Pilsky et al., 2009).

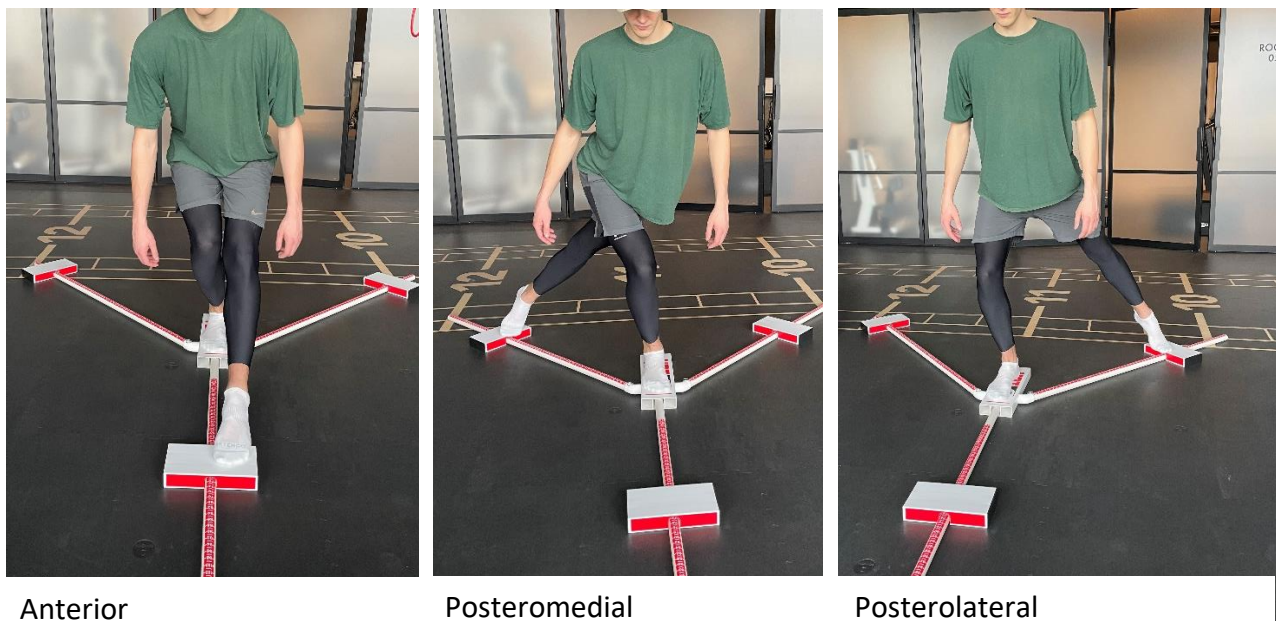


Figure 8. Y-balance test

4.1.4 Functional movement systems test

Functional movement patterns were evaluated by a physiotherapist specifically trained in using standard FMS[®] Test Kits (Functional Movement Systems Inc., Virginia, USA). The Functional Movement Screen (FMS[®]) is an analysis system designed to assess muscle strength imbalances and functional performance, particularly focusing on the nondominant side of athletes. Its primary objective is to identify stability and mobility issues that might be overlooked in asymptomatic active populations and athletes (Cook et al., 2014).

The FMS[®] consists of seven fundamental movement patterns (see Appendix 4):

- Deep Squat
- Hurdle Step
- In-Line Lunge
- Shoulder Mobility
- Active Straight Leg Raise
- Trunk Stability Push-Up
- Rotary Stability

Each athlete received detailed verbal instructions regarding the correct positioning of the head, body, knees, and feet for each movement. The evaluation process involved scoring each movement on a scale from 0 to 3:

- 3 points: The athlete performs the movement correctly and without compensation.
- 2 points: The athlete completes the movement but with some compensation mechanisms activated.
- 1 point: The athlete completes the movement with significant compensation or balance issues.
- 0 points: The athlete experiences pain during the movement or is unable to complete it.

The highest possible total score is 21 points. Each movement was carefully observed, and scores were assigned based on the quality and accuracy of the performance. In cases where the athlete experienced pain at any point during the movement, a score of 0 was given for that specific parameter.

This comprehensive assessment aimed to provide a detailed evaluation of the athletes' functional movement capabilities, highlighting areas that might require targeted intervention to enhance performance and prevent injury.

4.2 Development assignment data and its collection

In the research work, data collection was carried out through a structured approach involving several steps:

1. **Participant Recruitment:** Participants were recruited primarily through personal contacts within beach volleyball groups. This targeted approach ensured that individuals with relevant experience and interest were included in the study.
2. **Informed Consent:** Prior to enrollment, participants received detailed information about the research objectives, procedures, potential risks, and benefits. They provided formal consent, indicating their willingness to participate voluntarily and their understanding of the study's parameters.
3. **Data Collection Tools:** A combination of methods was employed to collect data, including surveys and measurements/tests such as isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk assessments. These tools were selected to comprehensively capture relevant data points related to the research objectives.
4. **Data Collection Procedure:** The data collection process was conducted meticulously, ensuring consistency and accuracy across all participants. Multiple sessions were scheduled for data collection, with appropriate breaks provided to mitigate participant fatigue and maintain data quality.
5. **Timetable:** The timetable for data collection was contingent upon factors such as sample size and the availability of participants. Realistic timelines were established, considering potential delays or unforeseen circumstances, and the planned schedule was adhered to as closely as possible.
6. **Ethical Considerations:** Throughout the data collection process, strict adherence to ethical guidelines and principles was maintained. Participant confidentiality, privacy, and safety were paramount, with all personal or sensitive information handled with the utmost care and stored securely in compliance with data protection regulations.
7. **Data analysis:** For the correlation data obtained from quantitative measures, such as isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk assessments, SPSS (Statistical Package for the Social Sciences) was utilized for analysis.

4.3 Analysis of data

The statistical analysis of the collected data was performed using SPSS 24 (IBM SPSS Statistics 24.0, IBM SPSS® software, USA). The following steps and methods were utilized:

- **Normality Test:** The normality of the data was assessed using the Shapiro–Wilk test. This test evaluates whether the data follows a normal distribution, which is a prerequisite for many parametric statistical tests.
- **Correlation Analysis:** To explore the relationships between various measured parameters, Spearman Correlation Analysis was employed. This non-parametric test is used to assess the strength and direction of the association between two ranked variables. The specific parameters analyzed included: knee flexion muscle strength, knee extension muscle strength, jump performance, balance, Functional Movement Screen (FMS®) scores.
- **Significance Level:** The threshold for statistical significance was set at $p < 0.05$. This means that any p-value less than 0.05 would indicate a statistically significant relationship between the variables, suggesting that the observed associations are unlikely to have occurred by chance.

Detailed Steps:

- **Data Entry and Cleaning:** All collected data were entered into the SPSS software, and data cleaning procedures, including checking for missing values, identifying and addressing outliers, and verifying data consistency, were conducted to ensure accuracy.
- **Descriptive Statistics:** Basic descriptive statistics, including means, standard deviations, and ranges, were calculated for each variable to provide an overview of the data.
- **Spearman Correlation Analysis:** This test was chosen because some variables were suspected of not meeting the assumptions of normality required for parametric tests. Normality was tested using the Shapiro-Wilk test, and the results confirmed that the data were not normally distributed. Consequently, Spearman's rho (ρ) values were computed to quantify the degree of correlation between the variables. The correlation coefficients range from -1 to 1, where:
 - **1** indicates a perfect positive correlation,
 - **-1** indicates a perfect negative correlation,
 - **0** indicates no correlation.
- **Interpretation of Results:** The correlation coefficients were interpreted to understand the nature of the relationships. Strong correlations (closer to -1 or 1) indicate a stronger relationship between the variables, while weak correlations (closer to 0) suggest a weaker relationship. By following these detailed procedures, the analysis aimed to provide a comprehensive understanding of the relationships between muscle strength, jump performance (jump height), balance (injury risk), and functional movement patterns among the athletes.

5 Results

5.1 Descriptive statistics

The descriptive statistics for the measured variables, including knee flexion and extension muscle strength, jump performance, balance, and FMS[®] scores, are summarized in Table 1. The table provides an overview of the data distribution, presenting the mean, standard deviation, minimum, and maximum values for each parameter.

Table 1. Descriptive statistics

	Minimum	Maximum	Mean	Std. Deviation
FMS [®] score	15	20	18	1,503
Balance (YBT-LQ Score) Right	88	124	103	8,038
Balance (YBT-LQ Score) Left	92	123	104	7,925
Peak torque (N•m); (Extension 60°/s) Right	199,6	365,0	285,8	46,1478
Peak torque (N•m); (Extension 60°/s) Left	173,8	365,1	276,7	41,4188

Peak torque (N•m); (Flexion 60°/s) Right	90,7	182,1	139,5	24,4116
Peak torque (N•m); (Flexion 60°/s) Left	95,2	175,6	135,7	22,2087
H:Q score Right	38%	61%	49%	4,910
H:Q score Left	39%	60%	49%	5,791
MAX jump height (cm)	37,6	69,9	51	8,1931

Main Findings:

The mean right knee extension strength among the athletes was 285,8 Nm with a standard deviation of 46,15Nm. The mean right knee flexion strength had a higher mean value of 139,5Nm with a standard deviation of 24,4Nm. The mean left knee extension strength among the athletes was 276,7Nm with a standard deviation of 41,4Nm. The mean left knee flexion strength had a higher mean value of 135,7Nm with a standard deviation of 22,2Nm. These results indicate that, on average, athletes exhibited slightly greater strength in both knee flexion and extension on the right side compared to the left side.

The maximum jump height recorded among the athletes was 69.9 cm. This represents the highest leap achieved during the testing sessions and highlights the peak explosive power capability within the group. The mean jump height was 51cm, with a standard deviation of 8,2cm.

The Y Balance Test – Lower Quarter (YBT-LQ) scores had a right side mean of 103 with a standard deviation of 8 and left side mean of 104 with a standard deviation of 7,9. So, the left side result was better than the right side.

The Functional Movement Screen (FMS®) scores averaged 18 out of a possible 21 points, with a standard deviation of 1,5. The scores ranged from 15 to 20, highlighting variability in functional movement quality and identifying potential areas for improvement.

These findings provide a comprehensive overview of the athletes' physical performance and functional capabilities, revealing slight asymmetries in muscle strength between the right and left

sides. The results highlight variations in individual strengths and weaknesses observed among participants, including differences in muscle strength, balance, and jump performance.

5.2 Correlation

Spearman's correlation is a non-parametric measure that assesses the strength and direction of the association between two ranked variables. Unlike Pearson's correlation, it does not require normally distributed data and is suitable for ordinal data or non-linear relationships. The correlation coefficient, Spearman's rho (ρ), ranges from -1 to 1, where +1 indicates a perfect positive correlation, -1 indicates a perfect negative correlation, and 0 indicates no correlation. This makes Spearman's correlation useful for identifying monotonic relationships, where variables move in the same or opposite directions but not necessarily at a constant rate. Typically, a correlation is considered:

- Weak: $|r| < 0.3$
- Moderate: $0.3 \leq |r| < 0.7$
- Strong: $|r| \geq 0.7$

In this study, no significant correlations were found between the variables, and all results are detailed in Table 2.

Table 2. Correlation results

			Balance (YBT-LQ Score) Right	Balance (YBT-LQ Score) Left	Balance (YBT-LQ Score) MEAN	MAX jump height (cm)	FMS® score
Spearman's rho	Peak torque (N•m); (Ex- tension 60°/s) Right	Correla- tion Co- efficient	0.169	0.143	0.180	0.175	-0.216
		Sig. (2- tailed)	0.431	0.505	0.400	0.414	0.310
		N	24	24	24	24	24
	Peak torque (N•m); (Ex- tension 60°/s) Left	Correla- tion Co- efficient	0.079	0.022	0.054	0.262	0.034
		Sig. (2- tailed)	0.713	0.920	0.802	0.216	0.873
		N	24	24	24	24	24
	Peak torque (N•m);	Correla- tion Co- efficient	0.239	0.255	0.256	0.285	0.026

(Flexion 60°/s) Right	Sig. (2-tailed)	0.260	0.229	0.228	0.177	0.904
	N	24	24	24	24	24
Peak torque (N•m); (Flexion 60°/s) Left	Correlation Coefficient	0.358	0.247	0.337	0.199	-0.055
	Sig. (2-tailed)	0.086	0.245	0.108	0.351	0.800
Peak torque (N•m); (Extension 60°/s) MEAN	Correlation Coefficient	0.164	0.120	0.162	0.267	-0.082
	Sig. (2-tailed)	0.443	0.575	0.450	0.207	0.703
Peak torque (N•m); (Flexion 60°/s) MEAN	Correlation Coefficient	0.318	0.255	0.307	0.301	-0.025
	Sig. (2-tailed)	0.130	0.229	0.145	0.153	0.909
FMS® score	Correlation Coefficient	0.061	.452*	0.275	0.113	1.000
	Sig. (2-tailed)	0.776	0.026	0.193	0.599	
	N	24	24	24	24	24
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Potentially Strong Correlations (if significant):

1. Peak Torque Hamstrings Right vs Y-Balance Right: $r = 0.358$ (Moderate to Strong if significant)
2. FMS vs Y-Balance Left: $r = 0.452$ (This one is already significant and is Moderate)

Moderate Correlations (if significant):

1. Peak Torque Quadriceps Right vs Jump height: $r = 0.414$
2. Peak Torque Hamstrings Mean vs Jump height: $r = 0.301$
3. Peak Torque Hamstrings Left vs Jump height: $r = 0.351$

To summarize, the table shows that there are several moderate correlations that could be significant with a larger sample size or more precise measurements. The interpretation of "strong" would generally be applied to correlations greater than or equal to 0.7, which are not present in this table. However, the correlations listed as moderate (especially those around 0.35 and above) indicate noteworthy relationships that could become significant with additional data.

6 Discussion

Our analysis revealed that the expected strong correlations between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk, as measured by the Functional Movement Screen (FMS), in amateur male beach volleyball players were not statistically significant, contrary to our initial hypothesis. This lack of significant findings prompts a closer examination of potential factors contributing to these outcomes. One plausible explanation for the non-significant results could be the relatively small sample size of our study. Previous research, with larger participant pools ranging from 29 to 169 individuals, reported significant correlations between isokinetic knee strength and jump performance (Fischer et al., 2017; Schons et al., 2018; Tsiokanos et al., 2002). The smaller size of our sample may have limited our statistical power to detect similar relationships.

The second plausible explanation for non-significant results could be differences in jump test methodology. Variations in jump test methodologies across studies might have influenced the observed correlations. Different jump tests have distinct mechanical requirements and assess various aspects of jump performance. This diversity in methodologies introduces potential sources of variability that could have impacted the strength and significance of the associations observed in our study. Studies that found a statistically significant difference between jump height and isokinetic muscle strength utilized different variations of jump tests, such as: countermovement jump, vertical jump (Harrison et al., 2012; Atik et al., 2024).

A possible explanation for the non-statistically significant results could be the choice of performance metrics. While Peak Torque (PT) primarily measures maximal muscle strength, Reactive Strength Index (RSI), which accounts for jump height relative to contact time, may provide a more direct and dynamic measure of an athlete's elastic energy utilization and neuromuscular coordination. The inclusion of RSI might have better captured performance relationships related to jump height. In our study, notable tendencies included higher muscle strength aligning with better jump performance and imbalances observed in dynamic balance measures, particularly in the non-dominant leg. These observations suggest potential areas for targeted intervention despite the absence of statistically significant correlations. Prior research (e.g., Barker et al., 2018; McMahon et al., 2018) has similarly emphasized the importance of using dynamic performance metrics in evaluating athletic performance and injury risk.

Despite the non-significant results, observed tendencies emphasize the multifaceted nature of the relationships between muscle strength, jump performance, balance, and injury risk in athletes. These tendencies suggest areas where athletes might benefit from targeted interventions to improve their overall performance and reduce injury risk.

The results from the Functional Movement Screen (FMS) indicated specific areas of concern. A significant majority, 22 out of 24 participants, exhibited a lack of dominant shoulder mobility. This suggests a widespread issue with shoulder flexibility and strength among the athletes. Additionally, 15 participants demonstrated a lack of trunk stability, highlighting potential weaknesses in core strength and control. None of the participants were able to perform the full Rotary Stability movement, indicating deficiencies in neuromuscular coordination and the ability to efficiently transfer energy through the torso. This could have implications for overall athletic performance and susceptibility to injury.

In terms of muscle strength and jump performance, a clear tendency was noted where athletes with higher muscle strength tended to achieve better jump performance. This suggests warranty if the correlation was not statistically significant, there is an underlying relationship between these variables that warrants further investigation with a larger sample size or different methodologies.

The Y Balance Test results revealed that the anterior reach was the most challenging direction for participants, with 16 out of 24 athletes showing limited anterior mobility in the non-dominant leg. This finding suggests a potential imbalance in flexibility and strength between the dominant and non-dominant legs. Although this imbalance could influence movement efficiency, further research would be needed to establish its direct impact on performance or injury risk. Previous studies have shown that such imbalances can contribute to asymmetries in movement patterns, which may affect overall athletic performance and increase the risk of injury (Hertel, 2002; Plisky et al., 2006).

Despite no significant correlations, our study highlighted key tendencies in athletes. The Functional Movement Screen (FMS) revealed issues with shoulder mobility and trunk stability, impacting performance and injury risk. Higher muscle strength correlated with better jump performance, and the Y Balance Test showed flexibility and strength imbalances in the non-dominant leg. These

findings suggest targeted interventions could enhance performance and reduce injury risk. Future research should use larger sample sizes, varied jump tests, and metrics like the Reactive Strength Index (RSI) for better insights. Overall, our study underscores the need for a nuanced approach to optimizing athletic performance and injury prevention.

6.1 Reliability and ethicality

The master's thesis meticulously adhered to a stringent set of ethical guidelines throughout its execution. Participants enlisted in the research were specifically volunteer volleyball players, chosen based on their proficiency level in the sport. On the test day, participants were confirmed to be in good health, ensuring their suitability for inclusion in the study.

To safeguard ethical standards, prior to engaging in the study, participants received comprehensive briefings detailing the exact nature and objectives of the research. These briefings aimed to fully inform participants about the study's purpose, procedures, and potential implications. Following this, participants were given the opportunity to provide their informed consent by voluntarily signing a research participation form, affirming their willingness to participate.

The ethical framework employed in the research was constructed upon the ethical recommendations for thesis writing established by universities of applied science (Arene). This framework ensured that the rights, dignity, and well-being of all participants were upheld throughout the research process, maintaining the highest ethical standards.

6.2 Conclusions and development proposals

Our study provides crucial insights into the nuanced relationships between muscle strength, jump performance, balance, and injury risk specifically within the context of beach volleyball athletes. Despite the absence of statistically significant correlations, our findings offer valuable conclusions and suggest avenues for future research and development tailored to this athletic domain.

In terms of conclusions, our analysis of the Functional Movement Screen (FMS) revealed limitations in shoulder mobility and trunk stability among the beach volleyball players in our sample. These findings suggest that improving shoulder flexibility and core strength might be beneficial for

this specific group, potentially enhancing performance and reducing injury risk. Additionally, a tendency was observed where athletes with higher muscle strength seemed to perform better in jump performance, which may indicate a relationship worth exploring further in future studies. The Y Balance Test also highlighted imbalances in flexibility and strength, particularly in the non-dominant leg, suggesting that interventions focusing on improving lower body symmetry, such as targeted strength and flexibility exercises, could be beneficial for these athletes. However, further research is needed to confirm these tendencies and their potential impact on performance and injury prevention.

Looking ahead, we propose several development strategies tailored to the beach volleyball context. Firstly, future research endeavors should prioritize larger sample sizes specific to beach volleyball athletes to ensure the relevance and applicability of findings to this population. Secondly, employing varied jump test methodologies, considering the distinct challenges posed by beach volleyball movements, can offer a comprehensive understanding of jump performance and its associations with muscle strength within this sport. Incorporating metrics such as the Reactive Strength Index (RSI) tailored to beach volleyball-specific movements may provide more nuanced insights into performance dynamics on the sandy court. Additionally, the development of targeted intervention strategies, customized to address identified deficiencies in shoulder mobility, trunk stability, and leg imbalances within the context of beach volleyball, holds promise for optimizing athlete performance and reducing injury susceptibility in this dynamic sport.

In conclusion, our study underscores the intricate interplay between muscle strength, jump performance, balance, and injury risk in the realm of beach volleyball. By addressing the unique needs and challenges of beach volleyball athletes and pursuing further research in this area, we can advance our understanding and contribute to the development of tailored strategies for optimizing performance and injury prevention in this exhilarating sport.

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Appendices

Appendix 1. Data management plan

A Data Management Plan created using DMPTuuli

Title: Corelation between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk in amateur male beach volleyball players

Creator:Evelina Jotkeviciute

Data Manager: Evelina

Affiliation: Jamk University of Applied Sciences

Template: Data management plan for theses at Jamk University of Applied Sciences

ID: 23858

Start date: 08-01-2024

End date: 30-04-2024

Last modified: 14-02-2024

CORELATION BETWEEN ISOKINETIC MUSCLE STRENGTH, DROP JUMP PERFORMANCE, DYNAMIC BALANCE, AND INJURY RISK IN AMATEUR MALE BEACH VOLLEYBALL PLAYERS

1. GENERAL DESCRIPTION OF DATA

Describe, what kinds of data is your research based on? What data will be collected, produced, or reused? What file formats will the data be in?

The research is based on both quantitative and qualitative data related to amateur male beach volleyball players participating in the highest-level amateur competitions. This includes:

- Quantitative data: Measurements from physical tests including isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk assessments.
- Qualitative data: Responses from surveys regarding volleyball experience, injury history, and willingness to participate in examination sessions.

What data will be collected, produced, or reused?

Data collected will include:

- Participant demographic information (age, height, weight).
- Volleyball experience (years of playing, level of competition).
- Injury history (previous injuries, severity, treatment).
- Test measurements (isokinetic muscle strength, drop jump performance, dynamic balance).
- Survey responses (willingness to participate in examination sessions, subjective feedback on training experiences).
- Data produced will encompass the results of statistical analyses conducted on the collected data, such as correlation coefficients and descriptive statistics.

What file formats will the data be in?

- Data collected from physical tests and surveys will likely be stored in digital formats such as:
- Excel spreadsheets (.xlsx) for survey responses and tabulated measurements.
- CSV files (.csv) for raw data from physical tests.
- Word documents (.docx) or PDFs for any qualitative data obtained from open-ended survey questions.
- Statistical software output files (e.g., SPSS files) for analyses conducted using statistical software.

How will the consistency and quality of data be controlled?

1. Standardized procedures will be followed for data collection.

2. Regular quality checks will be conducted.
3. Data will undergo validation and double-entry verification.
4. Equipment will be calibrated regularly.
5. Data cleaning will be performed before analysis.
6. Documentation and version control will be maintained for transparency and reproducibility.

2. ETHICAL AND LEGAL COMPLIANCE

What ethical and legal issues are related to your data management, for example, the Data Protection Act and other legislation related to the processing of the data? Do you process personal data (yes/no)?

Legal issues related to my data management: data protection laws, informed consent, data retention and disposal and ethical considerations.

The personal data would not be processed

Data access rights? Is the data confidential?

I am solely responsible for the data and its security. Confidentiality is assured in accordance with all ethical and confidentiality standards. Each participant signs a consent form before the study, granting permission for the results obtained to be used exclusively in my master's thesis.

3. DOCUMENTATION AND METADATA

How do you document and describe your data

To ensure that my data is findable, accessible, interoperable, and reusable for both me and others, I will document it thoroughly. This documentation will include metadata standards, README files, and other detailed descriptions to help users understand and utilize the data effectively. Metadata standards will be employed to provide structured information about the data, while README files will offer comprehensive guidance on data organization, formatting, and interpretation. By adhering to these practices, I aim to enhance the usability and impact of my research data.

4. STORAGE AND BACKUP DURING THE THESIS PROJECT

Where will your data be stored, and how will it be backed up?

The data will be stored in secure, reliable storage systems, such as password-protected servers to safeguard against unauthorized access. Regular backups of the data will be performed using automated backup systems to ensure redundancy and prevent loss in case of technical failures or data corruption. By employing these measures, I aim to protect the integrity and availability of the data throughout the research process.

Who will be responsible for controlling access to your data, and how will secured access be controlled?

As the sole researcher, I will be responsible for controlling access to the data. Secured access will be managed through robust user authentication, typically using a username and password. Access will be restricted to myself, ensuring that only I have the ability to view, modify, or manage the data. These measures will help protect the confidentiality and integrity of the data throughout the research process.

5. ARCHIVING AND OPENING, DESTROYING OR STORING THE DATA AFTER THE THESIS PROJECT

Can some of the data be made openly available and published? Where will the data be published?

The data will be securely stored and accessible only to myself throughout the research project.

Where will data be stored, and for how long? How is the data destroyed?

The data will be archived two years after the completion of the thesis, after which it will be securely deleted in accordance with data retention policies.

6. DATA MANAGEMENT RESPONSIBILITIES AND RESOURCES

Who will be responsible for specific tasks of data management during the life cycle of the research project? Estimate the resources.

To ensure that the data aligns with FAIR principles, resources will be dedicated to making it:

- Findable: Implementing metadata standards and utilizing appropriate data repositories to enhance discoverability.
- Accessible: I will be the sole user of the data, ensuring access for myself only.
- Interoperable: Structuring the data using standardized formats and protocols to promote interoperability with other datasets and tools.
- Reusable: There are no plans to share the data with others; it will be used exclusively in my thesis.

Appendix 2. Survey



Paplūdimio tinklininkų tyrimas

Esu Evelina Jotkevičiūtė, magistro studentė Suomijoje (JAMK, Master of Sport and exercises physiotherapy).

Magistro tema: „Correlation between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk in amateur male beach volleyball players“.

Šios apklausos tikslas-surinkti duomenis apie jūsų tinklinio patirtį ir traumų istoriją.

Kviečiu dalyvauti tyrime, kuriame įvertinsiu jūsų maksimalią izokinetinę raumenų jėgą, šuolį, pusiausvyrą ir traumų riziką. Visi tyrimai bus atliekami „Hila“, reabilitacijos ir sporto medicinos centre (Lvivo g. 101, Vilnius).

Jūsų dalyvavimas tyrime yra savanoriškas, o atsakymai bus naudojami tik tyrimo tikslais. Dalyvaudami tyrime sutinkate, kad jūsų elektroninis paštas būtų naudojamas informacijai apie tyrimą suteikti.

1. Kokiame paplūdimio tinklinio mėgėjų lygyje žaidžiate?

- A
- B
- C
- D

2. Ar per pastaruosius metus buvote patyręs traumą?

- Taip
- Ne

3. Įvardinkite visas traumas per pastaruosius metus (pvz.: lūžiai, patempimai, panirimai, raiščių plyšimai ir pan.)

4. Tyrimas bus dalinamas į tris dalis. Ar galėsite atvykti tris skirtingas, iš anksto suplanuotas, dienas?

Taip

Ne

5. Kontaktai

Vardas

El. paštas

Appendix 3. Consent to participate in the study (original)**ASMENS SUTIKIMAS DALYVAUTI TYRIME**

(data)

Aš, Evelina Jotkevičiūtė, rengiu magistro baigiamąjį darbą tema: Corelation between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk in amateur male beach volleyball players.

Tyrimo duomenų naudojimas: užtikrinamas asmens anonimiškumas ir tyrimo rezultatų konfidencialumas. Tyrimo rezultatai bus naudojami magistro baigiamajame darbe, tyrimo tikslui įgyvendinti ir kitoje mokslinėje veikloje.

Aš, _____, sutinku dalyvauti Evelinos Jotkevičiūtės atliekamame tyrime.

Tyrimo dalyvis (vardas, pavardė, parašas)

Consent to participate in the study (English)



CONSENT TO PARTICIPATE IN THE STUDY

(date)

I am Evelina Jotkevičiūtė and I am writing a master's thesis on the topic: Correlation between isokinetic muscle strength, drop jump performance, dynamic balance, and injury risk in amateur male beach volleyball players.

Use of research data: personal anonymity and confidentiality of research results are ensured. The research results will be used in the master's thesis, to implement the research objective and in other scientific activities.

I, _____, agree to participate in the research conducted by Evelina Jotkevičiūtė.

Research participant (name, surname, signature)

Appendix 4. FMS® 7 movement patterns

The 7 Movement Patterns

1. DEEP SQUAT



The Deep Squat pattern challenges total body mechanics and neuromuscular control. We use it to test bilateral, symmetrical, functional mobility and stability of the hips, knees and ankles. The dowel overhead requires bilateral symmetrical mobility and stability of the shoulders, scapular region and the thoracic spine. The pelvis and core must establish stability and control throughout the entire movement to achieve the full pattern.

2. HURDLE STEP



The hurdle step pattern is an integral part of locomotion and acceleration. This movement challenges the body's step and stride mechanics, while testing stability and control in a single-leg stance. The hurdle step requires bilateral mobility and stability of the hips, knees and ankles. The test also challenges stability and control of the pelvis and core as it offers an opportunity to observe functional symmetry.

3. INLINE LUNGE



The Inline Lunge pattern places the body in a position to simulate stresses during rotation, deceleration and lateral movements. The inline lunge places the lower extremities in a split-stance while the upper extremities are in an opposite or reciprocal pattern. This replicates the natural counterbalance the upper and lower extremities use to complement each other, as it uniquely demands spine stabilization. This test also challenges hip, knee, ankle and foot mobility and stability.

4. SHOULDER MOBILITY



The Shoulder Mobility pattern demonstrates the natural complementary rhythm of the scapular-thoracic region, thoracic spine and rib cage during reciprocal upper-extremity shoulder movements. This pattern also observes bilateral shoulder range of motion, combining extension, internal rotation and adduction in one extremity, and flexion, external rotation and abduction of the other.

5. ACTIVE STRAIGHT-LEG RAISE



The Active Straight-Leg Raise pattern not only identifies the active mobility of the flexed hip, but looks at the core stability within the pattern, as well as the available hip extension of the alternate hip. This is not so much a test of hip flexion on one side, as it is an appraisal of the ability to separate the lower extremities in an unloaded position. This pattern also challenges the ability to dissociate the lower extremities while maintaining stability in the pelvis and core.

6. TRUNK STABILITY PUSH UP



The Trunk Stability Push-Up pattern is used as a basic observation of reflex core stabilization, and is not a test or measure of upper body strength. The goal is to initiate movement with the upper extremities in a push up pattern without allowing movement in the spine or hips. The movement tests the ability to stabilize the spine in the sagittal plane during the closed kinetic chain, upper body symmetrical movement.

7. ROTARY STABILITY



The Rotary Stability pattern is complex, requiring proper neuromuscular coordination and energy transfer through the torso. This pattern observes multi-plane pelvis, core and shoulder girdle stability during a combined upper and lower extremity movement. The movement demonstrates reflex stabilization and weight shifting in the transverse plane, and it represents the coordinated efforts of mobility and stability observed in fundamental climbing patterns.