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Relationships of Functional Tests of a Field-Based Test Battery for the Identification of Athletes at Risk for ACL Injury: An Exploratory Factor Analysis

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Abstract: (1) Background: There is a need for a parsimonious test battery to efficiently assess the functional performance of athletes without redundant measurements. This study investigates the interrelationships between elements of an experimental field-based test battery during pre-season assessment (PA), with the purpose of enhancing comprehension of the underlying structure of the assessed variables and suggesting guidelines for the tests incorporated in a PA; (2) Methods: Sixty-two professional athletes performed a PA included strength, hop and core stability tests and evaluation of landing performance through kinetic and electromyographic data; (3) Results: For the dominant lower limb, the factor analysis resulted in 6 factors, explaining 79,04 % of the variance including core stability, Ground Reaction Forces, Dynamic balance, Hamstrings Strength, Quadriceps-Hamstring EMG ratio and Quadriceps performance. For the non-dominant lower limb, factor analysis resulted in 5 factors, explaining 76,60 % of the variance including Core stability, Dynamic balance, Ground Reaction Force, Quadriceps-Hamstring EMG ratio and Quadriceps - Abductors Strength. LESS was loaded with various factors. (4) Conclusions: Given the need for efficient field-based assessments that can be repeated throughout the season without sacrificing data quality, we suggest incorporating LESS, the prone bridge test, and force plate-based landing performance evaluation as key elements of the PA.

Keywords: knee injuries; risk screening; soccer; surface electromyography; factor analysis;

1. Introduction

Anterior cruciate ligament (ACL) injuries have been on rise in the last decades consisting a substantial problem for teams' performance, athletes' health and financial integrity of team and society. The multifactorial and complex nature of ACL injuries as well as the questionable efficacy of many screening tests to identify athletes at risk make the prevention of injuries a challenging task [1]. Athletes' pre-seasonal assessment (PA) is considered an essential first step in order to design effective injury prevention programs. PA through prospective research study and appropriate statistical methods fosters the identification of potential risk factors and athlete at risk of ACL injury. Further, the information gained by the application of PA can guide sports physical therapists to apply targeted preventive interventions to specific deficits in muscle and performance. Although PA is a routine practice for football teams, there are currently no established guidelines in place. Determining which evaluations should be incorporated into a PA and establishing the threshold values that could identify an athlete at risk remain subjects of ongoing investigation [2,3].

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Recently, a comprehensive set of assessments has been suggested for evaluating knee functionality to determine safe participation in sports involving pivoting movements, particularly when considering an athlete's return to sport (RTS) following ACL reconstruction. An effective RTS assessment protocol should incorporate a diverse range of evaluations, including tests for muscular strength, jumping ability, and the quality of movement patterns [4].

Researchers primarily aim to develop optimal PA that eliminates the need for expensive and time-consuming lab tests. Their goal is to provide trainers and medical staff with affordable, field-based screening methods that can be implemented even by teams with limited budgets, without disrupting the established training plan. Utilizing portable devices like push dynamometers, along with field tests such as the Landing Scoring System (LESS), PA could provide a comprehensive evaluation of athletes' functional performance and injury risk profiles without compromising the high standards of validity and reliability [5,6]. This approach may offer a more complete examination of an athlete's capabilities and potential vulnerabilities. Nevertheless, the performance on single-limb drop-jump landing has been identified as a potential contributing factor to ACL injuries, and the evaluation requires more sophisticated equipment such as force plates and electromyography, despite their portability.

It appears that there is a substantial number of physical measurements encompassing strength, core stability, and landing performance domains, with various metrics available for analysis that could be included in PA; Therefore, there is a need for a parsimonious combination of tests and measures to effectively determine the functional performance of athletes without potentially redundant measurements that consume additional time. A step toward addressing this requirement is the utilization of exploratory factor analysis to synthesize and categorize data by grouping measurement items into latent factors based on item correlations. This approach may potentially allow for the elimination of certain measurements within the battery of tests. Therefore, the objective of this investigation was to examine the relationships among components of a proof-of-concept test battery during pre-season assessment, to facilitate understanding of the underlying structure of the measured variables and propose guidelines for the incorporated tests included in a PA.

2. Materials and Methods

2.1. Study Design

The research employed a cross-sectional design, adhering to the STROBE guidelines for reporting observational studies in epidemiology, specifically those pertaining to cross-sectional investigations [7]. In the period spanning from the end of July to the beginning of August 2022, a preliminary screening evaluation was conducted on football players at both the professional and semi-professional levels. The evaluations were conducted at the teams' training facilities using mobile equipment.

2.2. Participants

Sixty-two athletes from five football teams competing in the professional Greek second and third divisions participated in the study. To be eligible for the study, participants needed to meet several requirements: they had to be free from injuries or completely rehabilitated, hold a valid professional contract with their team, and have participated in five to six training sessions per week during the previous season, with adjustments based on the game calendar. Demographics are presented in Table 1.

Table 1. Athletes' demographics characteristics.

	Mean ± SD
Age	21,32±4,54
Weight	74,64±8,03
Height	178,75±6,42
BMI	23,33±1,83

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Football starting age	7,40±2,66
Years in Professional Level	3,27±3,49

2.3. Data Collection

The athletes initially made 10 minutes warm-up that included jogging and mobility exercises. Each athlete completed the PA that included drop landing, strength, core stability and balance tests. All tests were performed for the dominant and non-dominant limb. The preferred kicking lower limb was defined as the dominant lower limb [8].

2.3.1. Drop Landing

The unilateral drop jump landing test was chosen to closely reflect the real demands of the sport. The participants were asked to perform a single-lower limb drop jump landing by jumping from a box 30-cm in height, which was placed 5 cm behind the force plate. The participants were instructed to jump with two feet, land on the testing lower limb, stabilize as quickly as possible, and then balance their hands on their hips. The configuration of drop landing test is presented in Figure 1. Before testing, one test trial for each lower limb was performed for familiarization. Three trials were performed for each lower limb. All trials were performed barefoot, but with socks to prevent variations caused by shoe properties. A trial was discarded if the player lost his balance and touched the floor with the contralateral foot, or if moved his arms from the hip to regain balance.

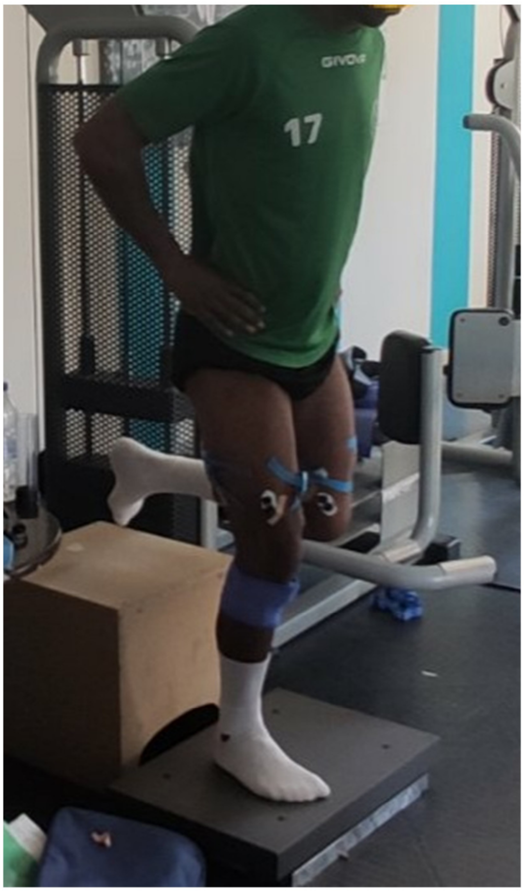

Figure 1. Drop landing test configuration.

The Ground Reaction Forces (GRF) from the dominant and non-dominant lower limbs were measured using a 40 × 60 cm force plate (Bertec) at a sampling frequency of 1000 Hz. The force plate was placed at a hard, horizontal, and anti-slip surfaces of each team facility. A digital inclinometer was used when installing the equipment for each team to verify the zero-degree inclination of the

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force plate. The offline data processing was performed using Microsoft Excel. The raw GRF data were cropped from the initial contact (vertical GRF > 10 N) to 2,5 s after the initial contact. Raw GRF data of GRFs at the x-, y-, and z-axes along with the three moment components were used to compute the Center of Pressure (CoP). Outcome measures based on ground reaction forces were the peak Vertical Ground Reaction Force (VGRF), the rate of force development (RDF), the time-to-peak GRF, the center of pressure (COP) standard deviation at the x- and y- axes, and total COP length for 2,5 seconds after landing. The RDF was calculated as the peak VGRF divided by the duration between the initial contact and peak vGRF [9].

2.3.2. Surface Electromyography

Electromyographic (EMG) data were reported according to the International Society of Electrophysiology and Kinesiology [10] as follows: passive disposable dual-surface Ag/AgCL circular electrodes, 27 mm × 40 mm (width × length), with low-impedance solid gel in the contact area (Noraxon, Inc.) were placed in the following muscles of each lower lower limb: vastus medialis (VM). Vastus lateralis (VL), and biceps femoris (BF). The skin over the muscles was shaved, cleaned using an isopropyl alcohol solution, and allowed to vaporize so that the skin was dry before the electrodes were placed. The same researcher identified the muscles and placed the electrodes in the middle part of the muscle bellies on both lower limbs parallel to the direction of the muscle fiber, according to the recommendations of SENIAM [11]. The sensors, electrodes, and cables were slightly bandaged with Kinesio tape and elastic bands to prevent motion artifacts and cable movements. The six surface EMG signals were recorded using a telemetric EMG receiver (Ultium Desktop Receiver; Noraxon, Scottsdale, AZ, USA) at a sampling frequency of 2000 Hz. The signal was pre-amplified with an overall gain of 500, filtered with a high-pass filter set at 10 Hz, and low-pass filtered with a cutoff at 500 Hz. Each EMG channel had a common mode rejection ratio greater than 100 dB, and the input impedance was greater than 100MΩ. The raw EMG signals were smoothed in the subsequent offline analysis using a Root Mean Square (RMS) filter with a time constant of 50 ms [12]. The EMG RMS for each muscle during the drop-landing test was normalized to the maximal EMG RMS amplitude obtained from the respective muscles during isometric muscle voluntary contraction (MVIC). Muscle activation was recorded during muscle strength testing as described below. Mean EMG RMS amplitudes were obtained for the pre- and post-landing phases of each drop landing. The EMG RMS amplitude was obtained for a 25-ms window before and 70-ms after landing. The time windows for EMG amplitude analysis for the prelanding and postlanding phases were chosen based on the relevance of these short durations of ACL injury [13]. The 25-ms pre-activation has been used to detect ACL injury risk in athlete populations [12,14]. In addition, a time window of 70-ms for the post-landing phase was chosen because the ACL is injured during the first 70ms after initial contact [13].

Furthermore, two EMG sensors were placed over the tibial tuberosity of each lower limb and operated as inertial measurement units to detect the initial contact. The sampling rate of the accelerometer was set to 500 Hz. The IMU measures the accelerations along the x-, y-, and z-axes. Behavioral analysis of the IMU during drop landing was conducted in a pilot session before the preseason measurements. The x-axes corresponding to the vertical axes and resultant accelerations were observed in relation to the force platform data. In the pilot session, the resultant acceleration data closely matched the force platform data, while the IMU data of the x-axis were presented with delay. At the resultant acceleration during the flight phase, the acceleration amplitude was close to 0 g, and when touching the floor, an initial peak close to 1G was noted. Thus, to determine the landing in the present study, a cutoff point was set at 1G of the resultant acceleration of the tibia. The Quadriceps: Hamstring (Q:H) EMG ratio prelanding and postlanding was used in the analysis.

2.3.3. Muscle Strength Testing

Isometric tests for the quadriceps and abductors, as well as isometric for the hamstrings along with the brake test, were performed using a Hand-Held Dynamometer (HHD) (MicroFET 2; Hoggan Scientific). HHD is suitable to measure isometric muscle strength in field-based setting with moderate good reliability and validity when compared with the gold standard isokinetic dynamometer [5,15]. After a warm-up including two trials of approximately 2 s of submaximal contraction, athletes performed three maximal 5 s contractions, separated by a rest of at least 20 s. All tests were recorded in Newton, and the higher value was used for the analysis.

The evaluation of quadriceps muscle strength was performed as described by Hansen at al. [16] in the modified belt-stabilized HHD configuration. Further, to prevent thigh movement during maximum isometric quadriceps contraction, a physical therapist stabilized the thighs by applying pressure directly above the hip joint. Participants were instructed to maximally contract their quadriceps by attempting to forcefully extend their tibia as much as possible.

The evaluation of hamstring strength included a standard configuration for the measurement of isometric muscle test described elsewhere [5] and the "brake test" [5]. During the "brake test" after about 3 seconds of maximal isometric contraction, the examiner extended the knee. Following the "brake," the external force was removed. The hip abductor strength was evaluated with athletes lying on their side as described by Thoborg et al. [17]. The configuration of the strength tests is presented in Figure 2.

(a) (b) (c)

Figure 2. Strength test configuration with Hand Held Dynamometer. (a) Quadriceps strength test; (b) Hamstrings strength test; (c) Abductors strength test.

2.3.4. Triple Hop for Distance

Athletes performed the functional test triple hop distance (THD) test as described elsewhere [18,19]. THD is a valid and reliable measurement for the identification of strength and power deficits in the lower extremities and it has been suggested to be incorporated into the PA [18,19]. Each lower limb was tested three times. A successful trial required the participant to maintain balance on one lower limb for roughly 3 seconds after landing, without touching the ground with the other foot or adjusting their stance to stay stable. To prevent fatigue, participants alternated lower limbs between trials. A rest period of approximately 10 seconds was provided between hops, resulting in a 20-second break between trials on the same lower limb.

2.3.5. Landing Error Scoring System

To evaluate the quality of landing we employed the test Landing Error Scoring System (LESS), a validated and reliable assessment tool for evaluating landing patterns during drop jump tasks [6]. The guidelines by Padua et al. [20] was followed for the configuration of the test and the evaluation of the landing technique. Participants jumped from a 30 cm platform with both feet, landing at a distance equal to half their height, before executing a maximal vertical jump. After 1-2 familiarization trials, three successful jump-landing attempts were recorded. Two standard cameras (Panasonic HC-V770 and Sony HDR-CX625) captured frontal and sagittal views of the trials. The recorded footage was stored on a computer and analyzed using Kinovea software (0.8.26 experimental version). A single examiner, the NIL author with clinical experience in sports injury assessment, rehabilitation, and proper use of the LESS scoring instrument, rated all videos [3,21,22]. Additionally, two evaluators assessed a subset of 37 athletes' trials, demonstrating excellent intra-rater reliability for

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both experienced (interclass correlation coefficient (ICC) = 0.95, 95% CI, 0.89–0.97; $p < 0.001$) and novice raters (ICC = 0.95, 95% CI, 0.90–0.97; $p < 0.001$), as well as very good to excellent inter-rater reliability for the first (ICC = 0.90, 95% CI, 0.77–0.95; $p < 0.001$) and second (ICC = 0.86, 95% CI, 0.71–0.93; $p < 0.001$) evaluations [21]. The average LESS score derived from three trials was used for the analysis.

2.3.6. Core stability

The evaluation of the core stability is of high importance due to its potential connection with ACL injuries [23]. To evaluate the endurance of abdominal muscles the prone bridging test was used according to de Blaizer et al. [24]. Side bridge tests were used to evaluate the endurance of the lateral abdominal muscles as proposed by McGill et al. [25]. The Biering-Sonsen test was used to evaluate the endurance of the back extensors [26]. Researchers documented the longest duration, measured in seconds, that participants maintained the correct posture. This data was subsequently utilized for statistical analysis.

2.3. Statistical Analysis

A series of EFA was performed to identify the most appropriate factor solution that better describes the underlying structure of the measured variables. The EFA is a multivariate statistical approach that groups measurement items into latent factors based on item correlations. EFA is a statistical method that enables data reduction and the summarization of fewer factors that better represent the measured indicators (Hair et al., 2010). Multivariate regression was initially conducted to explore multicollinearity among variables using the variance inflation factor as a metric (cut-off value of 3) [27]. Time-to-Peak (dominant lower limb: VIF 4,515, non-dominant lower limb: VIF 6,078) was removed in this phase because of high correlation values with peak VGRF and RFD; all the remaining variables showed a VIF below the cut-off value. An exploratory factor analysis (EFA) was then conducted on hamstring strength, hamstring strength (brake-test), triple hop, prone bridge, dominant-side bridge, non-dominant side bridge, Biering-Sorensen Test, peak VGRF, RDF, COP length, COP SDx, COP SDy, LESS, Quadriceps strength, Abductors strength, Quadriceps-Hamstrings (Q-H) EMG ratio pre-landing and Q-H EMG ratio post landing.

The appropriateness of data for EFA was examined using the Barlett's test of sphericity and KMO (Kaiser-Meyer Measurements of Sampling Adequacy) statistics. For suitability of the data, Barlett's test of sphericity statistics should be significant, and KMO values above 0.50 are acceptable [28]. The Extraction method of Principal Component Analysis and Promax rotation method were used for the EFA. [28,29]. Eigenvalues greater than 1.0 rule and scree test were followed to determine the number of factors to retain.

Communalities measure the between item's correlation. Items with low communalities values < 0.30 are candidates for removal after examining the pattern matrix. Pattern matrix is reviewed to identify the structure of extracted factors and the load of items on each factor. A measure item was removed when extreme cross-loading among factors was observed. An item should clearly load into only one factor. If cross-loading exists, the primary loading must be at least 0.20 larger than the second loading. The analysis of the dominant lower limb yielded a high cross loading of LESS among core stability, hamstring strength, quadriceps strength and Q-H EMG ratio. Further, high cross loading was yielded at abductors strength with quadriceps strength, Q-H EMG ratio, and Core Stability. Consequently, the decision was made to exclude these variables from the Exploratory Factor Analysis (EFA), which was subsequently conducted without them. For the non-dominant lower limb, LESS was removed due to low communality and high cross-loadings among core stability, dynamic balance, and strength. Further, Biering-Sorensen was highly correlated with all the factors and removed. Additionally, hamstring strength and hamstring strength (brake-test) were both also highly cross-loaded among strength (abductors and quadriceps), core stability, and GRF. Thus, the EFA was performed again without them. The SPSS (v. 28) was used for data analysis.

3. Results

Descriptive statistics for all the variables collected are presented in Table 1. A correlation matrix (Table 2) was computed among all the collected variables. As explained above, LESS and abductors strength for dominant lower limb analysis and LESS, hamstring strength and hamstring strength (brake-test) along with and Biering-Sorensen test for non-dominant lower limb analysis were not included in the EFA. The KMO values were 0.647 for the dominant lower limb and 0,621 for the non-dominant lower limb, confirming the factorability of the data. For the dominant lower limb, the correlation matrix resulted in 6 factors, explaining 79,04 % of the variance (Figure 2). The first factor (F1) accounted for 22.5 % of the total variance in the data sets. The results showed that Factor 1 (F1) was positively correlated with prone bridge, side bridge, side bridge and Biering Sorensen: This first component could be named "core stability". The second factor (F2), which accounted for 21.63 % of the total variance, showed a positive correlation with peak VGRF and RDF: This component could be defined as "force attenuation." The third factor (F3) represented 10.52 % of the total variance. The D3 was positively correlated with total COP length, COP SDx, and COP SDy: this component could be referred to as "dynamic balance". The fourth factor (F4) accounted for 10,17% of the total variance, showing a positive correlation with isometric hamstring strength and the hamstrings brake-test. This factor could be named as "Hamstring Strength". The fifth factor (F5) represented 8,43 % and was positively correlated with Q-H EMG ratio pre-landing and Q-H EMG ratio post-landing. This factor could be referred to as "Q-H EMG ratio". Finally, the sixth factor (F6) accounted for 5,77% of the total variance and was positively correlated with Quadriceps strength and triple hop. This factor could be named "Quadriceps performance".

Table 2. Pattern Matrix with factors and measured items for the dominant lower limb. Abbreviations: F-Factors, Q-H EMG-Quadriceps-Hamstrings Electromyography, THD-Triple Hop for Distance, D-Dominant, ND-Non-dominant, VGRF-Vertical Ground Reaction Forces, COP SD-Centrer of Pressure Standard Deviation, RDF-Rate of force development.

	F1 (22,5%) Core stability	**F2 (21,63%) GRF**	**F3 (10,52%) Dynamic balance**	**F4 (10,17%) Hamstrings Strength**	**F5 (8,43%) Q-H EMG ratio**	**F6 (5,77%) Quadriceps performance**
Q-H EMG ratio prelanding					0,844	
Q-H EMG ratio post-landing					0,936	
Hamstrings isometric (brake)				0,884		
Hamstrings isometric				0,866		
Quadriceps isometric						0,871
THD						0,731
Prone Bridge	0,837					
Side Bridge D	0,885					
Side Bridge ND	0,713					
Peak VGRF-normalised		0,973				
Total COP length			0,678			
COP SDx			0,791			
COP Sdy			0,922			
RDF		0,959				
Biering Sorensen	0,667					

For non-dominant lower limb, correlation matrix resulted to 5 factors, explaining 76,60 % of the variance. The first factor accounted for 22.19% of the total variance in the data sets. The results indicated that factor1 (F1) was positively correlated with prone bridge and dominant side bridge, non-dominnat side bridge and triple hop: thus, this first factor could be named "core stability". The second factor (F2) represented 20,35% of the total variance and was positively correlated with COP length, COP SDx and COP SDy. Thus, this factor could be named "dynamic balance". The third factor (F3) accounted for 13,78% of the total variance and was positively correlated with VGRF and RDF.

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The F3 could be referred as "force attenuation". The forth factor (F4) accounted for 10,12% of the total variance and was positively correlated with Q-H EMG ratio pre-landing and Q-H EMG ratio post-landing. Thus, this factor could be named "Q-H EMG ratio". Finally, the fifth factor (F5) represented 8,13% of the total variance and was positively correlated with Quadriceps and Abductors (QD-ABD) Strength. Thus, the F5 could be referred as "Strength".

Table 3. Pattern Matrix with factors and measured items for the non-dominant lower limb. Abbreviations: F-Factors, Q-H EMG-Quadriceps-Hamstrings Electromyography, THD-Triple Hop for Distance, D-Dominant, ND-Non-dominant, VGRF-Vertical Ground Reaction Forces, COP SD-Centrer of Pressure Standard Deviation, RDF-Rate of force development, QD-Quadriceps, ABD-Abductors.

	F1 (22,19%) Core stability	F2 (20,35%) Dynamic balance	F3 (13,78%) GRF	F4 (10,12%) Q-H EMG ratio	F5 (8,13%) QD-ABD Strength
Q-H EMG ratio prelanding				0,864	
Q-H EMG ratio post-landing				0,897	
Peak VGRF-normalised			0,973		
RDF			0,935		
Total COP length		0,704	0,318		
COP SDx		0,725			
COP Sdy		0,939			
Prone Bridge	0,784				
Side Bridge D	0,869				
Side Bridge ND	0,886				
Abductors isometric					0,828
THD	0,619				
Quadriceps isometric					0,848

4. Discussion

The purpose of this study was to determine if the different components of a PA involve a series of functional tests used to assess the functional capacity of football athletes, provide unique information regarding lower limb performance and core stability. The factors loadings on the dominant and non-dominant lower limb indicated that multiple measures of dynamic balance, force attenuation and muscle activation loaded onto separate factors, indicating that provide unique information and cannot be extracted from other functional tests. The stability of the knee joint during dynamic activities is influenced by the neuromuscular control of the thigh muscles, which regulates knee motion and loading. A balanced co-contraction of the quadriceps and hamstrings at one-lower limb landing is crucial in order to manage the loading effectively during landing [30]. EMG and kinetic data seem that provide unique information but require additional equipment and time, which may limit its application to wider field settings. In the present study, there was no functional test that was highly correlated in order to replace these time – consuming measurements.

Core stability tests along with kinetic data accounted for the greatest amount of the total variance. Although, greatest core endurance has been associated with better landing performance [23], the results of the present study support the use of both measurements for core stability and landing performance, such as prone bridge and peak VGRF. These factors are loaded on separate factors, suggesting the uniqueness of these information. However, since the factor "core stability" prone bridge was highly correlated with side bridge tests it can be suggested that for core stability one of these two tests can be safely performed.

The triple hop test was correlated with quadriceps strength on dominant lower limb, while, on the non-dominant lower limb, was correlated with core stability. The relationship between isokinetic quadriceps strength and triple hop has been identified in previous studies [18,31]. In the present study, a moderate relationship with quadriceps strength in the dominant lower limb and core stability with non-dominant lower limb was identified. The high loadings on abdominal endurance tests on core stability and quadriceps strength on factor "quadriceps performance" support that triple hop could be omitted by the battery as its information is similar to the information given from quadriceps strength and core stability tests.

Finally, regarding LESS there are some interesting results. Note that LESS has been used as a valid and reliable tool for the identification of high-risk biomechanical patterns for ACL injury [6]. In addition, LESS has been identified as the most crucial predictor for ACL risk categorization with a cutoff point of LESS = 5, followed by prone bridge test [3]. The results of the present study showed that LESS does not provide unique information on a single aspect of neuromuscular control, based on the cross-loading with various factors during factor analysis. On the contrary, it may reflect the function of various components of neuromuscular control, although not determined by research yet [32]. Therefore, the utilization of LESS in the PA may provide a first holistic view of the athlete's neuromuscular control.

Further analyses with prospective design and greater sample size are needed to establish an optimal PA. The sample size, although limited, encompasses measurements that necessitate sophisticated equipment and expertise in data collection and processing. Further research employing confirmatory factor analysis is required to validate the findings of the current study.

5. Conclusions

The configuration of an optimal PA is crucial for designing effective and individualized injury prevention programs. Considering the necessity for time-efficient field-based tests that can be conducted multiple times throughout the season without compromising the quality of information obtained, we propose the utilization of LESS, prone bridge test, and landing performance assessment with force plates as fundamental components of the PA. Strength and muscle activation assessment could be conducted in a subgroup during a subsequent phase for those athletes who exhibited suboptimal performance in the initial PA to inform the development of individualized injury prevention programs that address specific deficits in muscle strength and activation.

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Informed Consent Statement: Written informed consent has been obtained from all subjects to publish this paper.

Data Availability Statement: We encourage all authors of articles published in MDPI journals to share their research data. In this section, please provide details regarding where data supporting reported results can be found, including links to publicly archived datasets analyzed or generated during the study. Where no new data were created, or where data is unavailable due to privacy or ethical restrictions, a statement is still required. Suggested Data Availability Statements are available in section "MDPI Research Data Policies" at https://www.mdpi.com/ethics.

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