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Peak Isokinetic Torques of Football Players Participating in Different Levels in Cyprus and Lower Limb Asymmetries

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Abstract: BACKGROUND: Lower body strength is considered to be a critical component towards successful exercise performance in football players. The aim of this study was to describe the peak isokinetic torque of the knee in professional football players of different League divisions in Cyprus and assess bilateral and unilateral asymmetries of strength. METHODS: Four hundred and twenty-nine professional male football players participated in this study (Division 1, n = 245 and Division 2, n = 184). The isokinetic muscle function of the knee was measured using the Humac Norm Testing and Rehabilitation system (CSMi Medical & Solution, USA). Measurements were collected at angle speeds of 60 °/sec and 300 °/sec, for 3 and 25- repetitions respectively. RESULTS: At both angle speeds, peak isokinetic torque of the knee joint was significantly higher in the right and left knees of players in Division 1 (D1) compared to those competing in Division 2 (D2). At both testing speeds, peak flexor torque of the left hamstrings was significantly higher in players participating in Division 1 compared to those competing in Division 2. The right hamstrings yielded similar results, except at 60 °/sec, where no difference was found between the groups. CONCLUSION: This study provides valuable data regarding the forces produced by the lower body of football players participating in D1 and D2 in Cyprus, whilst also disclosing there to be no bilateral imbalances or abnormal H/Q ratios. The results of this study may provide pertinent information that can be used by the coaching staff for training and recruiting purposes.

Key words: Isokinetic testing, muscle imbalances, knee torque.

1. Introduction

Lower body strength is considered to be a critical component towards successful exercise performance [1, 2] and injury prevention [3] in football players. Possessing muscle balance may positively influence the level of athletic performance whereas muscular imbalances may have negative impact on performance. The injury may also depend on the magnitude of the imbalance [4]. Technical video analysis demonstrated that football players are often involved in high intensity activities that require high levels of lower body strength [1]. The players are frequently required to use their lower limbs unilaterally for actions such as kicking and dribbling [5, 6]. This results in strength asymmetries between the two legs and in unbalanced agonist and antagonist muscle groups [7, 8]. Asymmetries and weakness of the lower limbs were linked to increased rate of musculoskeletal injuries in elite football players [3, 9-11] with the rate of muscle injury being significantly greater in players with untreated imbalances compared to those with no imbalances [3, 10]. Even though several investigators have suggested that asymmetries are linked to increased rate of musculoskeletal injuries in elite football players [3, 11, 12], strength adaptations in players with high professional training age was demonstrated to correlate with lower risk of football injuries [7, 10].

Pre-season isokinetic testing may provide valuable information to the coaching team for the design of the most appropriate training protocols thus allow a more productive pre-season preparation. When football players of varying divisions were compared

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isokinetically, elite players exhibited higher knee flexor torque compared to sub-elite and amateur football players. This was found to be the case at all isokinetic speeds except at 300 °/sec, suggesting that hamstring strength plays an important role in joint balance and stabilization [13]. Research demonstrated that the probability of sustaining a hamstring injury is high if the concentric H/Q ratio, tested isokinetically at 60 °/sec, is less than 0.8 [12]. Conventional H: Q ratios range from 0.6 to 0.9 [14] with those ratios increasing when testing at higher velocities [15, 16]. Low H/Q ratios were associated with strong quadriceps muscles in football players, while those with lower quadriceps strength demonstrated H/Q ratios around the suggested values [17]. When the quadriceps generates substantially greater forces than the hamstrings, excessive anterior translation may occur, especially during dynamic activities, such as those that involve sudden change in position. This may in turn, lead to both hamstring strain [12] and ACL injuries [18, 19]. Hamstring strains accounts for 12% of the total injuries sustained over two seasons [20]. This equated to 15 matches and 90 days missed per club per season. Furthermore, the re-occurrence of hamstring strains is reported to be as high as 12%, and is considered greater than the reoccurrence rate for all other injuries (7%), thus emphasizing the importance of preventing the initial injury [20].

A difference between the right and left side is another important parameter measured through the isokinetic testing. Bilateral asymmetries of more than 10% have been reported to pose an increased risk of injury to football players [21]. With regards to bilateral imbalances in female collegiate athletes, it has been suggested that when a difference of 15% or more exists on either side of the body, the likelihood of sustaining an injury to the lower extremities increases [22].

Knowledge of peak isokinetic torques of the knee in professional football players may provide the coaches with pertinent information not only on how to maximize exercise performance but also for recruiting purposes. Normative values at 60 °/sec on athletes show concentric torque measurements ranging from 201 to 319 N.m, and 114 to 170 N.m for quadriceps and hamstring muscle groups respectively [23, 24]. A significant relationship between knee peak torques and sprint times was revealed in a study of English Premier League football players. The study indicated that high muscle strength is an important parameter for sprint running times in football players [24]. To the best of our knowledge, there is currently no published data on peak torques of quadriceps and hamstring muscles of football players participating in different divisions in Cyprus. Therefore, the primary aim of this study was to describe the peak isokinetic torque of the knee for these athletes. The secondary aim was to investigate bilateral and unilateral asymmetries of strength. Due to the more advance training regiments and rigorous gaming schedule, we hypothesise that division one athletes will be stronger and have less imbalances compared to division two players.

2. Materials and Methods

2.1 Study Design

Descriptive characteristics included age, height and weight (Table 1). A wall stadiometer was used to measure height. The isokinetic muscle function of the

Table 1 General characteristics of participants.

Variables	D1, (*n* = 245) Mean (SD)	D2, (*n* = 184) Mean (SD)
Age (yrs)	25.5 (4.7)	25.0 (4.9)
Height (cm)	178.4 (12.9)	178.8 (9.5)
Weight (kg)	77.3 (7.0)	75.6 (9.5)

Values are Mean (SD).

D: Division.

knee was measured using the Humac Norm Testing and Rehabilitation system (CSMi Medical & Solution, USA).

2.2 Participants

Four hundred and twenty-nine professional male football players from two different divisions participated in the study (D1, n = 245 and D2, n = 184). All participants completed a written consent to participate in the study, after being briefed on the procedures and methods. All subjects had medical clearance by their club's medical doctor to perform the test. Their participation in the study was voluntary. The study was approved by the University of Central Lancashire Science, Technology, Engineering, Medicine and Health (STEMH) ethics committee board (reference number STEMH 541) and by the Cyprus National Committee on Bioethics (CNCB).

2.3 Procedures

Prior to testing, the participants performed a controlled 10 minutes warm up (100 watts at 70 rpm) on a mechanically braked cycle ergometer (Monark 894 E Peak Bike, Weight Ergometer, Vansbro, Sweden). Next, the participants were permitted to perform their own warm up routine (1 minute) to increase confidence prior to the testing. The testing began with the players sitting with their thigh at an angle of 85 ° to the trunk, which was measured by the chair's goniometry. The mechanical axis of the dynamometer was aligned with the knee's lateral epicondyle. The knee's range of motion was 100 ° (0 ° of extension to 100 ° of flexion). The thigh area and the upper body were tightly fixed using the chair's strap and a belt. In addition, the ankle was fixed by a strap that was in accordance with the length of the lower leg. The axis was then adjusted using an adapter. The participants performed flexion and extension exercises of the lower limb 3-times at speeds of 60 °/sec and 300 °/sec, in order to familiarize themselves with the procedure. The participants performed 3 repetitions at the angle speed of 60 °/sec and 25 repetitions at 300 °/sec. Each player was individually tested and encouraged to exert maximal effort during the functional performance test. Participants who reported musculoskeletal injuries in the six months prior to testing were excluded from the study.

2.4. Statistics

SPSS for windows version 23.0 (SPSS Inc., USA) was used for the analysis of the results. To test for group differences an independent sample t-test was performed. The Shapiro-Wilk testm was used to verify approximately normal statistical distributions. The Levene's Test for Equality of Variances was used to verify the homogeneity of variance. Means and standard deviations (*SD*) were computed for all the parameters. The level of significance was set at $P \leq 0.05$.

3. Results

Peak isokinetic torque of the knee joint was significantly higher in players participating in D1 compared to those of D2. This was found to be the case in both knees, at angle speeds of 60 °/sec ($P < 0.05$) and 300 °/sec ($P < 0.05$) (Table 2). Furthermore, peak hamstring torque was significantly higher in players participating in D1 compared to those of D2, for the left hamstrings at both testing speeds ($P < 0.05$). Referring to peak torque of the right hamstrings, results demonstrated significantly higher torque of the right flexor at 300 °/sec ($P < 0.05$) for those playing in D1, while no such difference was observed between D1 and D2 players for the peak torque of the right flexor at 60 °/sec (Table 2). Table 3 shows the results comparing the ratio (H/Q) between the two divisions. No significant differences were observed between the two divisions and the mean values were above 0.7. In addition, no bilateral significant differences were found. It should be noted that even though there was no statistical significance for bilateral imbalances, 76 (56 D1 and 20 D2 players) out of the 429 players, accounting

Table 2 Comparison of isokinetic peak torque.

			D1	D2
Extensor (Nm)	60 °/sec	Right	***239.7 (33.5)	228.6 (32.5)
		Left	**234.8 (36.1)	224.9 (35.4)
	300 °/sec	Right	***125.1 (17.4)	119.6 (17.2)
		Left	***122.7 (17.9)	117.8 (16.5)
Flexor (Nm)	60 °/sec	Right	176.7 (27.6)	170.6 (25.8)
		Left	**178.9 (27.0)	171.7 (29.5)
	300 °/sec	Right	**104.7 (15.8)	99.7 (17.0)
		Left	***106.1 (15.6)	100.9 (16.9)

Values are Mean (SD) *$P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
D: Division.

Table 3 Comparison of the Hamstring to Quadriceps ratios at 60^0/sec.

H:Q	D1	D2
Right Leg	0.74 (0.15)	0.75 (0.11)
Left Leg	0.77 (0.18)	0.76 (0.11)

Values are Mean (SD) * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
H:Q: Hamstring to Quadriceps ratios.
D: Division.

for 17.72% of the total number of players, displayed such imbalances between the right and left quadriceps. Also, 84 players (65 D1 and 19 D2 players), accounting for 19.59% of the total number of players, displayed imbalances between the right and left hamstrings. Furthermore, 18 players (13 D2 players and 5 D1 players), which accounts for the 4% of the total participants, showed H/Q ratios of less than 60%.

4. Discussion

The aim of this study was to describe the isokinetic peak torque of the knee in professional football players of different divisions in Cyprus, as well as to assess bilateral and unilateral asymmetries of strength. This study demonstrated that the isokinetic peak torque of D1 professional players in Cyprus vary significantly when compared to D2 players. Players in D1 exhibited greater peak torques at both slow and fast testing speeds. The torque measurements obtained in this study were in keeping with previous studies that demonstrated concentric quadriceps torques to range from 201 to 319 N.m, and hamstring torques from 114 to 170 N.m, when tested at 60 °/sec [23, 24]. Therefore, this study provides important torque data for professional players in Cyprus and demonstrates that the isokinetic torque production of players in the country (both D1 and D2) is similar to those playing abroad. The H/Q ratios of this study were also similar to those in previous reports. Conventional H:Q ratios range from 0.6 to 0.9 [14] with such ratios rising when testing at higher velocities [15]. Ratios below 0.8 have been reported to increase the likelihood of sustaining a hamstring injury [12]. Although not a statistically significant finding, 18 players, accounting for the 4% of the total number of participants, displayed H/Q ratios of less than 0.6. This may aid the coaches in developing pre-season training routines, by enabling them to focus on the hamstrings in order to minimize the risk of injury. It is suggested that the strength of the hamstrings should be higher, due to the fact that it enhances the stability of the knee joint during short distance sprints, allowing for correct foot techniques [2]. Therefore, football players with ratios of less than 0.6 should be examined further. The results of this study demonstrated no significant bilateral imbalances in professional players of D1 and D2. Despite the non-statistically significant differences it should be noted 76 (56 D1 and 20 D2 players) out of the 429 players displayed imbalances between the right and left quadriceps. Also, 84 players (65 D1 and 19 D2 players) displayed imbalances between the right and left hamstrings. Given the fact that players who sustained musculoskeletal injuries in the six months prior to testing commencing, were not included in this study, these results can be partially explained. Previous injury and/or insufficient rehabilitation may contribute to increase or favorite imbalances [10]. Furthermore, professional players (D1 and D2 players) may display less tendency for strength asymmetries and better strength ratios of the knee [7, 10]. Researchers explained that players, with a greater level of training experience, effectively balance the use of the lower extremities [7], so as to display less strength asymmetries. The fact that previously injured players were excluded from this study, and only D1 and D2 players with vast levels of training experience were tested, may explain the low rate of strength imbalances observed in this study. The position that the player adopts in a match, may also influence strength asymmetries due to the varying demands of each position [25]. This study, however, did not compare the players according to their playing position; the results of the goalkeepers were also not included. Furthermore, this study did not collect data on the incidence of injury. It is however suggested that players who displayed bilateral imbalances are examined further to assess possible imbalances in the ankle joint as such imbalances may influence performance [10, 26].

To the best of our knowledge, this is the first study to evaluate the isokinetic torque of the knee in professional football players from within the different divisions in Cyprus, whilst also assessing the bilateral and unilateral asymmetries of strength. Therefore, this study provides important data from footballers participating in D1 and D2 in the country. Furthermore, this study demonstrated that the majority of players in D1 and D2 do not have bilateral imbalances or abnormal H/Q ratios.

4.1 Implications for Future Research

Further research should examine the rate of injury to determine the relationship with the level of imbalance. Further research using players from various playing standards could be used to determine the strength levels compared to the elite players. Also, seasonal variations in strength may be examined to determine the changes in the rate of imbalances due to the seasonal game schedule and or the training load.

5. Conclusion

Isokinetic testing is routine procedure for professional athletes and it is routinely used in football players to assess their lower body strength. The results demonstrated the peak torque of the knee at the two highest playing standards in Cyprus. These results may be used for comparative purposes for professional teams and football players. The results of this study may provide valuable information to the coaching team for the design of the most appropriate training protocols thus allow a more productive pre-season preparation. Furthermore, this study provides evidence that can be used for recruiting purposes.

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