



Research Article

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Differences in anthropometric measures and performance profiles between Cypriot and foreign players participating in first division in Cyprus

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Abstract

Background: Football is undoubtedly one of the most popular sports not only in Cyprus but also worldwide. One of the main issues in the Cypriot league is the selection of a large number of foreign players. It is unclear whether player selection can be at least partially explained by a difference in lower body strength, Vo₂ max and anthropometric characteristics between foreign and Cypriot players. The current study aimed to investigate and compare the aforementioned variables between Cypriots and foreign players. **Methods:** Four hundred and twenty five first division players (Cypriots n=252, foreigners n=173) took part in this study. **Results:** It was indicated that Cypriot players were significantly younger and lighter compared to foreign players. Despite the differences in body weight, no significant differences were identified with regards to the percentage of BF between the two groups. The isokinetic testing revealed that Cypriot players generated significantly lower torques (at slow isokinetic speeds) in the hamstring muscles compared to foreign football players. The cardiopulmonary exercise testing revealed that foreign players had significantly greater Vo₂max values. **Conclusions:** Foreign players were older, which may provide some explanation as to why first division teams select them instead of the Cypriot players. Furthermore, it was indicated that foreign players exhibit greater hamstring torques, which is an essential component for explosiveness, balance and stabilization. Coaches and trainers should aim at improving those parameters of Cypriot players, something that could enable these players to gain more participation time in games, which could in turn increase their chances of securing a position.

Keywords: Isokinetic testing, Soccer, Maximal oxygen uptake.

INTRODUCTION

Football is without a doubt one of the most popular sports not only in Cyprus but also worldwide. One of the main issues in the Cypriot league is the selection of a large number of foreign players with 80.2% of the players in the first division being foreigners^[1]. However, it is unclear whether player selection and recruitment can be at least partially explained by a difference in lower body strength, Vo₂ max and anthropometric characteristics between foreign and Cypriot players.

In addition to the technical and tactical skills required in football, physical fitness and anthropometric characteristics are also crucial in the player selection process and/or when assessing the performance of players. It is well-documented that players should maintain high cardiovascular fitness in order to meet the requirements of such a physically demanding sport^[2-4]. Furthermore, it has been indicated that high fitness level can promote the recovery from high-intensity interval exercise, which is essential in football, through the increase in aerobic response, lactate removal and the enhancement of PCr regeneration^[5]. In general, Vo₂ max values for male football players range between 50 to 75 mL/kg/min, with goalkeepers demonstrating slightly lower values^[6]. Even though Vo₂ max is not the only determinant of successful performance, an average of 60 ml/ (kg.min) is reported as a threshold for a satisfactory physiological attribute in men's elite football^[7].

In addition to Vo₂ max, lower body strength is also considered to be an important component for a successful exercise performance in football^[8,9]. Furthermore, it has been established that hamstring strength plays an essential role in the knee joint stability and balance^[10]. Increased muscle strength was also found to be an important parameter for the sprint running times of soccer players^[11]. Using isokinetic testing, normative values at 60 °/sec on athletes during concentric torque measurements were found to range between 201 to 319 N.m, and 114 to 170 N.m for quadriceps and hamstring muscle groups

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respectively [11,12]. Although technical and tactical skills play a significant role in soccer, some European Leagues consider age, stature and body composition crucial when it comes to fulfilling the demands of different playing positions; therefore, these parameters are also taken into account when recruiting players [13]. The differences in anthropometric characteristics often documented among players in professional soccer teams usually depend on their playing position and on the requirements needed to perform the positional tasks [14, 15]. The average age of elite players ranges between 24-26 years [13, 16, 17]. Brazilian soccer players were found to have different anthropometric characteristics (smaller statures and lighter) and Vo2 max profiles than European soccer players, something that may be partially explained by the fact that the former group places more focus on the technical component rather than the physical aspects of the game [18]. Furthermore, Spanish and Italian leagues appear to have shorter and lighter players compared to English and German leagues [13]. Even though some European Leagues consider physical shape and size to be crucial when it comes to fulfilling the demands of different playing positions, it has been demonstrated that these parameters cannot be used as the sole predictors of success [19]. Body fat percentage (BF%) is also important for soccer players, as higher values can be associated with increased body weight. Marcos *et al.*, [20] demonstrated that the BF% of players participating in different divisions in Cyprus ranged from 10-12% with no significant differences across playing standards or positions.

The current study aimed to investigate the anthropometric measures, lower body strength and Vo2 max profiles of Cypriot players and compare them to those of the foreign players. The results of this study can offer some insights into why there is such a large number of foreign players in the first division teams. Furthermore, the results of this study can help coaches and trainers in the design and identification of a variety of program options to maximize performance in addition to providing them with guidelines for recruiting purposes.

MATERIALS and METHODS

Participants

Four hundred and twenty five first division football players (Cypriots n=252, foreigners n=173) participated in this study. Football players signed an informed consent to take part in the study, after being informed about the tests and procedures. All participants were cleared by a medical doctor before performing any test. Subjects with musculoskeletal injuries within six months before the testing could not participate in the project. Volunteers were also informed that they could withdraw from the study at any point. The University of Central Lancashire Science ethics committee (STEMH 541) and the Cyprus National Committee on Bioethics approved the project. An observational design was utilised to investigate anthropometric measures, lower body strength and VO2 max profiles of the players at the beginning of pre-seasonal training.

Procedures

The functional tests were performed on two different occasions to avoid potential fatigue from subsequent testing. Measurements were obtained between 8:00 am to 5:00 pm. All players were advised to abstain from any physical activity 24 hours prior to the measurements. Anthropometric measurements included height (wall stadiometer), body mass, body mass index (BMI), and BF% (Bioelectrical Impedance, BC 418 MA, Tanita, Japan). The aerobic physical fitness was evaluated using cardiopulmonary testing (CPET) on a maximal incremental treadmill test. The isokinetic torque of the knee was measured using the Humac Norm and Rehabilitation system (CSMi Medical & Solution, USA) to evaluate lower body strength.

Anthropometric measurements included stature; body mass, BMI and %BF. Body composition was evaluated using the leg-to-leg bioelectrical impedance analyser system (BC 418 MA, Tanita, Japan).

Cardiopulmonary exercise testing (CPET) was performed using a maximal incremental test (modified Heck protocol) on a treadmill (Cosmos Quasar med hp, H-P-Cosmos Sports & Medical GmbH, Germany). The air VO2 flowmeter and the oxygen - carbon dioxide meters were calibrated while the room temperature remained at 22 ± 1°C.

The modified Heck protocol was demonstrated to be valid and reliable for testing football players. The protocol was composed of a warm-up, exercise and a recovery phase. The inclination was kept constant at 3% throughout the test. During the warm up phase, the starting speed was 4.8 km/h and increased by 1.2 km/h every 1 minute. During the exercise phase, the initial speed was 8.2 km/h and increased by 1.2 km/h every 2 minutes to exhaustion. The test was terminated in case the VO2 values remained constant or reduced with the increased workload or if the player could no longer continue. During the recovery phase, the speed was reduced to 4.8 km/h and remained constant for 3 minutes with no inclination. The results were filtered and the maximum Vo2 was reordered. The heart rate, Vo2, carbon dioxide production and expired minute volume (VE) were monitored throughout the test.

Isokinetic testing was performed using the Humac Norm and Rehabilitation system (CSMi Medical & Solution, USA). Before the testing, the participants warmed for 10 minutes (100 watts at 70 rpm) on a cycle ergometer (Monark 894 E Peak Bike, Weight Ergometer, Vansbro, Sweden). Thereafter, they were allowed to follow their own warm up routine for one minute in order to increase their levels of confidence. The testing began with the players sitting with their thigh at an angle of 85 ° to the trunk while the axis of rotation of the dynamometer was aligned with the lateral epicondyle of the knee joint. Range of motion at the knee joint was 100 °. The upper body, the thigh and ankle were fixed using the machines straps. The participants performed a familiarization training before the actual testing. The participants performed 3 repetitions at 60 °/sec and 25 repetitions at 300 °/sec. The players were tested individually and received the same motivation throughout the testing.

Statistical analysis

SPSS V22 (SPSS Inc., Chicago, IL, USA) was utilized for the analysis of the results. Shapiro-Wilk and Brown and Forsythe's tests were used to verify normal statistical distributions. Independent *t*-test with Levene's equality of variance test was utilized to compare anthropometric characteristics, VO2 max and lower body strength between Cypriots and foreign soccer players. Means and standard deviations were computed for all the parameters. The results will be considered significant if $p < 0.05$.

RESULTS

The results of the anthropometric measures are summarised in table 1. An important finding of this study was that the Cypriot players were significantly ($p < 0.05$) younger and lighter. Despite the differences in body weight between the 2 groups, no differences were observed in the percentage of BF. Furthermore, no significant stature differences were found.

The isokinetic testing (table 2) revealed that the Cypriot players exhibited significantly lower torques (as slower isokinetic speeds, 60 degrees/sec) at the hamstring muscles compared to the foreign participants [$F = 2.96$, $p < 0.05$ and $F = 1.51$, $p < 0.05$ for right and left H respectively]. Using isokinetic testing, normative values at 60 °/sec on athletes during concentric torque measurements were found to range

between 201 to 319 N.m, and 114 to 170 N.m for quadriceps and hamstring muscle groups respectively ^{11, 12}. The concentric hamstrings torque exhibited by the foreign players in this study is greater than the normative values (table 2). It should be noted, however, that both groups produced torques within the normal range for professional soccer players. No significant differences were indicated concerning torque production of the right and left quadriceps at 60 °/sec, right

quadriceps and right and left hamstrings at 300 °/sec. Finally, the cardiopulmonary exercise testing on a maximal incremental treadmill test revealed significant differences ($F=3.72$, $p<0.05$) between the two groups with the foreign players having greater Vo2max values (mean=55.40, SD=5.58) compared to the Cypriot players (mean=53.83, SD=6.36).

Table 1: Demographic characteristics

	Cypriots (n=252)	Foreigners (n=173)
	Mean (SD)	Mean (SD)
Age (y)	23.43(4.91)*	27.38(4.26)*
Height (cm)	178.24(8.92)	179.23(15.10)
Weight (kg)	74.10(6.99)*	79.17 (7.67)*
BMI	23.39(1.62)*	24.30(1.42)*
BF%	11.17(3.01)	11.94(2.91)

BMI: Body Mass Index, BF: Body Fat

* $P<0.05$

Table 2: Lower body performance of professional soccer players

	Cypriots (n=252)	Foreigners (n=173)
	Mean (SD)	Mean (SD)
Right quadriceps (60 °/sec)	233.67(34.84)	234.04(34.89)
Left quadriceps (60 °/sec)	227.66(34.15)	232.42(38.19)
Right hamstrings (60 °/sec)	*170.08(26.51)	178.04(29.44)
Left hamstrings (60 °/sec)	*172.30(25.19)	181.52(28.71)
Right quadriceps (300 °/sec)	123.10(12.61)	124.48(18.84)
Left quadriceps (300 °/sec)	*117.43(14.24)	123.77(18.15)
Right hamstring (300 °/sec)	102.66(16.04)	104.27(16.89)
Left hamstrings (300 °/sec)	104.29(15.86)	107.12(16.88)

* $p<0.05$

Isokinetic testing at speeds 60 °/sec and 300 °/sec.

DISCUSSION

Although technical and tactical skills are essential in soccer, some European Leagues consider age, stature and body composition crucial in meeting the demands of different playing positions and standards ^[13]. This study aimed to investigate the anthropometric measures, lower body strength and Vo2 max profiles of Cypriot players and compared those to the foreign players. Soccer players can vary widely in terms of anthropometric characteristics ^[21, 22]. The average age of elite players ranges between 24-26 years ^[13, 16, 17], which is in accordance with the results of our study as far as Cypriot players are concerned (mean age 23.43, SD=4.91). The average age of football players participating in elite European Leagues was reported to be 26.4 years ^[13]. The foreign players in this study were significantly older than Cypriot players, with mean values above the reference values (mean age=27.38, SD=4.26). This may provide some explanation as to why first division teams select experienced foreign players instead of Cypriot players. It has been documented that age can be a key factor in the selection process, due to the fact that older players typically perform better than younger players in various physical tests ^[23]. Furthermore, Longo *et al.*, (2018) ^[24] examined Italian goalkeepers and demonstrated that those who played at least one match per year were

older and heavier compared to those who did not play at all. Even though age has been found to be associated with playing position ^[13], the examination of age differences in relation to playing position was not intended to be examined in the present study.

In a comparison of English, Spanish, Italian and German leagues, it was indicated that players of the Spanish La Liga had the shortest stature (1.80 ± 0.06), while players of the Bundesliga had the greatest stature (1.83 ± 0.06). In addition to the greatest stature, they had the greatest - body mass and BMI ^[13]. A study on anthropometric characteristics and soccer revealed that tall players enjoy an advantage when playing in certain positions and as a result, they choose positions such as goalkeepers, defenders and strikers ^[19]. Our results indicate that both foreign and Cypriot players are slightly shorter compared to previously published reference values ^[13], with no significant difference in stature between the two groups. Furthermore, the bone mass and BMI values of the foreign players were found to be higher than the reference values ^[13] and significantly higher than those of the Cypriot players. It should be noted, however, that even though foreign players were heavier and older, their BF% was not significantly different compared to Cypriot players and it was within the suggested values for elite soccer players ^[17 19]. Previously published data indicate that the % of

BF of players participating in different divisions in Cyprus range from 10-12% with no significant differences across playing standards or positions [20]. On the contrary, in a meta-analysis, the authors indicated that BF% was one of the most powerful discriminators between higher and lower level players [25]. These discrepancies could be due to the different training protocols and/ or playing styles.

Anthropometric measures in combination with cardiorespiratory endurance and muscular strength can provide insightful information into the differences between Cypriot and foreign players. In general, Vo₂ max values for male football players range between 50–75 mL/kg/min with the goalkeepers demonstrating slightly lower values [6]. Even though Vo₂ max is not the only determinant of successful performance, an average of 60 ml/ (kg.min) is considered as a threshold for a satisfactory physiological attribute in men's elite soccer [7]. Evidently, in a sport that requires frequent changes in movement types (e.g., walking, sprinting, running, tackling) for 90 minutes, both aerobic and anaerobic components are equally important. It has been noted that lower-ranked national teams had lower Vo₂ max values (e.g. India and Singapore) compared to national teams with better performance (e.g. Germany) [6]. Furthermore, a relationship between Vo₂ max and ranking was reported by Apor [21] who indicated that the leading team in the first division Hungarian league had the highest mean Vo₂ max values compared to the other teams. It is well-documented that having an enhanced aerobic endurance can improve football performance by maximizing the number of sprints, work intensity and distanced covered during the game². Andrzejewski and his colleagues (2016) [26] examined elite German soccer players and demonstrated that an increased mean running speed during the last 45minutes of the game was the most significant variable affecting the match outcome. The authors suggested that winning a game was in fact determined by the players' physical rather than technical activities. On the other hand, at high-level games the total distance covered was not found to be an absolute factor in winning the game. The decisive role was in fact attributed to technical performance related to goal-scoring skills [27]. Lastly, it has been demonstrated that high fitness level promotes the recovery from high-intensity interval training, which is essential in football, through the increase in aerobic response, lactate removal and the enhancement of PCr regeneration [5]. The Vo₂ max values for foreign players in this study were significantly greater compared to the values for Cypriot players, even though the average values of both groups were lower than the 60 ml/ (kg.min) which is reported as a threshold for a satisfactory physiological attribute in men's elite football [7]. Even though the Vo₂ max values reported in this study are lower than the reference value, the average Vo₂ max of the foreign players is similar to that reported for Saudi Arabian [28], Brazilian [18] and Greek [29] elite football players. These discrepancies could be due to differences in training modalities, training time and playing style. Even though Vo₂ max does not have an absolute decisive role in football performance, it seems that it can accurately differentiate between selected and non-selected football players.

This project revealed that the Cypriot players generated significantly lower torques at the hamstring muscles compared to the foreign football players. The significantly greater hamstring torques are important for joint stabilization and balance as well as explosiveness [10]. It has been indicated that strong hamstrings (with a normal hamstring-to-quadriceps ratio) enhance the stability of the knee joint during short distance sprints, allowing for correct foot techniques [9]. Furthermore, the significance of hamstring strength can be supported by the fact that an explosive start and the ability to attain peak running speed quickly are essential components affecting the players' efficiency during games [26].

Even though foreign players demonstrated significantly greater hamstring torques compared to Cypriot players, the measurements obtained in this project are in line with previous studies, which reported concentric torques of the quadriceps muscle to range from

201 to 319 N.m, while torques for the hamstring muscle ranged from 114 to 170 N.m, when tested at 60 °/sec [13]. It should be noted that foreign players produced torques that were above the reference values for the hamstring muscles.

Despite the fact that isokinetic testing is a frequent routine procedure for the fitness evaluation of soccer players, it is not always predictive of soccer functional performance [30]. However, it is considered to be a valid and reliable tool for assessing lower body muscle performance and asymmetries that could lead to musculoskeletal injuries [31]. Cotte and Chatard (2011) [11] examined English Premier League football players and indicated a significant correlation between peak torques generated by the knee and sprint times. This study indicated that increased muscle strength is an important parameter for sprint running times in football players. Furthermore, it is well-documented that professional football players demonstrate higher values in peak isometric strength, one-repetition maximum of lower limb strength, leg extensor strength, and maximum torque production of knee flexors and extensors in eccentric action compared to sub-elite, amateur or recreational soccer players [10, 16, 32]. Therefore, knowing about peak isokinetic torques of the knee is crucial in professional football, as lower body strength could be among the most important factors leading to success. In addition, lower body strength could be used to discriminate between selected and non-selected football players.

CONCLUSION

It was concluded that foreign players were older, which may provide some explanation as to why first division teams select them instead of the Cypriot players. Furthermore, it was indicated that foreign players exhibit greater hamstring torques, which is an essential component for joint stabilization and balance as well as explosiveness. In addition, foreign players were found to produce significantly greater VO₂ max values. It is generally acknowledged that "one size does not fit all" when it comes to exercise programs; thus, it is incumbent upon coaches and trainers to design or identify a variety of program options that can help Cypriot players effectively maximize their performance by improving those parameters, something that could enable these players to gain more participation time in games, which could in turn increase their chances of securing a position.

Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

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Authors' contributions

Both authors read and approved the final manuscript. KP wrote the paper, KP and MM collected data and contributed to statistical analysis.

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