Coll. Antropol. **38** (2014) 2: 525–531
Original scientific paper

Short-term Power Output and Local Muscular Endurance of Young Male Soccer Players According to Playing Position

Pantelis Theodoros Nikolaïdis

Hellenic Army Academy, Department of Physical and Cultural Education, Laboratory of Human Performance and Rehabilitation, Athens, Greece and Exercise Physiology Laboratory, Nikaia, Greece

A B S T R A C T

Although the contribution of anaerobic power in soccer performance is recognized and there is evidence that many anthropometric and physiological characteristics vary according to playing position, the association between playing position and short-term power output, and local muscular endurance is not well studied, especially in young players. Therefore, the aim of the present study is to examine whether this component of sport-related physical fitness of young soccer players varies according to playing position. Young male (N=296; aged 10.94–21.00 y), classified in five two-year age-groups, and adults (N=30; aged 21.12–31.59 y), all members of competitive soccer clubs, performed the 30-s Wingate anaerobic test against braking force 0.075 kg·kg^{-1} of body mass. One-way analysis of variance (ANOVA) revealed significant differences between age groups with regard to peak power in absolute, P_{peak} ($F_{5,320}$=86.7, p<0.001), and in relative to body mass values, rP_{peak} ($F_{5,320}$=43.27, p<0.001), mean power in absolute, P_{mean} ($F_{5,313}$=108.97, p<0.001), and in relative values, rP_{mean} ($F_{5,313}$=41.64, p<0.001), while there was no difference with respect to fatigue index, FI ($F_{5,312}$=1.09, p=0.370). One-way analysis of covariance, considering age as covariate, did not reveal any significant differences among playing position groups with regard to P_{peak} ($F_{3,289}$=1.46, p=0.226), rP_{peak} ($F_{3,289}$=0.87, p=0.457) and P_{mean} ($F_{3,283}$=0.31, p=0.817), while goalkeepers had lower rP_{mean} than defenders, midfielders and forwards ($F_{3,283}$=6.32, p<0.001). One-way ANOVA revealed differences with regard to FI ($F_{3,283}$=5.97, p<0.001), according to which goalkeepers had higher values than defenders and midfielders. Compared with data from previous studies in general population, participants had superior short-term power output and local muscular endurance. Both these anaerobic parameters were in direct relationship with age (r=0.64, p<0.001, and r=0.68, p<0.001 respectively), even when the influence of body mass was partitioned out (r=0.50, p<0.001 in both cases). The comparison between playing positions revealed similar alactic anaerobic profile for all groups, and indicated local muscular endurance as the anaerobic parameter that discriminated goalkeepers from outfield players.

***Key words**: development, anaerobic capacity, exercise test, football*

Introduction

Performance in soccer results from the combination of physiological, psychological, social and environmental factors. In addition, it is important to consider the anthropometric and physiological characteristics of soccer players according to playing position, because there are players with specialized roles in the game (goalkeeper, defender, midfielder and forwards). These players differ with regard to tactical and technical aspects. Recent research[1–3] showed that they play under diverse physiological demands. Consequently, players should display anthropometric and physiological characteristics that correspond to these demands. The physical and physiological characteristics of players who play in different positions should fit with their specific workload in game[4]. Until now, most of the research about physical and physiological characteristics according to playing position has focused on age[5], anthropometric characteristics[1,4–6], body composition[5,7], match running performance[1–3], sprint time, jump performance[4], and repeated sprint ability[8]. However, no such study has been ever conducted about

Received for publication August 25, 2011

short-term power output and local muscular endurance, parameters of anaerobic power, especially in young soccer players.

Due to inherent ethical and methodological issues about the direct assessment of anaerobic metabolism in young populations, the employment of alternative non-invasive methods targeting mechanical short-term power output was suggested by Van Praagh and Doré[9]. Detailed information about one's anaerobic power can be obtained by valid and reliable laboratory methods, such as Wingate 30 s anaerobic test (WAnT)[10], Bosco 60 s test[11] and Force-velocity (F-v) test[12]. Compared with the other tests, WAnT has the advantage that it provides information about both alactic and lactic anaerobic energy transfer system. The main indices of this test are: a) peak power (P_{peak}), the highest power elicited from the test taken as the average power of any 5-s period; b) mean power (P_{mean}), the average power during the 30-s test; and c) fatigue index (FI), the difference between P_{peak} and minimal power, divided by P_{peak}. Regarding the taxing of human energy transfer systems during the test, P_{peak} is considered as a descriptor of short-term power output that relies mainly upon adenosine triphosphate-creatine phosphate (alactic anaerobic system), and P_{mean} and FI as descriptors of local muscular endurance that relies mainly upon anaerobic glycolysis resulting in lactate production (lactic anaerobic system).

Therefore, in the present study, we have examined anaerobic power of youth male soccer players with the WAnT. Our goal was to test two related research hypotheses: 1) there are differences with regard to WAnT indices between age-groups of participants; and 2) there are differences between goalkeepers, defenders, midfielders and forwards with respect to anaerobic power.

Materials and Methods

Participants and procedures

In this investigation, a non-experimental, descriptive-correlation design was used to examine the association between anaerobic power and playing position. Testing procedures were performed during the beginning of competitive period of season 2009–2010. The local Institutional Review Board approved the study, and oral and written informed consent was received from all players or parents after verbal explanation of the experimental design and potential risks of study. Exclusion criteria included history of any chronic medical conditions and use of any medication. Young male (N=296; aged 10.94–21.00 years old, y), classified in five two-year age-groups (under 13 y (U13), U15, U17, U19, U21), and adult Caucasians (C; N=30; aged 21.12–31.59 y), all members of competitive soccer clubs, volunteered for this study (Table 1). The players visited our laboratory once; at first, anthropometric and body composition data were obtained, followed by a guided 15-min warm-up. Then the WAnT was performed.

Equipment and protocols

Stature, body mass and skinfolds were measured, body mass index was calculated, and percentage of body fat (BF) was estimated from the sum of ten skinfolds (cheek, wattle, chest I, triceps, subscapular, abdominal, chest II, suprailiac, thigh and calf; $BF=-41.32 + 12.59 \log_e x$, where x the sum of the ten skinfolds)[13]. An electronic weight scale (HD-351 Tanita, Illinois, USA) was employed for body mass measurement (in the nearest 0.1 kg), a portable stadiometer (SECA, Leicester, UK) for stature (0.001 m) and a caliper (Harpenden, West Sussex, UK) for skinfolds (0.0005 m). Fat free mass was calculated as the difference between body mass and the product of body mass by the percentage of body fat. Skinfold measurement was taken in the dominant side of each athlete. In addition to the above anthropometric measurements, all athletes performed the WAnT for lower limbs in a cycle ergometer (Ergomedic 874 Monark, Varberg, Sweden)[14]. The test was preceded by a standardized warm-up and familiarization session. Braking force for the 30-sec WAnT was determined by the product of body mass in kg by 0.075. Seat height was adjusted to each participant's satisfaction, and toe clips with straps were used to prevent the feet from slipping off the pedals. Participants were instructed before the tests that they should pedal as fast as possible and during test they were verbally encouraged throughout the test.

TABLE 1
ANTHROPOMETRIC CHARACTERISTICS AND BODY COMPOSITION OF AGE GROUPS

	Age groups					
	U-13	U-15	U-17	U-19	U-21	Adult
N	37	89	87	48	35	30
Age (y)	12.37±0.52	14.13±0.57	15.87±0.59	17.70±0.49	19.98±0.61	25.39±3.07
Body mass (kg)	46.9±8.6	59.1±8.9	67.1±9.5	69.6±9.4	73.8±6.3	76.5±6.8
Stature (m)	1.545±0.092	1.685±0.077	1.744±0.064	1.752±0.055	1.771±0.060	1.794±0.058
BMI (kg m^{-2})	19.49±2.14	20.77±2.37	22.02±2.55	22.65±2.39	23.52±1.63	23.71± 1.20
Body fat (%)	16.7±5.4	16.1±3.9	16.1±3.6	15.6±3.5	15.0±2.9	15.2±3.1
FFM (kg)	38.8±6.4	49.4±6.6	56.1±6.7	58.6±6.6	62.6±4.7	64.7±5.4

Values are presented as mean with standard deviation in brackets. BMI, body mass index; FFM fat free mass

Data and statistical analysis

Results are presented as mean±standard deviation ($\overline{X}$±SD). The association between age and anaerobic power was examined by Pearson product moment correlation coefficient (*r*). Differences between age-groups were assessed using one-way analysis of variance (ANOVA). A one-way ANCOVA was conducted to examine those parameters of anaerobic power of participants that were under the influence of age according to their playing position. The independent variable, playing position, included four levels: goalkeepers, defenders, midfielders and forwards. The dependent variable was the participants' power outcome (P_{peak}, rP_{peak}, P_{mean}, rP_{mean} and FI) and covariate was the age. Correction for multiple comparisons was undertaken using the Tukey-Kramer multiple-comparison test. Significance level was set at alpha =0.05. Statistical analyses were performed using SPSS v.17.0 statistical software (SPSS Inc., Chicago, IL, USA).

Results

The anthropometric characteristics of the age groups are presented in Table 1. The age groups differed with regard to body mass ($F_{5,320}$=61.18, p<0.001), stature ($F_{5,320}$= 65.00, p<0.001), BMI ($F_{5,320}$=21.52, p<0.001) and FFM ($F_{5,320}$=89.46, p<0.001), while there was no difference in BF ($F_{5,320}$=1.14, p=0.340). For all the aforementioned characteristics, older participants had higher values than their younger counterparts.

The scores of the age groups in the main indices of WAnT are presented in Table 2. The age groups differed with regard to P_{peak} ($F_{5,320}$=86.70, p<0.001), rP_{peak} ($F_{5,320}$=43.27, p<0.001), P_{mean} ($F_{5,313}$=108.97, p<0.001), rP_{mean} ($F_{5,313}$=41.64, p<0.001), while there was no difference with respect to fatigue index ($F_{5,312}$=1.09, p=0.370). These differences are depicted in Figure 1. Moreover, age was moderately in direct relationship with P_{peak} (r=0.64, p<0.001), rP_{peak} (r=0.50, p<0.001), P_{mean} (r=0.68, p< 0.001) and rP_{mean} (r=0.50, p<0.001), while there was no association with FI (r=–0.07, p=0.244). Therefore, age was employed as covariate in the comparison of WAnT indices between playing position groups, except in the case of FI.

Anthropometric characteristics and scores in the main indices of WAnT according to playing position are presented in Table 3 and Table 4 respectively. One-way ANCOVA did not reveal any significant differences with regard to P_{peak} ($F_{3,289}$=1.46, p=0.226), rP_{peak} ($F_{3,289}$= 0.87, p=0.457) and P_{mean} ($F_{3,283}$=0.31, p=0.817), while there was significant difference with respect to rP_{mean}

TABLE 2
ANAEROBIC POWER OF AGE GROUPS

	Age groups					
	U-13	U-15	U-17	U-19	U-21	Adult
P_{peak} (W)	417.13±96.75	596.66±116.79	717.12±123.57	775.42±129.53	835.93±81.46	863.85±94.85
rP_{peak} (W. kg^{-1})	8.88±1.06	10.05±1.00	10.70±0.83	11.11±0.93	11.31±0.80	11.29±0.71
parP_{mean} (W)	318.70±76.13	471.35±92.22	566.75±88.93	610.49±82.47	669.11±64.74	691.50±67.68
rP_{mean} (W. kg^{-1})	6.84±1.22	7.95±0.86	8.53±0.79	8.79±0.65	9.09±0.73	9.06±0.62
FI (%)	43.55±10.48	41.04±9.50	42.26±8.89	43.46±8.86	40.85±7.60	40.05±6.10

Values are presented as mean with standard deviation in brackets. P_{peak}, peak power; P_{mean}, mean power; rP_{peak}, relative peak power; rP_{mean}, relative mean power; FI, fatigue index

TABLE 3
ANTHROPOMETRIC CHARACTERISTICS AND BODY COMPOSITION ACCORDING TO PLAYING POSITION

	Playing position			
	Goalkeepers	Defenders	Midfielders	Forwards
N	32	117	102	43
Age (y)	17.65±4.79	16.99±3.54	16.73±3.59	16.08±3.81
Body mass (kg)	71.8±13.3^{M,F}	66±11.3	62.8±11.0^{G}	63.3±14.5^{G}
Stature (m)	1.754±0.089^{M,F}	1.729±0.096	1.703±0.089^{G}	1.694±0.110^{G}
BMI (kg. m^{-2})	23.13±2.63^{M}	21.97±2.48	21.52±2.58^{G}	21.61±2.78
Body fat (%)	17.9±3.8^{D,M,F}	15.7±4.0^{G}	15.7±3.1^{G}	15.3±4.4^{G}
FFM (kg)	58.9±10.9^{M}	55.6±9.1	52.9±8.7^{G}	53.2±11.9

Values are presented as mean with standard deviation in brackets. BMI, body mass index; FFM fat free mass. Letters in capitals, next to standard deviations, are the initials of the corresponding groups with which there are significant differences (p<0.05)

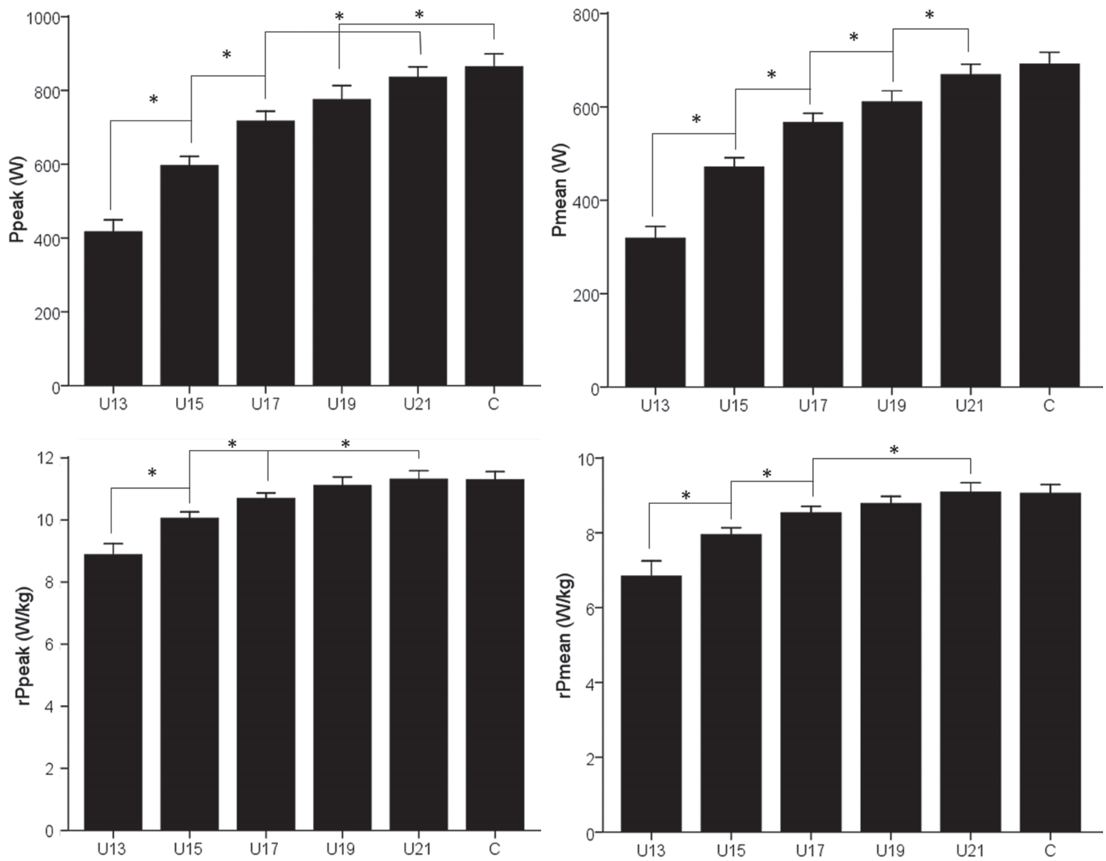

*Fig. 1. Mean values (error bars represent 95% confidence intervals of mean) of anaerobic power of age groups. Peak power (P_{peak}) in absolute (left) and in relative to body mass values (right) is depicted in the first row, while corresponding values of mean power (P_{mean}) are illustrated in the second row. Symbol * indicates significant difference between groups (p<0.05), according to Tukey-Kramer multiple-comparison test.*

TABLE 4
ANAEROBIC POWER ACCORDING TO PLAYING POSITION

	Playing position			
	Goalkeepers	Defenders	Midfielders	Forwards
P_{peak} (W)	759.06±183.48	701.72±158.59	675.97±165.66	674.88±211.07
rP_{peak} (W. kg^{-1})	10.47±1.03	10.54±1.11	10.63±1.13	10.48±1.31
P_{mean} (W)	560.94±139.17	558.03±128.67	541.19±129.29	537.63±172.97
rP_{mean} (W. kg^{-1})	7.86±0.90^{D,M,F}	8.40±1.05^{G}	8.51±0.96^{G}	8.32±1.22^{G}
FI (%)	47.95±6.98^{D,M}	41.51±10.46^{G}	40.39±7.94^{G}	42.79±6.29

Values are presented as mean with standard deviation in brackets. P_{peak}, peak power; P_{mean}, mean power; rP_{peak}, relative peak power; rP_{mean}, relative mean power; FI, fatigue index. Letters in capitals, next to standard deviations, are the initials of the corresponding groups with which there are significant differences (p<0.05)

($F_{3,283}$=6.32, p<0.001). Post-hoc analysis revealed significant differences between goalkeepers and outfield players: goalkeepers had lower level of relative P_{mean} than defenders, midfielders and forwards. One-way ANOVA revealed differences with regard to FI ($F_{3,283}$=5.97, p<0.001), in which goalkeepers had higher values than defenders and midfielders. These differences are depicted in Figure 2.

Discussion

Although it is clearly recognized that anaerobic power is linked with performance in soccer, little is known about short-term power output and local muscular endurance, as a function of playing position, of those who practice this sport. This is the first study to examine the relationship between age and WAnT main indices (P_{peak},

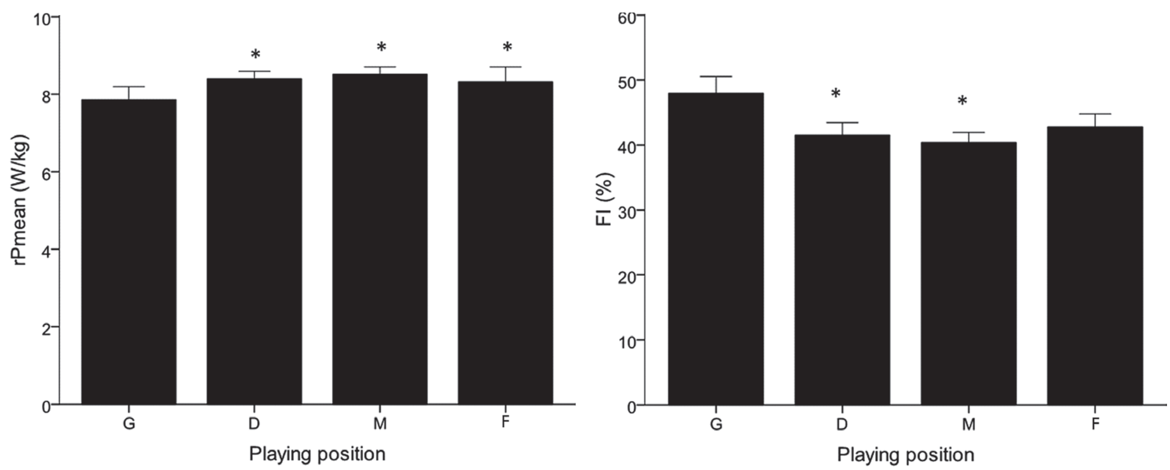

*Fig. 2. Mean values (error bars represent 95% confidence intervals of mean) of mean power in relative to body mass values (rP_{mean}) on the left and fatigue index (FI) according to playing position (goalkeeper, G; defender, D; midfielder, M; forward, F). Symbol * indicates significant difference from group G ($p < 0.001$), according to Tukey-Kramer multiple-comparison test.*

P_{mean} and FI) in a large sample of young male soccer players, and potential positional differences in these traits. First, we examined the level of participants' anaerobic power in the light of previous studies. Overall, participants exhibited high level of anaerobic power. Anaerobic power of our sample was comparable to that of U.S.A. Olympic squad[15] and superior to that of general population[14,16]. For instance, compared with 12.2 y boys[14], U13 age group had higher P_{peak} (417.13 W vs. 321 W), rP_{peak} (8.88 W kg^{-1} vs. 7.89 W kg^{-1}), P_{mean} (318.7 W vs. 269 W) and rP_{mean} (6.84 W kg^{-1} vs. 6.61 W kg^{-1}). Compared with normative data of general population[16], adult players had »excellent« P_{peak} and P_{mean}, in a 7-degree scale (»very poor« to »excellent«), and they were classified higher than the 95th percentile.

Second, we demonstrated that P_{peak} and P_{mean} differed significantly between age groups of young players, i.e. the older the group, the higher the short-term power output, whereas there was no difference with regard to FI. Correspondingly, there was a direct relationship between age and P_{peak} and P_{mean} either in absolute or in relative to body mass values. Our findings were scrutinized in the light of previous data on general population[17] and on soccer players[15,18]. In these studies, P_{peak} was 9.3±0.2 W kg^{-1} in U14, 10±0.3 W kg^{-1} in U15 and 10.5 W kg^{-1} in U16, P_{mean} 8±0.2 W kg^{-1}, 8.1±0.2 W kg^{-1} and 8.7±0.2 W kg^{-1}, and FI 27.1±1.9%, 36.8±1.9% and 35±1.9% respectively[15], while corresponding values in older adults were 10.6±0.9 W kg^{-1}, 8.7±0.4 W kg^{-1} and 36.3±7.4%[18]. In a research on general population, mean power was increased from 6.3±1.1 W kg^{-1} (11–12 y) to 6.7±1.2 W kg^{-1} (13 y) and 7.6±1 W kg^{-1} (14–15 y)[17]. Thus, our findings came to terms with previous research, which indicated direct relationship between age and anaerobic power parameters, and no association in the case of FI.

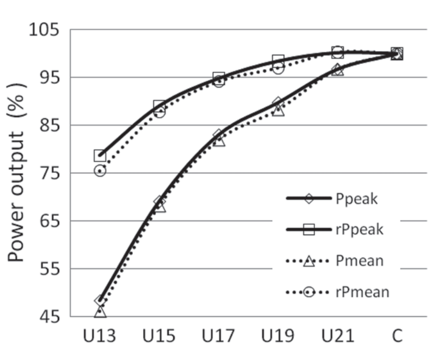

Fig. 3. Age-related differences in absolute and relative (to body mass) anaerobic power, presented as percentage of value of adult group. rP_{peak}, relative peak power; rP_{mean}, relative mean power.

The increase of short-term power output across adolescence in soccer players (from U13 to U19 +70% in P_{peak}) was lower than what was reported by previous studies[16,19,20]. Particularly, maximal power, estimated by the combination of 40 m sprint time and body mass, increased by 152% in soccer players from 11 y to 18 y (1046±122 W and 2641±384 W), and estimated by the combination of countermovement vertical jump displacement and body mass, increased by 127% (448±51 W and 1017±92 W)[19], whilst in general population an increase by 100% (461.5±80.4 W and 923.8±179.8 W) was reported[20]. P_{peak}, index of WAnT, increased by 120% from 12.2 y to 17 y (321±83 W and 707±114 W[16]). This discrepancy should be attributed to differences in assessment methods and to the training level, as it is expected that in a more homogeneous sample smaller variability in physiological parameters can be identified.

Third, regarding the outcome of the comparison between playing position groups, there was no difference with respect to P_{peak}, while goalkeepers had lower relative P_{mean} than all outfield players, and higher FI than defenders and midfielders. Similar levels among groups were found with regard to P_{peak}, which indicates that short-term power output does not characterize a specific playing position. Goalkeepers exhibit the highest short-term power output in absolute values, without considering the effect of age and body mass, and even when body mass is partitioned out they are in the same level with outfield players. This finding indicates the similarity of metabolic demands during maximal efforts lasting a few seconds, placed on players with various roles, independently from the specific form of actions performed in each position. Therefore, soccer players show a similar alactic anaerobic profile.

Although there is a large proportion of common variance in P_{peak} and P_{mean} either in absolute (93.5%) or in relative to body mass values (72.1%), differences between playing position groups do not follow a similar pattern in the cases of alactic and lactic anaerobic profile. Thus, in the case of local muscular endurance, our findings indicate a significant lower capacity to maintain maximal effort for 30 s, and correspondingly a higher decrease in performance during this period, in goalkeepers in comparison with the outfield players. This diversity may be attributed to the specific metabolic demands of goalkeepers' actions that usually do not last longer than a few seconds. Similar findings were revealed in a study[8], in which performance in running repeated sprint ability was lower in goalkeepers than outfielders, and further differences were found between outfield players.

These variations in anaerobic profile were accompanied by corresponding differences in anthropometric characteristics. The age of goalkeepers, who participated in our study, was older than that of defenders, defenders were older than midfielders, who in turn were older than forwards. This finding came to terms with a study, in which goalkeepers were older than midfielders and forwards, and defenders were older than forwards[5]. Therefore, age was also a parameter that discriminate soccer players according to their playing position. Moreover, as it was suggested by previous research[4,7], important differences were found between goalkeepers and outfield players with regard to height, weight and body composition, with goalkeepers being the tallest and the heaviest and having the highest percentage of body fat.

Limitations

A potential methodological limitation in the present research could be the disproportionate number of players consisting the groups that were compared. Particularly, the number of defenders and midfielders was the highest, followed by forwards, whilst the number of goalkeepers was the lowest. This finding confirmed previous observations. For instance, in a study on soccer players, aged 14–21 y (N=241), the number of defenders and midfielders was very close (N=77 *vs.* N=79), both were higher than forwards (N=56), which in turn was higher than goalkeepers (N=29)[4]. A higher number of participants could provide the opportunity to investigate the time when differences in the anaerobic profile of goalkeepers and outfield players appear.

In addition, recent research has highlighted the need for soccer-specific field tests of anaerobic power[18,21,22]. On the other hand, field tests cannot be used interchangeably with laboratory tests, such as WAnT, which does not correspond to soccer movements, but offers valid and reliable results, and there is plethora of normative data. Moreover, WAnT was able to discriminate participants' short-term power output, as well as local muscular endurance, according to their age and playing position. Therefore, even if it is not a sport-specific test, its further use in soccer players is recommended. With regard to the methodology of WAnT, the application of the same relative braking force for all participants, independently of age, may induce higher physical stress in the younger participants than in the older, but had the advantage that it offered comparable findings among age groups.

Finally, this study was carried out on Greek soccer players. Consequently, its results could be generalized to similar populations of other countries, too, on the assumption that these countries are in similar or lower level than Greece (FIFA world ranking 10th on February 2011)[23]. It is presumed that in higher international level, considering the contribution of physical fitness on soccer performance, players have better anaerobic power among the other parameters of physical fitness and thereafter differences between age groups, and among playing positions may be attenuated or even annihilated.

Conclusions

Considering the importance of short-term and repetitive high-intensity activities in soccer performance, and the lack of information about the anaerobic profile of young players, short-term power output and local muscular endurance assessed by WAnT, and their variation according to playing position, were investigated in this paper. The anaerobic profile of participants found to be superior with regard to general population. P_{peak} and P_{mean} were significantly less in those soccer players in the lower spectrum of adolescence than for their older counterparts, even after adjustment for body mass or fat free mass, and there was a direct relationship between these WAnT indices, except in the case of FI, and age. In addition, there were differences according to playing position concerning only local muscular endurance, due to which goalkeepers had lower capacity that their outfield counterparts.

REFERENCES

1. RIENZI E, DRUST B, REILLY T, CARTER JE, MARTIN A, J Sports Med Phys Fitness, 40 (2000) 162. — 2. BUCHHEIR M, MENDEZ-VILLANUEVA A, SIMPSON BM, BOURDON PC, Int J Sports Med, 31 (2010) 818. — 3. DI SALVO V, BARON R, GONZALEZ-HARO C, GORMASZ C, PIGOZZI F, BAHL N, J Sports Sci, 28 (2010) 1489. — 4. GIL SM, GIL J, RUIZ F, IRAZUSTA A, IRAZUSTA J, J Strength Cond Res, 21 (2007) 438. — 5. BLOOMFIELD J, POLMAN R, BUTTERLY R, O'DONOGHUE P, J Sports Med Phys Fitness, 45 (2005) 58. — 6. MATKOVIC

BR, MISIGOJ-DURAKOVIC M, MATKOVIC B, JANKOVIC S, RUZIC L, LEKO G, KONDRIC M, Coll Antropol, 27 (2003) S167. — 7. SUTTON L, SCOTT M, WALLACE J, REILLY T, J Sports Sci 27 (2009) 1019. — 8. AZIZ AR, MUKHERJEE S, CHIA MY, TEH KC Int J Sports Med, 40 (2008) 162. — 9. VAN PRAAGH E, DORÉ E, Sports Med, 32 (2002) 701. — 10. AYALON A, INBAR O, BAR-OR O, Relationships among measurements of explosive strength and anaerobic power. In: NELSON RC, MOREHOUSE CA (Eds) International Series on Sport Science 1: Biomechanics IV (University park press, Baltimore, 1974). — 11. BOSCO C, LUHTANEN P, KOMI PV, Eur J Appl Physiol, 50 (1983) 273. — 12. VANDEWALLE H, PERES G, HELLER J, MONOD H, Eur J Appl Physiol, 54 (1985) 222. — 13. PARIZKOVA J, Lean body mass and depot fat during autogenesis in humans. In: PARIZKOVA J, ROGOZKIN V (Eds) Nutrition, Physical Fitness and Health: International Series on Sport Sciences (University Park Press, Baltimore, 1978). — 14. BAR-OR O, SKINNER JS, Wingate anaerobic test (Human Kinetics, Champaign, 1996). — 15. VANDERFORD LM, MEYERS MC, SKELLY WA, STEWART CC, HAMILTON KL, J Strength Cond Res, 18 (2004) 334. — 16. ARMSTRONG N, WELSMAN JR, CHIA MYH Br J Sports Med, 35 (2001) 118. — 17. FALGAIRETTE G, BEDU M, FELLMANN N, VAN PRAAGH E, COUDER J, Eur J Appl Physiol, 62 (1991) 151. — 18. MECKEL Y, MACHNAI O, ELIAKIM A, J Strength Cond Res, 23 (2009) 163. — 19. LE GALL F, BEILLOT J, ROCHCONGAR P, Sci Sports, 17 (2002) 177. — 20. HERTOGH C, MICALLEF JP, MERCIER J, Sci Sports, 7 (1992) 207. — 21. PSOTTA R, BUNC V, HENDL J, TENNEY D, HELLER J, J Sports Med Phys Fitness, 51 (2011) 18. — 22. WRAGG CB, MAXWELL NS, DOUST JH, Eur J Appl Physiol, 83 (2000) 77. — 23. FIFA/Coca-Cola World Ranking. Available from: URL: www.fifa.com/worldfootball/ranking/lastranking/gender=m/fullranking.html. Access date: Mar 2, 2011.

P.T. Nikolaïdis

Hellenic Army Academy, Department of Physical and Cultural Education, Laboratory of Human Performance and Rehabilitation, Vari 16673, Athens, Greece
e-mail: pademil@hotmail.com

KRATKOTRAJNA IZLAZNA SNAGA I IZDRŽLJIVOST LOKALNIH MIŠIĆNA MLADIH MUŠKIH NOGOMETAŠA S OBZIROM NA POZICIJU

S A Ž E T A K

Iako je doprinos anaerobne snage prepoznat u nogometnoj uspješnosti te postoje dokazi da se mnoge antropometrijske i fiziološke karakteristike razlikuju prema poziciji, povezanost između igrajućeg položaja i kratkoročnog prekida snage te lokalne mišićne izdržljivosti nije dovoljno istražena, osobito među mladim igračima. Dakle, cilj ovog istraživanja je ispitati varira li komponenta sporta vezana uz fizičku spremnost mladih nogometaša ovisno o poziciji. Mladi muškarci (N=296; u dobi od 10,94 do 21,00 godina), razvrstani u pet dvogodišnjih dobnih skupina, i odrasli (N=30, u dobi od 21,12 do 31,59 godina), a svi članovi konkurentnih nogometnih klubova, izveli su 30 Wingate anaerobnih testova protiv sila kočenja 0,075 kg.kg-1 tjelesne mase. Jednosmjerna analiza varijance (ANOVA) otkrila je značajne razlike među dobnim skupinama s obzirom na apsolutni vrhunac snage, Ppeak ($F_{5, 320}$=86,7, p<0.001), a u odnosu na vrijednosti mase tijela, rPpeak ($F_{5, 320}$=43.27, p <0.001), aritmetičku sredinu apsolutne snage, Pmean ($F_{5, 313}$=108,97, p<0,001) te u relativnim vrijednostima, rPmean ($F_{5, 313}$=41.64, p<0.001), dok nije bilo razlike s obzirom na indeks umora FI ($F_{5, 312}$=1,09, p=0,370). Jednosmjerna analiza kovarijance, s obzirom na dob, kao kovarijancu, nije pokazala značajne razlike između igraće pozicije skupine s obzirom na Ppeak ($F_{3, 289}$=1.46, p=0,226), rPpeak ($F_{3, 289}$=0,87, p=0,457) i Pmean ($F_{3, 283}$=0,31, p=0,817), dok su vratari imali su niži rPmean od braniča, veznjaka i napadača ($F_{3, 283}$=6.32, p<0,001). Jednosmjerna ANOVA pokazala je razlike s obzirom na FI ($F_{3, 283}$=5,97, p<0,001), prema kojemu su vratari imali veće vrijednosti nego braniči i veznjaci. U usporedbi s podacima u općoj populaciji iz ranijih studija, sudionici su imali vrhunsku kratkoročnu izlaznu snagu i lokalnu mišićnu izdržljivost. Oba anaerobna parametra su u izravnoj vezi s dobi (R=0,64, p<0,001, a R=0,68, p<0,001, razmjerno), čak i kada se razdijeli utjecaj tjelesne mase (R=0,50, p<0,001 u oba slučaja). Usporedba između igraće pozicije otkrila je sličan neutralno laktatni anaerobni profil za sve skupine te istaknula lokalnu mišićnu izdržljivost kao anaerobni parametar koji razlikuje vratare od terenskih igrača.