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ANAEROBIC CAPABILITY OF SOCCER PLAYERS WITH DIFFERING AEROBIC POWER LEVELS

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SUMMARY

As contemporary soccer is played at a higher pace and intensity, players have to adapt to physical requirements of the game. Players with higher aerobic power levels seem to have relatively lower anaerobic power levels. Possessing low anaerobic capability in spite of a high aerobic power might be disadvantageous. We aimed to investigate anaerobic capabilities of soccer players with differing aerobic power levels. Two groups of soccer players with high (n = 19, 21.4 ± 2.3 years of age, VO_2max = 63.7 ± 5.2 $ml{\cdot}min^{-1}{\cdot}kg^{-1}$) and low (n = 36, 23.0 ± 3.9 years of age, VO_2max = 50.6 ± 3.2 $ml{\cdot}min^{-1}{\cdot}kg^{-1}$) mean aerobic power were compared in terms of their anaerobic power. Aerobic power was indirectly estimated via the Astrand cycle ergometer test, and anaerobic performance was evaluated by means of the Wingate anaerobic test and also by measuring 10-m and 30-m sprint times, clocked with optical sensors. Statistical analysis was done through unpaired t-testing. Peak anaerobic power scores of the group with high aerobic power were higher ($p<0.01$) than that of the group with low aerobic power. No significantly different figures were found for the 10-m and 30-m sprint times, peak power/kg body mass, total average power and average power/kg body mass parameters, between the two groups. We conclude that soccer players with high aerobic power levels may possess high anaerobic capability at the same time, which adds to their total physical performance capacity.

Key words: Soccer, aerobic power, anaerobic power and capacity, exercise

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ÖZET

FARKLI AEROBİK GÜÇ DÜZEYLERİNE SAHİP FUTBOLCULARDA ANAEROBİK PERFORMANSIN DEĞERLENDİRİLMESİ

Çağdaş futbolun daha hızlı ve yüksek yoğunlukta oynanmaya başlaması nedeniyle oyuncuların bu duruma adapte olmaları gerekmektedir. Genellikle yüksek aerobik güce sahip oyuncuların göreceli olarak daha düşük anaerobik güç düzeylerine sahip oldukları gözlenmektedir. Bu durum günümüz futbolunda dezavantaj yaratabilmektedir. Çalışmamızda farklı aerobik güç değerlerine sahip olan futbolcuların anaerobik performans özelliklerini araştırmayı amaçladık. Araştırmada, ortalama aerobik gücü yüksek (n = 19, 21.4 ± 2.3 yaş, VO_2max = 63.7 ± 5.2 ml·min^{-1}·kg^{-1}) ve düşük (n = 36, 23.0 ± 3.9 yaş, VO_2max = 50.6 ± 3.2 ml·min^{-1}·kg^{-1}) olan futbolculardan oluşan iki grup anaerobik kapasite ve güçleri açısından karşılaştırıldı. Aerobik güç bisiklet ergometresinde endirekt olarak Astrand testi ile, anaerobik performans ise Wingate anaerobik testi ve 10 ile 30 metre sprint zamanlarıyla değerlendirildi. Buna göre yüksek aerobik güce sahip olan futbolcu grubunda düşük olan gruba göre zirve anaerobik güç değerleri anlamlı şekilde yüksek bulundu ($p<0.01$). Ancak 10 ve 30 metre sprint zamanları ve kilogram başına düşen zirve güç, total ortalama güç ve kilogram başına düşen ortalama güç değerlerinde iki grup arasında anlamlı bir fark saptanmadı. Sonuç olarak yüksek seviyede aerobik güce sahip olan futbolcuların aynı zamanda yüksek bir anaerobik performansa sahip olabilecekleri gözlendi. Bu durum total fiziksel performansı olumlu etkileyecektir.

Anahtar sözcükler: *Futbol, aerobik güç, anaerobik güç ve kapasite, egzersiz*

INTRODUCTION

Physiological demands of competitive soccer are considered as being high degrees of endurance, speed, agility, muscular strength, and anaerobic power, technical and tactical skills (1,22). During a match, players perform different types of exercise ranging from standing still to maximal running, and the intensity can change at any time (5). Although predominant metabolic pathways during soccer are mainly aerobic, actions playing essential role on more crucial moments of the game require anaerobic performance. Anaerobic power is important in accelerating the body during short movements, in leaping to win the ball or contesting its possession in the air (18). Power output during such activities is critical for the overall success of the performance. Therefore, beside high aerobic power, having a high anaerobic power is also desirable for a better performance. However, it is argued that players who have higher aerobic power levels possess relatively lower anaerobic power levels.

The range of movement patterns and different exercise intensities utilized in soccer game leave the understanding of relationships among aerobic and anaerobic performance variables still difficult and controversial. In an attempt to clarify the subject, we investigated anaerobic power and capacity characteristics in soccer players with differing aerobic power levels.

MATERIAL AND METHODS

Data were collected from 55 male professional soccer players of Turkish second division league teams in the pre-season training period. Subjects were allocated to groups with respect to their maximal oxygen uptake (VO_2max) level over or below 55 $ml \cdot min^{-1} \cdot kg^{-1}$. Group I consisted of 19 players (As means ± SD: 21.4 ± 2.3 years of age, 175 ± 4.6 cm height, 70.4 ± 5.9 kg body mass, and VO_2max 63.7 ± 5.2 $ml \cdot min^{-1} \cdot kg^{-1}$) and Group II consisted of 36 players (23.0 ± 3.9 years of age, 177 ± 5.8 cm height, 72.4 ± 6.4 kg body mass, VO_2max 50.6 ± 3.2 $ml \cdot min^{-1} \cdot kg^{-1}$).

The day preceding the tests, subjects refrained from training and maintained their normal diet. All players were habituated with the test procedures. Laboratory tests were carried out on the same day in similar conditions. Room temperature was 22-23°C and relative humidity was 50%. Aerobic power was indirectly estimated via the Astrand cycle ergometer (Monark Ergomedic 814E, Sweden) test (3), both anaerobic power and capacity were evaluated by means of the Wingate test (7) and anaerobic power also by using 10-m and 30-m sprint times. Players applied a standardized warm up. In the Wingate anaerobic test (Monark Ergomedic 894E, Sweden), braking force (75 g x body mass in kg) was set at its full right from the start, and subjects cycled at maximal speed for 30 s.

The following day, field sprint tests were performed on grass by using a Newtest 2000-Sprint Timing System (Newtest Powertimers, Finland). Electronic timing gates were placed at 10 m and 30 m to record performances. Players carried out a 20-minute warm up including soccer specific drills and then performed three maximal attempts in each distance with 2 min rest between trials. The best times were taken into account for analysis.

Data are expressed as means (± SD). The two groups were compared in terms of their anaerobic power and capacity and group means were compared with unpaired t-tests.

RESULTS

Physical characteristics and exercise performance results of both groups are given in Tables 1 and 2, respectively. There were no significant differences between the two groups in terms of physical characteristics. Peak anaerobic power score of the group with high aerobic power was higher ($p<0.01$) than that of the group with low aerobic power. No significantly different figures were found though, for the 10-m and 30-m sprint times, peak power/kg body mass, average power and average power/kg body mass parameters, between the groups.

Table 1. Physical characteristics of soccer players in both groups (mean ± SD)

	N	Age (years)	Body height (cm)	Body weight (kg)
Group I	19	21.4 ± 2.3	175.0 ± 4.6	70.4 ± 5.9
Group II	36	23.0 ± 3.9	177.0 ± 5.8	72.4 ± 6.4

Table 2. Performance test characteristics of the subjects in both groups (mean ± SD)

	Group I	Group II
VO_2max ($ml \cdot min^{-1} \cdot kg^{-1}$)	63.7 ± 5.2*	50.6 ± 3.2
Peak power (W)	920 ± 187*	872 ± 153
Peak power ($W \cdot kg^{-1}$)	2.9 ± 2.5	12.1 ± 2.1
Average power (W)	638 ± 97	622 ± 71
Average power ($W \cdot kg^{-1}$)	8.9 ± 1.2	8.6 ± 0.9
10-m sprint (s)	1.60 ± 0.05 (n=10)	1.61 ± 0.04 (n=23)
30-m sprint (s)	4.11 ± 0.11 (n=10)	4.12 ± 0.11 (n=23)

*$p < 0.01$

DISCUSSION

The maximum oxygen intake for elite soccer players has been determined in numerous studies and it ranges between 56-70 $ml \cdot min^{-1} \cdot kg^{-1}$, which is partly associated with the standard of play and different positions (1,2,6,8,10,12,14,15,16,19,21,25). High aerobic power values were reported mostly in mid-field players and outside full-backs (15,16). In the present study, aerobic power measures also varied, although players were competing at the same level. These differences in endurance performance illustrate that a high degree of VO_2max level may not be the leading characteristic for playing soccer. Moreover, reports indicating inconsistent results for the relationship between maximal aerobic power levels and overall success of soccer teams are cited in current literature (2,5,10,20).

Whereas exercise 'off-the-ball' comprises mainly aerobic activity during a game, direct involvement in play is largely of anaerobic nature (19). During these most decisive actions of the game, anaerobic performance becomes capital. Anaerobic performance characteristics of soccer players have also been reported in some studies (1,11,17,19,23). High anaerobic power levels are reported mostly in goalkeepers, center-backs and strikers (1,11). It seems that players who have higher aerobic power levels possess relatively lower anaerobic power. This might be a disadvantage in performing better, as actions playing an essential role in the crucial moments of the game mostly require anaerobic performance.

Al-Hazzaa et al. (1) reported aerobic (VO_2max 56.0 ± 4.8 $ml \cdot min^{-1} \cdot kg^{-1}$) and anaerobic power (peak power 873.6 ± 141.8 W, peak power/kg 11.9 ± 1.3 W), and capacity (average power for 30 s, 587.0 ± 55.4 W) measures for Saudi elite soccer players. They indicated an inverse relationship between VO_2max and 30 s average power measures. Katch and Weltman (11) also reported a negative correlation between these two fitness measures. Conversely, Dawson et al. (9) revealed significant positive correlations between VO_2max and anaerobic performance indices in a group of athletes from six different sports. Contrasting to this heterogeneous study group, Wadley and Le Rossignol (24) reported no significant correlation between the two fitness measures in Australian Rules footballers. Aziz et al. (4) neither found any correlation between VO_2max and the fastest 40-m sprint time, while pointing to a moderate correlation between VO_2max and total time for eight sprints.

In the present study, peak anaerobic power score of the group with high aerobic power was higher ($p<0.01$) than that of the group with low aerobic power. However, the difference was not significant when considering peak power/kg body mass. This inconsistency and that in the different study results given above may be related to differences in methodology, subject characteristics and the use of different anaerobic power indices.

Comparison of our findings with the study results obtained by Al-Hazzaa et al. (1) reveals that group I had higher levels for both aerobic and anaerobic measures, and that group II had lower VO_2max, similar peak power, slightly higher peak power/kg, and higher average power levels. Furthermore, although the differences were not statistically significant, players with higher aerobic levels had slightly better 10-m and 30-m sprint times. Strudwick et al. (22) indicated mean VO_2max levels, and 10-m and 30-m sprint times as 59.4 ± 6.2 $ml \cdot kg^{-1} \cdot min^{-1}$, 1.75 ± 0.08 s and 4.28 ± 0.12 s, respectively, in 19 professional soccer players from the English Premier League. Although our players were from second division teams, and had different levels of aerobic performance in the present study, both groups had better sprint times than those reported by Strudwick et al. (22).

These considerable variations in aerobic and anaerobic capabilities among subjects may affect the success of the teams. In fact, sufficient recovery among anaerobic efforts is provided mainly by high aerobic capacity. Thus, players who possess an aerobic power above 60 $ml \cdot kg^{-1} \cdot min^{-1}$ might be preferable for a soccer team. Malomsoki (13) indicated that over this mean aerobic power level, soccer teams might not be affected negatively by their high anaerobic performance. Findings of our study are compatible with this statement.

The present study results indicate that soccer players with high aerobic power levels have no disadvantage in terms of anaerobic capability. Possessing high anaerobic capability beside a high aerobic power, may add to their total physical performance capacity.

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