ANAEROBIC RESISTANCE OF SOCCER PLAYERS

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ABSTRACT

Introduction: Anaerobic resistance, i.e. the capacity to perform repeated series of anaerobic exercises at the maximum, is an indispensable feature for soccer players. The aim of the study was thus to determine the anaerobic resistance of soccer players by applying repeated maximal sprints. Materials and Methods: A group of 14 soccer players aged 19 - 27 years-old was subjected twice, in January and March, to a test consisting of maximal running 6x50 m with 15s intermissions between runs. The registered times were converted to speeds. The ratio of average speed to the maximum one achieved in all 6 runs, or the Performance Index (PI), was the measure of anaerobic resistance. Results: Average and maximum speeds were significantly (p<0.001) higher in March (5.47 ± 0.25 and 5.67 ± 0.28, respectively) than in January (5.73 ± 0.31 and 5.97 ± 0.31, respectively), although still rather low. The PI values were on both occasions alike (0.960 and 0.965) and were not correlated with maximum speeds. Discussion: The presented method may serve as a useful tool in determining and classifying athletes with respect to their anaerobic resistance by applying repeated series of specific exercise.

KEYWORDS

Physical Endurance, Athletic Performance, Soccer.

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Resistência anaeróbica de jogadores de futebol

Resumo

Introdução: A resistência anaeróbica, ou seja, a capacidade de realizar séries repetidas de exercícios anaeróbicos na potência máxima é uma característica indispensável para os jogadores de futebol. O objetivo do estudo foi determinar a resistência anaeróbica de jogadores de futebol aplicando repetidos sprints em velocidade máxima. Materiais e Métodos: Um grupo de 14 jogadores de futebol com idades entre 19 e 27 anos foi submetido duas vezes, em janeiro e março, a um teste consistindo de corridas máximas de 6x50m com 15s de intervalo entre as corridas. Os tempos registrados foram convertidos para velocidades. A proporção da velocidade média para a máxima, obtida em todas as seis corridas, ou índice de performance (IP), foi a medida da resistência anaeróbica. Resultados: As velocidades média e máxima foram significativamente maiores em março (5,47±0,25 e 5,67±0,28, respectivamente) com relação a janeiro (5,73±0,31 e 5,97±0,31, respectivamente), apesar de ainda muito baixos. Os valores de IP foram similares nas duas ocasiões (0,960 e 0,965) e não foram correlacionados com as velocidades máximas. Discussão: O método apresentado pode servir como uma ferramenta útil para determinar e classificar atletas no que diz respeito a suas resistências anaeróbicas, aplicando séries repetidas de um exercício específico.

Palavras-Chave
Resistência Física, Desempenho Atlético, Futebol.

Resistencia anaeróbica de los jugadores de fútbol

Resumen

Introducción: La resistencia anaeróbica, es decir, la capacidad de realizar series repetidas de ejercicios anaeróbicos en la potencia máxima es una característica indispensable para los jugadores de fútbol. El objetivo del estudio fue a determinar la resistencia anaeróbica de jugadores de fútbol aplicando repetidos sprints en velocidad máxima. Materiales y Métodos: Un grupo de 14 jugadores de fútbol con edades entre 19 y 27 años fue sometido dos veces, en enero y marzo, a un test consistiendo de carreras máximas de 6x50m con 15s de intervalo entre las carreras. Los tiempos registrados habían sido convertidos para velocidades. La proporción de la velocidad media para la máxima, obtenida en todas las seis carreras, o índice de performance (IP), fue la medida de la resistencia anaeróbica. Resultados: Las velocidades media y máxima fueron significativamente mayores en marzo (5,47±0,25 y 5,67±0,28, respectivamente) con respecto a enero (5,73±0,31 y 5,97±0,31, respectivamente), a pesar de todavía mucho bajos. Los valores de IP fueron similares en las dos ocasiones (0,960 y 0,965) y no habían sido correlacionados con las velocidades máximas. Discusión: El método presentado puede servir como una herramienta útil para determinar y clasificar atletas por lo que respecta a sus resistencias anaeróbicas, aplicando series repetidas de un ejercicio específico.

Palabras Clave
Resistencia Física, Rendimiento Atlético, Fútbol.

INTRODUCTION

Anaerobic resistance (AR), defined as the capacity to perform a task consisting of repeated series of anaerobic exercise at the maximum1, is an indispensable feature for soccer players. The definition of AR is thus close to sprint resistance2, i.e. the capacity to undertake many sprints and/or explosive series, without a substantial loss of speed. According to MacDougall et al.3 and Vrabas et al.4, that capacity is related to adaptation, induced by high-altitude training, to an efficient oxygen utilisation by muscle cells. Thus, soccer players having high anaerobic resistance would exhibit a high resistance to fatigue and fast recovery following intense, repeated exercises performed during a match, like shots, sprints and other actions. When breaks between such exercises are not long enough, the resynthesis of phosphagen sources would be insufficient and the energy would be supplied by lactic glycolysis leading to mounting fatigue and decreased performance5.

In the reported studies involving short-duration, repeated exercises6,7,8,9,10,11,12,13,14,15, the authors analyzed individual exercises in a series but not the entire exercise consisting of several series. Therefore, the previously described method using the commonly called performance index (PI)16,17,18,19,20 was used in this study to determine the anaerobic resistance of soccer players.

Objective

The aim of the study was to determine the effects of the standard training regimen in the preliminary training period on the anaerobic resistance of soccer players measured by applying repeated, maximal sprints.
MATERIALS AND METHODS

A group of 14 soccer players from “Glogovia” club, aged between 19 and 27 years-old, volunteered to participate in the study. The group included two goalkeepers, two forwards, five full-backs and five midfielders. Their body stature ranged from 162cm to 188 cm, body mass from 65kg to 88kg, and training experience from 6 to 14 years.

All players were submitted to maximal running tests consisting of six sprints, 50m each, separated by 15s passive breaks. The times of every sprint were registered and converted to speeds in order to render decreasing values. The test was preceded by a warm-up during about 10 min and consisting of dynamic exercises and a single 50m sprint at maximum speed. The measurements were conducted twice: at the beginning (January) and at the end (March) of the preliminary training to the second round.

The AR, i.e. the capacity to maintain the highest possible running speed throughout the test, was expressed as \( P_{16,17,18,19,20} \), defined as the ratio of average value registered in the series of exercises to the maximum the test. The heart rates were measured manually before the test (but after the warm-up) and after the test.

The ANOVA Three-way (subjects - exercise series - periods) was applied to the speed data followed by Scheffé’s post-hoc test for paired data and the Student’s “t” test for the difference in PI values. The measurements were conducted twice: at the beginning (January) and at the end (March) of the preliminary training to the second round.

RESULTS

The average values (± standard deviation) registered in the studied group, both somatic and performance-related, are presented in Table 1. Average and maximum speeds achieved in March were significantly (p<0.001) higher than in January. In contrast, average heart rates, both pre and post-exercise, were significantly lower (p<0.01). No significant difference was noted for the PI.

```
<table>
<thead>
<tr>
<th>variable</th>
<th>January</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>age (years)</td>
<td>20.4 ± 2.1</td>
<td></td>
</tr>
<tr>
<td>body stature (cm)</td>
<td>180.9 ± 5.4</td>
<td></td>
</tr>
<tr>
<td>body mass (kg)</td>
<td>73.4 ± 7.4</td>
<td></td>
</tr>
<tr>
<td>average speed (m/s)</td>
<td>5.47 ± 0.25</td>
<td>5.73 ± 0.31**</td>
</tr>
<tr>
<td>maximum speed (m/s)</td>
<td>5.67 ± 0.28</td>
<td>5.97 ± 0.31**</td>
</tr>
<tr>
<td>performance index</td>
<td>0.965 ± 0.020</td>
<td>0.960 ± 0.018</td>
</tr>
<tr>
<td>heart rate pre-exercise (bpm)</td>
<td>108 ± 10</td>
<td>92 ± 6*</td>
</tr>
<tr>
<td>heart rate post-exercise (bpm)</td>
<td>142 ± 9</td>
<td>126 ± 11*</td>
</tr>
</tbody>
</table>
```

Significantly different from the respective value in January:

* p<0.01; ** p<0.001

Average running speeds (± standard deviation) achieved in six consecutive sprints in two examination periods are presented in Image 1. The courses are non-linear, especially in March. Highest speeds were achieved in the 2nd or 3rd sprints and ranged between 5.60±0.30 m.s⁻¹ and 5.82±0.29 m.s⁻¹ (mean ± standard deviation) in January and March, respectively, individual values ranging from 5.24 m.s⁻¹ to 6.05 m.s⁻¹ and from 5.36 m.s⁻¹ to 6.25 m.s⁻¹, respectively. ANOVA revealed highly significant differences between subjects (\( F_{13,65} =16.95; \) p<0.001) and between examination periods (\( F_{1,83} =109.3; \) p<0.001). Significant (p<0.001) improvement in running speeds was observed in all subjects except one half-back in whom no significant change was noted and the speed increment was fairly constant (Image 2). In contrast, the values of PI registered on both occasions were uncorrelated (Image 3).

The relation between values of the performance index and of maximum speed achieved in the series of 6 sprints is shown in Image 4. The lack of significant correlation (r=-0.054) enabled classification of players according to their maximum sprint speed and anaerobic resistance. Among the 14 players studied, two (one forward and one full-back) exhibited high sprint speed combined with high anaerobic resistance.

DISCUSSION

The results achieved by soccer players in March were significantly higher than in January which may suggest an effect of training or lower engagement of subjects in the test in January than in March. Their engagement and/or running capacity were in any case unsatisfactory; the average maximum running speed amounting to 5.97±0.31 m.s⁻¹ was markedly (by about 1 m.s⁻¹) lower than that registered in a representative group of 17 to 20 years-old untrained schoolboys

\[ 20 \] . In contrast, average PI values measured on both occasions did...
Image 1 - Average values (± standard deviation) of maximum running speed achieved by soccer players (n=14) in a series of 6x50m sprints, separated by 15s intermissions, before (January) and after (March) preliminary training to the second round.

Image 2 - Maximum sprint speeds achieved by individual soccer players (n = 14) before (January) and after (March) preliminary training to the second round. The identity line is shown.

Image 3 - Performance index (PI) values achieved by individual soccer players (n=14) before (January) and after (March) preliminary training to the second round.

Image 4 - On the other hand, two players in the lower left corner are deficient in both - speed and anaerobic resistance.

In conclusion, the method used in this study enables determining individual players with respect to their anaerobic resistance, i.e. capacity to perform a task consisting of repeated series of anaerobic exercise at the maximum, by determining the PI, i.e. the ratio of average speed to the maximum one achieved in several maximal runs spaced by short intermissions. The PI was not correlated with maximum speed, thus enabling clas-
sification of players and adjusting the training charges to individual needs.

REFERENCES


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