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REPEATED SPRINT ABILITY IN PROFESSIONAL SOCCER vs. PROFESSIONAL FUTSAL PLAYERS

Capacidad de realizar esprints repetidos en jugadores profesionales de fútbol vs. Fútbol sala

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Resumen

Purpose: To investigate the changes through repeated explosive effort sequences (20+20-m sprint with change of direction), jumping, metabolic response (lactate), as well as the relationship between these variables and fitness qualities (strength and endurance) in professional futsal and soccer players. **Methods:** Male players (n =30, Twelve futsal and twenty soccer players) completed three testing sessions. In the first session was measured VO_{2max} on a motorized treadmill. In the second session was measured counter movement jump (CMJ) and full squat RM in Smith Machine. Finally, in the third session six repeated-explosive effort sequences (RES) was performed. **Results:** Similar values of lower limbs strength, CMJ height, LAC after RSA test and VO_{2max} (95,12 vs. 94,73; 34,5 vs. 35,9; 13,65 vs. 14,33; 62,78 vs. 62,95 soccer vs. futsal respectively) and significant differences when are analysed the loss of performance in velocity (total and between three first and three last) and vertical jump height (2,67 vs. 4,4**; 1,28 vs. 2,1*; 2,88 vs. 6,1**; 9,71 vs. 14,3* soccer vs. futsal respectively). **Conclusions:** Professional futsal and soccer obtain significant differences in speed and vertical jump height (CMJ) loss despite having similar values in squat, oxygen consumption, lactate after RSA test and CMJ height. Issue that could be attributed to the characteristics of the sport. This suggests that the volume should be increased oriented ability to perform repeated sprint actions over other type of training aimed at improving aerobic capacity especially at professional level.

Palabras clave: Esprines repetidos, pérdida de rendimiento, fútbol y fútbol sala

Abstract

Objetivo: Investigar los cambios producidos ante acciones de esprines repetidos (20+20 metros con cambio de dirección), el CMJ, la respuesta metabólica (lactato) , y la relación entre estas variables y la fuerza y resistencia en jugadores profesionales de fútbol y fútbol sala. **Métodos:** Jugadores profesionales (n=30, doce de fútbol sala y veinte de fútbol) completaron tres sesiones de evaluación; VO2max en tapiz rodante, el salto CMJ y la RM en sentadilla completa y finalmente, se realizó el test de RSA (6 x 40 (20+20)). **Resultados:** Se obtuvieron valores similares de fuerza en sentadilla, en CMJ, de LAC después de la prueba RSA y de VO_{2max} (95,12 kg vs 94,73 kg ; 34,5 cm vs 35,9 cm ; 13,65 mmol vs 14,33 mmol ; 62,78 ml·kg·min^{-1} vs . 62,95 ml·kg·min^{-1} fútbol vs. fútbol sala, respectivamente). Se obtuvieron diferencias significativas cuando se analizó la pérdida de rendimiento en velocidad (total y entre los tres primeros y tres últimos bloques de esprines) y en salto (2,67% vs 4,4%**; 1,28% vs 2,1%*; 2,88% vs 6,1%**; 9,71% vs 14,3%* de fútbol vs. fútbol sala, respectivamente). **Conclusiones:** Ambos deportes presentan diferencias significativas en las pérdidas de rendimiento en velocidad y salto a pesar de tener valores similares de fuerza, de VO_{2max}, de lactato tras RSA y de CMJ. Podría atribuirse a los esfuerzos propios de cada deporte y puede sugerir que debería incrementarse el volumen de entrenamiento orientado a la capacidad de realizar esfuerzos repetidos frente a otro tipo de objetivo como la mejora de la capacidad aeróbica, sobre todo a nivel profesional.

Keywords: RSA, loss of performance, futsal and soccer

Introduction

Team sports like soccer and futsal are characterized by performing different actions during a match; walking, jumping, jogging, run at different velocities and change of direction (Makaje, Ruangthai, Arkarapanthu, & Yoopat, 2012; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009). The intermittent actions are similar in both sports, with cycles of very high intensity in which the HRmax of the athlete is reached (Makaje, Ruangthai, Arkarapanthu, & Yoopat, 2012). Approximately 83% of the game, players remain above 85% of HR_{max} (Makaje, Ruangthai, Arkarapanthu, & Yoopat, 2012). These values indicate that for more than 80% of the time spent on the court, these players were performing very vigorous activity at a high intensity. These actions are intermittent and acyclic, changing intensity and duration of effort and only 2% of this activity is with ball (Reilly, 1996).

Previous studies have examined physical performance, especially high-intensity activities in competitive soccer match play (Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2009; Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009; Barbero-Álvarez, D' Ottavio, Granda Vera, & Castagna, 2009). Although these analysis were influenced by different variables such as: game location (Impellizzeri et al., 2008; Barbero-Álvarez, D' Ottavio, Granda Vera, & Castagna, 2009) and player´s competitive level (Impellizzeri et al., 2008; Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2009).

Players are often required to repeatedly produce maximal or near maximal sprints of short duration (1–7 s) with brief recovery periods (Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2009). Thus, the ability to repeat sprint are deemed relevant fitness prerequisites in competitive soccer players and for soccer physical performance (Impellizzeri et al, 2008). Indeed in elite players, Carling, Le Gall y Dupont (2012), and reported in match play more high-intensity actions interspersed by short recovery times in the players who showed lowest performance decrements in a repeated-sprint test. Moreover, it has also been recently shown by Faude, Koch y Meyer (2012), that straight sprinting was the most frequent action is soccer goal situations, stressing the importance of power and speed abilities in soccer decisive situations.

Moreover, metabolic factors directly related with the energetic contribution in this kind of efforts play an important role. The blood lactate concentration as consequence of glycolytic energetic contribution have been related with the reduction in strength or power output (Sahlin, 1992), and the repeated sprint ability (RSA) in soccer players Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2009).

Recent evidence suggests the incorporation of movements involving the stretch-shortening cycle (SSC) (Meeusen, Piacentini, & Busschaert, 2004) provides a more specific examination of neuromuscular fatigue (Nicol, Avela, & Komi, 2006). For instance, in RSA protocols have been verified a high relationship between CMJ and sprint ability (Comfort, Stewart, Bloom, & Clarkson, 2014; Wisloff, Castagna, Helgerud, Jones, & Hoff, 2004), as well as that the CMJ is a good indirect indicator of power for the lower body (Canavan & Vescovi, 2004), and, therefore it seems clear from this body of research that loss of CMJ height could be used as an indicator of neuromuscular fatigue (Sanchez-Medina & Gonzalez- Badillo, 2011).

For all these issues can be interesting to study different mechanical and metabolic variables during performance of repeated sprints, with changes of direction in professional soccer and futsal players. In addition, no studies have been found comparing these two different sports to professional level.

Therefore, the aim of this study was to assess the RSA in professional soccer and futsal using the test performed according to the procedures suggested by Impellizzeri et al. (2008), designed to measure both repeated sprint and change in direction abilities.

Material and Methods

Participants

Twelve futsal players (mean ± SD: age 26.5 ± 5.18 yr., height 1.79 ± 0.65 m, body mass 75.02 ± 7.2 kg, IMC 23.44 ± 1.71) and twenty-five soccer players (mean ± SD: age 28.6 ± 0.48 yr, height 1.78 ± 0.67 m, body mass 73.01 ± 12.10 kg, IMC 23.14 ± 1.67) volunteered to participate in this study. Participants played in a professional futsal team of the first division of National Spanish Futsal League and in a professional soccer team of the second division of National Spanish League. After being informed about the purpose, testing procedures, and potential risks of the investigation, all participants gave their voluntary written consent to participate. For those players who were minors, the written consent of their parents was obtained. No physical limitations, health problems, or musculoskeletal injuries that could affect testing or training were found after a medical examination. The present investigation was approved by the Research Ethics Committee of Jaen and was conducted in accordance with the Declaration of Helsinki.

Experimental design

All the tests were completed at the end of the season of each team and were carried out during three consecutive weeks and each one was done at least 48 hours after the most recent game. All participants were accustomed with the carrying out of repeated sprints with and without changes of direction and CMJ measurements with the devices used.

In the first session was measured VO_{2max}. The players run on a motorized treadmill (RunRace, Technogym, Gambettola, Italy) for 6 minutes at 8 $km{\cdot}h^{-1}$. The speed Increased 1 $km{\cdot}h^{-1}$ every 1 minute until exhaustion, which was reached in 8 to 12 minutes. Achievement of VO_{2max} was considered as the attainment a plateau in VO_2 despite increasing speeds.

In the second testing session players completed a progressive isoinertial loading test increasing loads using the full squat exercise performed in a Smith machine (Adam Sport; Granada, Spain), to measuring the RM (repetition maximum) of lower limbs.

In the third session the players executed the repeated-explosive efforts sequence test (RES). Made a standardized warm-up consisting of 5min of low intensity run, 3x30-m progressive accelerations, and a maximal 30m sprint, interspersed by 3 min of passive recovery. After that, a 30-m all-out running sprint, 2 maximal 40-m (20 + 20-m) shuttle sprints. The time of each sprint was measured to the nearest 0.01s with 3 photocell-timing gates (Polifemo Radio Light, Microgate, Bolzano, Italy). After that, jump ability was evaluated through three repetitions of the test CMJs separated by 5s. Furthermore, jump ability was assessed after first three sprint. Jump height was calculated at the nearest 0.1 cm from flight time measured with an infrared timing system (Optojump; Microgate, Bolzano, Italy). The average height of these jumps was recorded for later analysis (CMJ_{mean}). Repeated sprint tests began 3min after the last jump. The best maximal single shuttle sprint time was used as the players' reference performance (RSA_{best}). The test consisted in six repeated-maximal 40-m shuttle sprints (20-m + 20-m with 180 turns), separated by 30 seconds of recovery after each 40-m shuttle ran and without recovery time between actions. After last sprint each player executed again one repetition of test CMJ. Furthermore, capillary blood samples for the determination of lactate concentration were obtained from the player's fingertip just finish the test and 3 minutes before. The Lactate Pro LT-1710 (Arkray, Kyoto, Japan) portable lactate analyser was used for lactate measurements. The suitability and reproducibility of this analyser has been previously established throughout the physiological range of 1.0–18.0 mmol.l^{-1} (Pyne et al., 2000) This device were calibrated before exercise session according to the manufacturer´s specifications.

The mean sprint time (RSAmean1-6) expressed in seconds and the partial mean sprint times were calculated: the mean of the first three sprint times (RSAmean1-3) and finally the mean of the last three sprints (RSAmean4-6). (Bishop et al., 2001). The percent sprint decrement (Psd) was calculated as follows: (RSAmean/RSAbest x 100) – 100. (Spencer, Fitzsimons, Dawson, Bishop, & Goodman, 2006). The percent decrement of jump height (Pdjh) was calculated as follows: 100-(CMJpost / CMJpre x 100). Moreover, the sprint decrement was calculated for the three first and the three last sprints.

Statistical analysis.

The results are presented as means, standard errors of the mean (SEM), and percentages of totals. The assumption of normality was tested with the Shapiro-Wilks test for each of the variables segmented by teams. Moreover, analysis of graphs of normality and skewness and kurtosis. Comparisons between baseline measurements and post-game performances in sprint time, CMJ and blood lactate were determined by a two-way ANOVA with repeated measures. Significant main effects were subsequently analyzed using a Bonferroni post hoc test to locate the differences. The statistical analysis program used was SPSS Statistics 19.0 (SPSS Inc. IBM Company, 2010)

Results

Mean values and SD of the different variables assessed in both teams are reported in Table 1.

Table 1. Values in selected neuromuscular and physiological performance variables. Data are mean ± SD

	$V0_{2max}$ ($ml{\cdot}kg{\cdot}min^{-1}$)	LAC (Mmol)	RM (kg)	Sprint time (sec)	CMJ (cm)
Soccer	62,78 ± 5,05	13,65 ± 2,77	95,12 ± 16,53	7,01 ± 0,22	34,5 ± 2,48
Futsal	62,95 ± 5,21	14,33 ± 3,40	94,73 ± 17,01	7,26 ± 0,19	35,9 ± 5,29

VO_{2max}: Maximum oxygen consumption achieved in incremental treadmill test

LAC: Blood lactate concentration measured at the end of the last sprint

RM: Repetition maximum in full squat

Sprint time: The best time of the six sprints

CMJ: Counter movement jump test

Likewise, Post-exercise CMJ height, lactate concentration three minutes after and speed loss, were significantly different ($p \leq 0.001$) than pre-exercise following the RSA test (Table 2).

Table 2. Change values in selected neuromuscular and physiological performance variables. Data are mean ± SD

	CHLAC (%)	PSD (%)	PSD_{inter} (%)	'SD_{final} (%)	PDJH (%)
Soccer	16,23 ± 12,73	2,67 ± 0,64	1,28 ± 0,58	2,88 ± 1,74	9,71 ± 3,11
Futsal	20,5 ± 13,07	4,4 ± 1,21**	2,1 ± 1,44*	6,1 ± 2,66**	14,3 ± 5,54*

CHLAC: Percent change lactate values between the first and third minute after last sprint

PSD: Percent sprint decrement the six sprints

PSD_{inter}: Percent sprint decrement for the three first sprints

PSD_{final}: Percent sprint decrement for the three last sprints

PDJH: Percent decrement of jump height for the six repeat sprint sequences

*: Denotes significance at $P<0.05$

**: Denotes significance at $P<0.01$

When are compared the absolute values of the variables assessed in both sports, it can be observed that are very similar (Figure 1), however when are analysed the changes in these variables after the repeated sprint test, the values obtained are substantially different (Figure 2).

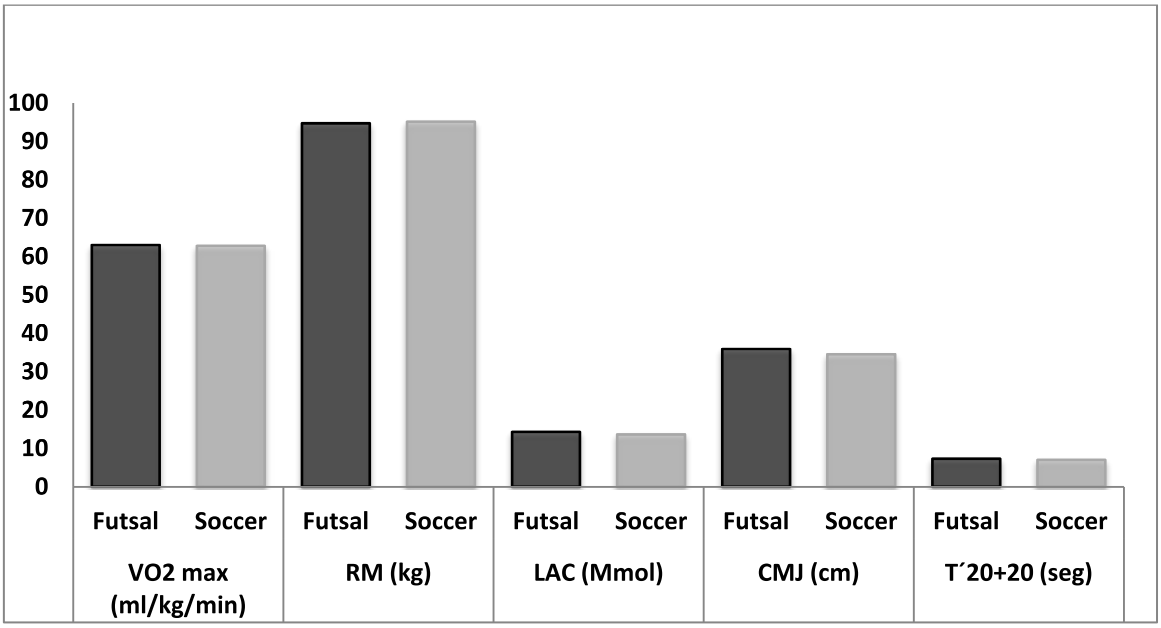

Figure 1. Values of performance. $VO_{2\ max}$ = Maximum Oxygen Uptake, RM = Repetition Maximum, LAC= Lactate concentration, CMJ= Counter Movement Jump, T´20+20= Time in twenty meters round trip

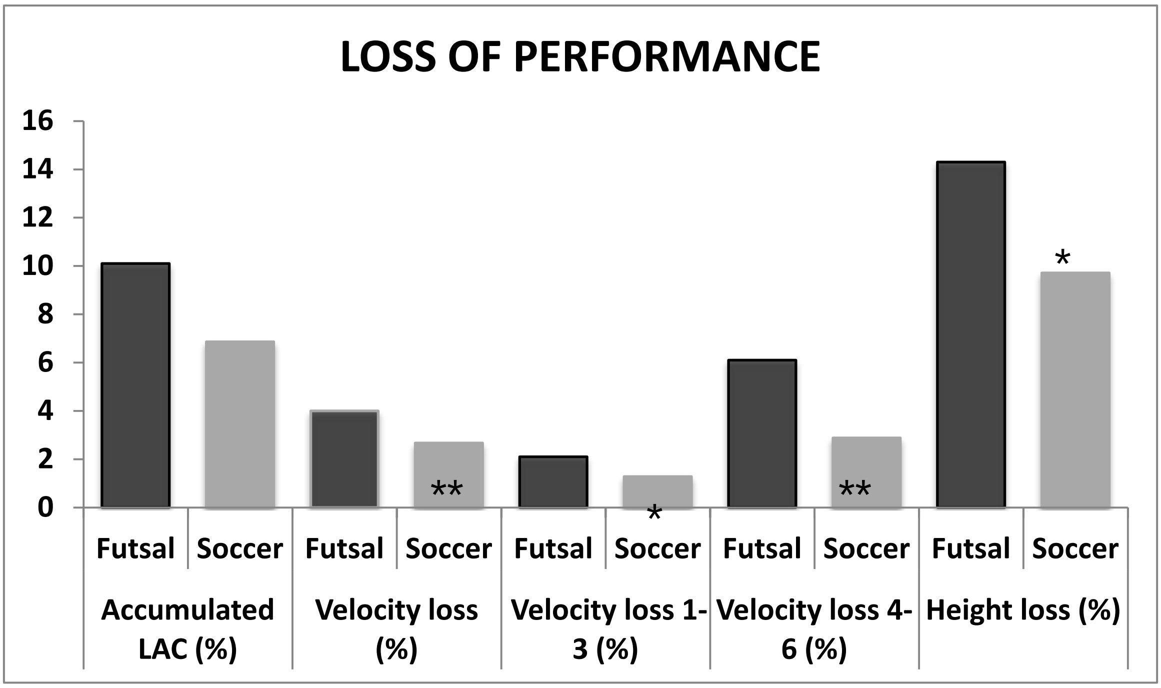

Figure 2. Loss of Performance. Accumulated LAC= Percentage changes in Lactate concentration between first and third minute after repeated sprint test, Loss velocity= Percentage loss of velocity between mean time and best time, Loss velocity 1-3= Percentage loss of velocity between mean of the first three sprint times and best time, Loss velocity 4-6= Percentage loss of velocity between mean the mean of the last three sprint times and best time, Loss height= Percentage loss in jump CMJ.

*: Denotes significance at P<0.05

**: Denotes significance at P<0.01

Discussion

Repeated sprint ability is receiving considerable attention from both researchers and practitioners interested in quantifying this aspect of fitness on team sports. (Da Silva, Guglielmo, & Bishop, 2010).

It has been much interest to know the changes of different mechanical and metabolic variables during this type of action (Da Silva, Guglielmo, & Bishop, 2010). They have been using various protocols with different race distances, repetitions and recovery times between sprint. In 2008, Impellizzeri studies the validity football, which includes travel to and from each repetition in order to get a little closer to the reality of team sports where making changes direction frequently. Some studies use different players of different competition level, differentiating between professional and no professional players. These studies analyzed the difference among various mechanical and metabolic variables before a repeated sprint test in both soccer and futsal (Pyne, Boston, Martin, & Logan, 2000; Makaje, Ruangthai, Arkarapanthu, & Yoopat, 2012). However, it has not found any studies that compare both sports in the same test

In view of the results presented in Table 1, it is observed that a good aerobic capacity in soccer and futsal is not a distinctive or decisive action in performance of repeated sprints variable. Both oxygen consumption values are higher than 62 ml · kg · min-1 as well as the values obtained by different authors (Castagna, Manzi, D' Ottavio, Annino, Padua, & Bishop, 2007).

There is much discussion on the relative importance of endurance and speed qualities in court- and field-based team sports. In AFL football, most team and fitness coaches consider that endurance, speed, and repeated sprint ability are all important qualities in a player's fitness profile (Da Silva, Guglielmo, & Bishop, 2010).

The inability to maintain repeated-sprint performance has been attributed mainly to metabolites accumulation, such as increase in [La] (Thomas, Sirvent, Perrey, Raynaud, & Mercier, 2004), the accumulation of H^+ (Glaister, 2005), and the depletion of muscle phosphocreatine (Gaitanos, Williams, Boobis, & Brooks, 1993). However, factors such as changes in the neuromuscular coordination of muscle contraction have also been linked to fatigue during repeated-sprint exercise (Mendez-Villanueva, Hamer, & Bishop, 2007). The large contribution of anaerobic glycolysis during the RSA test is supported by the high values of [La] in soccer and futsal (13,65 ± 2,77 vs. 14,33 ± 3,40 respectively) after the RSA test (Table 1). As for the values of strength, both teams have similar values of RM squat (95.12 ± 16.53 vs. 94.73 ± 17.01 kg soccer vs. futsal respectively), presented in Table 1. Moreover, the ability to apply force, measured through the vertical jump height (CMJ), is very similar in both sports (34.5 ± 2.48 vs. 35.9 ± 5.29 cm respectively).

When are analyzed performance losses (values shown in Table 2), a significant loss ($p < 0.01$) in sprint in futsal are show. The losses found in soccer are similar to those presented by Impellizzeri et al in 2008 for professional soccer players, and somewhat similar to those found in similar test about similar distances in professional Australian football players (Pyne, Saunders, Montgomery, Hewitt, & Sheehan, 2008) and a little lower than those found in well-trained soccer players who travel the same total distance distributed in one more repetition (Da Silva, Guglielmo, & Bishop, 2010).

Total performance losses found in futsal are significantly ($p < 0.01$) greater than soccer, in this work and in the work referred to above. Comparing the losses with other authors (Makaje, Ruangthai, Arkarapanthu, & Yoopat, 2012), some are higher than for professionals and more similar those made by amateur players who were assessed too. When the analysis focuses on the performance loss between the first three and the last three series, it appears that the loss is significant ($p < 0.05$) in the first three and very significant ($p < 0.01$) in the last three in futsal but not in soccer, where the loss is more constant and there is no significant difference between the first three and the last three. These results are similar to those found by Da Silva et al in 2008, where losses from the fourth sprint are significant ($p < 0.05$). When loss of vertical jump is analyzed after test of RSA, only is significant ($p < 0.05$) for futsal (values shown in Table 2). Although in both cases the fact is observed by other authors (Jimenez-Reyes, 2010) and with other athletes. This difference between both losses may be due to the fact that even though both actions have in common some determinants neuromuscular factors (Wisloff, Castagna, Helgerud, Jones, & Hoff, 2005; Vescovi and McGuigan 2008; Kale, Bayrak, & Acikada, 2009), may respond differently to peripheral fatigue and metabolic disturbances such as blood lactate accumulation (Buchheit, 2010).

It is observed that the difference between the loss is much higher than those found by Jiménez-Reyes (2010), at distances of 40m in sprinters and jumpers of high level, this fact may be due to the level of training in this type of action. Our study highlights that this situation is accentuated in futsal against soccer.

Conclusion

Professional futsal and soccer obtain significant differences in speed and vertical jump height (CMJ) loss (figure 2) despite having similar values in squat, oxygen consumption, and lactate after RSA test and CMJ height. Issue that could be attributed to the characteristics of the sport. This suggests that the volume should be increased oriented ability to perform repeated sprint actions over other type of training aimed at improving aerobic capacity especially at professional level.

Although various indices of aerobic fitness had been related to RSA, the strongest predictor of RSA was the anaerobic power (i.e., the fastest individual sprint time). This question suggests that to improve RSA, it is important to implement specific training targeting both aerobic and anaerobic components.

More comparative studies between both sports are needed to increase awareness of the differences in performance and to improve the training process. Moreover further studies would be necessary where the workouts are controlled and / or specific training aimed at repeated sprints actions.

Practical applications

The results of the present study can raise awareness about repeating futsal and soccer specific actions such as sprinting and jumping.

According to results, the performance of repeated sprints with changes of direction can be used as an assessment tool of specific performance and also as a training method, by monitoring the performance loss (defined as loss of speed or jumping). Moreover, would be appropriate to use different distances depending on the sport.

Following this framework, would be interesting in future studies, to use other devices (accelerometers, ammonia gauges, radar, etc), to provide relevant information about other variables, both mechanical and metabolic, in order to increase the knowledge of issues such as evolution in the horizontal application of force and blood ammonia concentration during a sequence of repeated sprints, typical in both these sports.

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