
**YO-YO INTERMITTENT RECOVERY TEST LEVEL 2. CARDIORESPIRATORY
RESPONSE AND PERFORMANCE IN COLOMBIAN PROFESSIONAL SOCCER
PLAYERS. COMPARISON BETWEEN SUB 20 AND OVER 20 YEARS OLD
PLAYERS**

Prueba Yo-yo de recuperación intermitente nivel 2. Respuestas
Cardiorrespiratorias y rendimiento en jugadores de futbol profesional colombiano.
Comparación entre jugadores menores y mayores de 20 años de edad

Teste Yo-yo de recuperação intermitente nível 2. Respostas cardiorrespiratórias e
rendimento em jogadores de futebol profissional colombiano. Comparação entre
jogadores menores e maiores de 20 anos

Arturo Cabrera¹

Luis Tafur²

Sergio Garcia-Corzo³

¹Facultad de Educación y Ciencias del Deporte, Institución Universitaria Escuela Nacional del Deporte, arturo.cabrera@endeporte.edu.co

²Facultad de Educación y Ciencias del Deporte, Institución Universitaria Escuela Nacional del Deporte, luis.tafur@endeporte.edu.co

³Facultad de Educación y Ciencias del Deporte, Institución Universitaria Escuela Nacional del Deporte, sergio.garcia@endeporte.edu.co

Abstract

This study aimed to compare the older players (O20) and the younger ones (U20) of the 2015 Colombian Professional National League champion team in cardiopulmonary responses and performance to Yo-Yo Intermittent Recovery Test level 2 (YYIR2). All subjects (N=9=O20; N=19=U20) were monitored for heart

rate, and a continuous breath-to-breath recording was executed while they perform the YYIR2. It was observed a significant difference in distance covered and speed in the ventilatory threshold between U20 players ($280 \pm 85,3\text{m}$) ($16,6 \pm 0,3\text{km.h}^{-1}$) and O20 players ($373 \pm 113,1\text{m}$) ($17 \pm 0,3\text{km.h}^{-1}$). Only in the U20 group, it was observed a significant correlation between the variables oxygen consumption in the ventilatory threshold ($\dot{V}\text{O}_{2\text{atVT}}$) and performance in the test (Dmax), $\dot{V}\text{O}_{2\text{atVT}}$ and maximum speed (Smax), peak oxygen consumption ($\dot{V}\text{O}_{2\text{peak}}$) and Smax and $\dot{V}\text{O}_{2\text{peak}}$ and Dmax. The only variable that differentiated the performance in the population was the analysis of the distance and speed in the course of the ventilatory threshold.

Keywords: *Colombia; soccer players; aerobic fitness.*

Resumen

El objetivo de este estudio fue comparar los jugadores mayores (O20) y los más jóvenes (U20) del equipo campeón de la Liga Nacional Profesional Colombiana 2015 en respuestas cardiopulmonares y el rendimiento en la prueba Yo-yo de recuperación intermitente nivel 2 (YYIR2). Todos los sujetos ($N = 9 = \text{O20}$; $N = 19 = \text{U20}$) fueron monitoreados para la frecuencia cardíaca y se realizó una grabación continua de respiración a respiración mientras realizaban el YYIR2. Se observó una diferencia significativa en la distancia recorrida y la velocidad en el umbral ventilatorio entre los jugadores U20 ($280 \pm 85,3\text{m}$) ($16,6 \pm 0,3\text{km.h}^{-1}$) y los jugadores O20 ($373 \pm 113,1\text{m}$) ($17 \pm 0,3\text{km.h}^{-1}$). Solo en el grupo U20, se observó una correlación significativa entre las variables consumo de oxígeno en el umbral ventilatorio ($\dot{V}\text{O}_{2\text{atVT}}$) y el rendimiento en la prueba (Dmax), $\dot{V}\text{O}_{2\text{atVT}}$ y velocidad máxima (Smax), consumo pico de oxígeno ($\dot{V}\text{O}_{2\text{pico}}$) y Smax y $\dot{V}\text{O}_{2\text{peak}}$ y Dmax. La única variable que diferenciaba el rendimiento en la población era el análisis de la distancia y la velocidad en el momento del umbral ventilatorio.

Palabras clave: *Colombia; jugadores de futbol; acondicionamiento aeróbico.*

Resumo

O objetivo deste estudo foi comparar os jogadores mais velhos (O20) e os mais jovens (U20) da equipe campeã da Liga Nacional Profissional da Colômbia 2015 em respostas cardiopulmonares e o rendimento no teste Yo-yo de recuperação intermitente nível 2. Todos os indivíduos ($N = 9 = O20$; $N = 19 = U20$) foram monitorados para a frequência cardíaca e se realizou uma gravação contínua de respiração a respiração enquanto realizavam o YYIR2. Observou-se uma diferença significativa na distância percorrida e na velocidade no limiar ventilatório entre os jogadores U20 ($280 \pm 85,3m$) ($16,6 \pm 0,3 \text{ km.h}^{-1}$) e os jogadores O20 ($373 \pm 113,1m$) ($17 \pm 0,3 \text{ km.h}^{-1}$). Apenas no grupo U20 se observou uma correlação significativa entre as variáveis consumo de oxigênio no limiar ventilatório ($\dot{V}O_{2atVT}$) e o rendimento no teste (D_{max}), $\dot{V}O_{2atVT}$ e velocidade máxima (S_{max}), o consumo pico de oxigênio ($\dot{V}O_{2peak}$) e S_{max} e $\dot{V}O_{2peak}$ e D_{max} . A única variável que diferenciava o rendimento entre todos era a análise da distância e velocidade no momento do limiar ventilatório.

Palavras-chave: Colômbia; jogadores de futebol; condicionamento aeróbico.

1. Introduction

In soccer, aerobic fitness is associated with sports performance. Different studies have found that soccer requires players to repeatedly perform high intensity actions with brief recovery periods (Di Salvo *et al.*, 2009).

Therefore, it has been proposed to measure the specific aerobic fitness of a soccer player through an intermittent test (Castagna *et al.*, 2009; Lemmink *et al.*, 2004). Although, laboratory treadmill tests it is considered the gold standard, this present practical, analytical and cost-benefit difficulties (Castagna *et al.*, 2006). On the contrary, a relationship with sports performance has been observed in intermittent

field tests, due to the specificity of their movement parameters (Castagna *et al.*, 2006; Castagna *et al.*, 2009; Lemmink *et al.*, 2004).

The Yo-Yo Intermittent Recovery Test it was created by Jens Bangsbo (Bangsbo, 1994) under the above-described rationalization. There are two levels of the test, level 1, starts at a lower speed and the speed increases are lower compared to level 2 (YYIR2).

But the relationship between performance in both levels of the test and aerobic fitness is not clear yet (Bangsbo *et al.*, 2008; Karakoç *et al.*, 2012).

Most studies compare cardiopulmonary responses and / or aerobic fitness with performance in the field test, making comparisons between the values obtained directly in a laboratory treadmill test, with the subsequent performance in the field test, without direct measurement of oxygen uptake in the latter, which would be an error due to the difference in the type of effort performed in both tests (Castagna *et al.*, 2006).

On the other hand, YYIR studies have been conducted among players of different performance levels (Ueda *et al.*, 2011), ages or stages of development (Veale *et al.*, 2010; Markovic & Mikulic, 2011) or season moment (Mohr & Kustrup, 2014) with both levels of the test. But, to our knowledge, there is no study that compares players with the same level of performance (elite level professionals) by age in YYIR2.

For this reason, the aim of this study was to compare the older players (over 20 years of age) and the younger ones (under 20 years old) of the Colombian

Professional National League 2015 champion team in cardiopulmonary responses to YYIR2 and performance in the test.

2. Method

Twenty-eight (28) players from a First Division soccer club of the Colombian Professional Soccer League were voluntarily evaluated, nine (9) over twenty (four defenders, three midfielders and two forwards) and nineteen (19) sub twenty years (ten defenses, four midfielders and five forwards). All the subjects were field players of the squad of the champion team of the Colombian National Professional League 2015; the goalkeepers were not included in the study. All trained generally six times per week, in daily sessions of between 90 to 120 minutes, plus at least one official match, and they had belonged to the professional team for at least one year. All had previous experience in the test and this study was carried out as part of the training program under the direction of the coaches. All signed an informed consent. This study was carried out under the codes of ethics of the Declaration of Helsinki and was approved by the Institutional Ethics Committee.

Two groups were defined according to age, one younger than 20 years (U20) and another older than 20 years (O20) to make the comparisons. The measured variables were: peak heart rate (HR_{peak}), heart rate at the ventilatory threshold (HR_{inVT}), percentage of peak heart rate at the ventilatory threshold (%HR_{peak inVT}), peak oxygen uptake (VO_{2peak}), oxygen uptake in the ventilatory threshold (VO_{2inVT}), percentage of peak oxygen uptake in the ventilatory threshold (%VO_{2peak inVT}), performance in the test (D_{max}), distance covered in the ventilatory threshold (D_{VT}), and percentage of performance in the test in the ventilatory threshold (%D_{max inVT}), maximum speed (S_{max}), speed in the ventilator threshold (S_{VT}) and percentage maximum speed in the ventilatory threshold (%S_{max inVT}).

3. Results and discussion

The main result of this study was that the DVT and SVT covered by O20 players in YYIR2 was higher, compared with U20 players.

U20 and O20 players showed similar anthropometric characteristics (Table1).

The results of the physiological variables, speeds and distances covered during YYIR2 are presented in Table2. It was observed a significant difference in DVT between U20 players ($280 \pm 85,3\text{m}$) and O20 players ($373 \pm 113,1\text{m}$; $p=0.02$), and a significant difference in SVT between U20 players ($16,6 \pm 0,3\text{km.h}^{-1}$) and O20 players ($17 \pm 0,3\text{km.h}^{-1}$; $p=0.01$).

Table 1. Physical characteristics of the group of players who participated in the study.

	Age (years)	Weight (Kg)	Height (cm)
U20 (n = 20)	18,8 (0,9)*	73,4 (4,7)	179,3 (6,2)
O20 (n = 11)	23,8 (2,3)	76,4 (7,0)	180,4 (6,1)

Note. Data expressed in mean (S.D)

* $p < 0.001$ when comparing with the senior group.

Table 2. Physiological variables, speed and distance covered in the YYIR2 test.

	O20	U20	Significance (p-value)
HR _{peak} (b·min ⁻¹)	182,1 (13,1)	186,2 (5,8)	0,38
HR at VT (b·min ⁻¹)	177,3 (17,1)	180,6 (5,2)	0,58
% HR _{peak} at VT	97,2 (3,9)	97,0 (2,8)	0,87
VO _{2peak} (ml·kg ⁻¹ ·min ⁻¹)	55,3 (3,8)	52,7 (5,8)	0,24
VO ₂ at VT (ml·kg ⁻¹ ·min ⁻¹)	51,0 (2,7)	48,7 (5,5)	0,25
% VO _{2peak} at VT	92,4 (5,6)	92,3 (5,2)	0,99
D _{max} (m)	528,8 (103)	475,7 (70,4)	0,18
D _{VT} (m)	373,3 (113,1)*	280,0 (85,3)	0,02
% D _{max} at VT	70,4 (15,2)*	58,4 (12,6)	0,03
S _{max} (km.h ⁻¹)	17,3 (0,2)	17,3 (0,2)	0,86
S _{VT} (km.h ⁻¹)	17,0 (0,3)*	16,6 (0,3)	0,01
% S _{max} at VT	98,3 (1,5)*	96,2 (1,6)	0,003

Note. Data expressed in mean (S.D).

* $p < 0,05$ when compared to sub-20 group.

Only in the U20 group, it was observed a significant correlation between the variables VO_{2atVT} and D_{max}, VO_{2atVT} and S_{max}, VO_{2peak} and S_{max} and VO_{2peak} and D_{max} (Table3 and 4).

Table 3. Pearson correlation (r) between physiological and mechanical variables in the YYIR2 test for the over 20 group.

	HR _{peak}	HR at VT	%HR _{peak} at VT	VO _{2peak}	VO ₂ at VT	%VO _{2peak} at VT	D _{max}	D _{VT}	%D _{max} at VT	S _{max}	S _{VT}	%S _{max} at VT
HR _{peak}		0,9										
(p value)		0,00										
HR at VT			0,9									
(p value)			0,00									
%HR _{peak} at VT				0,7								
(p value)				0,02								
VO _{2peak}												
(p value)												
VO ₂ at VT												
(p value)												
%VO _{2peak} at VT												
(p value)												
D _{max}										0,7	0,6	
(p value)										0,02	0,05	
D _{VT}										0,7	0,9	
(p value)										0,03	0,00	
%D _{max} at VT												
(p value)												
S _{max}							0,7	0,7			0,7	
(p value)							0,02	0,03			0,02	
S _{VT}							0,6	0,9		0,7		
(p value)							0,05	0,00		0,02		
%S _{max} at VT												
(p value)												

Table 4. Pearson correlation (r) between physiological and mechanical variables in the YYIR2 test for the sub 20 group.

	HR _{peak}	HR at VT	%HR _{peak} at VT	VO _{2peak}	VO ₂ at VT	%VO _{2peak} at VT	D _{max}	D _{VT}	%D _{max} at VT	S _{max}	S _{VT}	%S _{max} at VT
HR _{peak}		0,5	-0,5									
(p value)		0,02	0,01									
HR at VT												
(p value)												
%HR _{peak} at VT												
(p value)												
VO _{2peak}												
(p value)												
VO ₂ at VT												
(p value)												
%VO _{2peak} at VT												
(p value)												
D _{max}												
(p value)												
D _{VT}												
(p value)												
%D _{max} at VT												
(p value)												
S _{max}												
(p value)												
S _{VT}												
(p value)												
%S _{max} at VT												
(p value)												

4. Conclusions

It was observed that the only variable that differentiated the performance in the population was the analysis of the distance and speed at the time of the VT, measured through spirometry in the YYIR2 test; a better ability to apply force to perform intermittent actions such as changes of direction in the more experienced group of players could explain this behavior. However, the YYIR2 is an indirect measurement field test of $\dot{V}O_{2max}$, so that the determination of the VT requires a direct measurement with ergospirometer, which brings with it limitations in its execution due to the need for high technology equipment and personnel trained to perform and interpret the data; this is the reason why in order to make measurements of the VT in a field test, it is necessary to develop indirect methods of lower cost and that be practical in their application.

5. References

Bangsbo, J. (1994). *Fitness training in football: a scientific approach*. Copenhagen, Denmark: August Krogh Institute, University of Copenhagen.

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- Bangsbo, J., Iaia, F., & Krstrup, P. (2008). The Yo-Yo intermittent recovery test. *Sports Medicine*, 38(1), 37-51.
- Castagna, C., Impellizzeri, F. M., Chamari, K., Carlomagno, D., & Rampinini, E. (2006). Aerobic fitness and yo-yo continuous and intermittent tests performances in soccer players: a correlation study. *Journal of Strength and Conditioning Research*, 20(2), 320-325.
- Castagna, C., Impellizzeri, F., Cecchini, E., Rampinini, E., & Alvarez, J. (2009). Effects of intermittent-endurance fitness on match performance in young male soccer players. *Journal of Strength & Conditioning Research*, 23(7), 1954-1959.
- Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in Premier League soccer. *International Journal of Sports Medicine*, 30(03), 205-212.
- Karakoç, B., Akalan, C., Alemdaroğlu, U., & Arslan, E. (2012). The relationship between the yo-yo tests, anaerobic performance and aerobic performance in young soccer players. *Journal of Human Kinetics*, 35(1), 81-88.
- Lemmink, K., Verheijen, R., & Visscher, C. (2004). The discriminative power of the Interval Shuttle Run Test and the Maximal Multistage Shuttle Run Test for playing level of soccer. *Journal of Sports Medicine and Physical Fitness*, 44(3), 233.
- Markovic, G., & Mikulic, P. (2011). Discriminative ability of the yo-yo intermittent recovery test (level 1) in prospective young soccer players. *Journal of Strength & Conditioning Research*, 25(10), 2931-2934.
- Mohr, M., & Krstrup, P. (2014). Yo-Yo intermittent recovery test performances within an entire football league during a full season. *Journal of Sports Sciences*, 32(4), 315-327.
- Ueda, S., Yamanaka, A., Yoshikawa, T., Katsura, Y., Usui, T., Orita, K., & Fujimoto, S. (2011). Differences in physiological characterization between

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- Yo-Yo intermittent recovery test level 1 and level 2 in Japanese college soccer players. *International Journal of Sport and Health Science*, 9, 33-38.
- Veale, J., Pearce, A., & Carlson, J. (2010). The yo-yo intermittent recovery test (level 1) to discriminate elite junior Australian football players. *Journal of Science and Medicine in Sport*, 13(3), 329-331.