Journal of Human Sport and Exercise
E-ISSN: 1988-5202
jhse@ua.es
Universidad de Alicante
España

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Journal of Human Sport and Exercise, vol. 10, núm. 1, 2015, pp. 104-112
Universidad de Alicante
Alicante, España

Original Article

Comparison of maximum lactate between course navette test and hoff test in soccer players at 2600 meters above sea level

HENRY HUMBERTO LEÓN [1], JHON FREDY RAMÍREZ [2], ALVEIRO SÁNCHEZ [2], JEISON DANIEL SALAZAR [2], LEONARDO ORJUELA [2], SONIA VIVIANA ANZOLA [2]

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ABSTRACT

León, H.H., Ramírez, J.F., Sánchez, A., Salazar, J.D., Orjuela, L., & Anzola, S.V. (2015). Comparison of maximum lactate between course navette test and hoff test in soccer players at 2600 meters above sea level. *J. Hum. Sport Exerc., 10*(1), pp.104-112. Introduction: Nowadays football (soccer) requires a high aerobic capacity and for its assessment the Test of Course Navette (TCN) has been widely used. However, other tests closer to the current conditions like the Test of Hoff (TH) have also been applied. The study assessed the maximum production of lactate using both tests in similar conditions. Materials and Methods: 17 male soccer players were evaluated twice. One time using the TCN and the other time using the TH. At both times lactate was assessed at rest and at the end of maximum heart rate and lactate. The differences were statistically evaluated by Wilcoxon T and its correlation via a linear regression. Results: The initial lactate values were: TCN 4.9 ± 2.1 mmol/L and TH 4.2 ± 2.4 mmol/L, (p=0.162) Final lactate values: 11.6 ± TCN 3.3 mmol / L and TH 12.4 ± 3.8 mmol/L, (p=0.325), maximum heart rate 193.8 ± 9.3 beats TCN and TH: 188.1 ± 7.6 beats (p <0.05), the maximum speed reached at the TCN compared to the distance achieved by the TH, has a R2=0.55. Conclusion: TH is a test given under conditions closer to those of the game, and it has a strong relation with the TCN in the assessment of the aerobic capacity, without significant differences in the results of maximal lactate. **Key words**: LACTATE, COURSE NAVETTE TEST, HOFF TEST, AEROBIC CAPACITY.

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Submitted for publication November 2013
Accepted for publication April 2014
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2015.101.09

INTRODUCTION

Football today is characterized for being a highly demanding sport from the physical point of view, where physiological variables such as aerobic power are closely associated with competitive variables such as the quality of the game, the distance covered or the ability to perform high intensity activities as sprints, acceleration or direction changes among others (Impellizzeri et al., 2005; Helgerud et al., 2001). Assessment studies of the aerobic power have shown that professional footballers reach maximum oxygen consumption between 60-70 ml/kg/min (Stolen et al., 2005), and therefore its valuation has become increasingly important in evaluating the performance of the player.

The gold standard for determining the maximal oxygen consumption is constituted by laboratory testing, with the difficulty of requiring appropriate equipment and trained personnel which is not readily available to coaches and athletes (Leibetseder et al., 2012). On the other hand, its application been discussed for it does not represent actual playing conditions, which has led to suggestions that whenever possible physiological responses should be assessed in conditions similar to those experienced during the game (Currell & Jeukendrup, 2008; Reilly & Gilbourne, 2003).

In this sense, a test which has been widely used is the multi stage test (with distances of 20 meters), developed by Leger and Lambert (1982) which was amended by Bangsbo et al (2008) forming what today is known as the "Yo-yo test". More recently and with greater applicability to football Hoff developed in 2002, an evaluation test of aerobic capacity which in addition to using the ball, is done in conditions closer to the game. This test is performed at a distance of 290 meters for 10 minutes, with the player permanently dribbling the ball and including different movements similar to those required in the game (Hoff et al., 2002; Kemi et al., 2003).

In addition to aerobic power, the player because of the features of the game is constantly required to overcome the anaerobic threshold with its consequent lactate production and acidification of the extracellular medium. The lactate production is individual and is associated with the level of training and recovery capacity (Rivera-Brown & Frontera, 2012), Obtaining the maximum lactate values with their respective thresholds is currently the basis for planning multiple sports disciplines, allowing also establish relations with adaptive processes and performance itself (Denadai et al., 2005).

In response to the arguments the aim of this study is to evaluate the production of lactate in response to two tests for assessing field aerobic power, the Yo-Yo test and Hoff test as part of the validation process of the latter.

MATERIAL AND METHODS

Participants

A group of male players from a sports club in the city of Bogota, located at 2600 meters above sea level, were invited to participate in the study, taking into account the inclusion criteria for their participation: age, gender, membership to the sports club and sports participation at the time of evaluation. Athletes, who even though met the inclusion criteria, had osteo-articular injuries, personal or family history of cardiovascular disease, use of medications and those that were considered by the medical profession who oversaw the research were excluded.

In order to ensure respect for the use of information and integrity of patients, all athletes were informed of the type of study, the tests and potential risks. The approval on the use of the data was certified by signature and fingerprint.

All procedures were approved by the ethics committee of the Santo Tomás University and conform to the principles outlined in the Declaration of Helsinki, in the same way the tests to be performed are considered minimal risk in accordance with Article 10 of resolution 8430 of 1993 which apply to Colombia.

The total number of participants who met the criteria and participated signed the consent and took part in the assessment was 17 males, mean age 18.2 ± 1.8 years, weight 62.8 ± 7.4 kg, height 170.1 ± 5.8 cm. The overall characteristics are in Table 1.

Table 1. Physical characteristics of participants n = 17

	Average	SD
Age (years)	18.2	± 1.8
Weight (Kg)	62.8	± 7.4
Height (cm)	170.1	± 5.8
Fat percentage	10.0	± 1.7
Muscle percentage	52.3	± 4.4

Design

We used a non-experimental design of correlational descriptive scope, which compared the physiological response (maximum heart rate and maximum lactate) in a group of soccer players, after the application of two tests for assessing maximal aerobic capacity, Course Navette vs. a test of Hoff.

Procedure

Measurements included: body weight (kg), height (cm), percentage of fat and muscle mass as estimated by bioelectrical impedance using a Tanita® scale model, see Table 1.

Field tests were conducted under controlled conditions in the afternoon, at least three hours after the last food intake. Athletes were not allowed to drink soft drinks and caffeine in the hours before the test. Hydration was encouraged before and after the test, and athletes took the tests after 48 hours of rest and between tests there was a minimum rest period of 3 days.

The assessment of heart rate was made by RS800CX Polar® heart rate monitors with coded band. The lactate was assessed in a sample of capillary blood using h/p/cosmos Sirius©, with maximum error of 8%, at baseline (before warming up) and within one minute after the completion of each test.

Course Navette Test

A warming up was performed which consisted in joint mobility, general warm up and light exercise for muscle flexibility. After that, the Course Navette test was applied over a distance of 20 meters and with an

initial speed of 8.5 km/h, which increased progressively (0.5 km/h every minute). For speed control an audio signal in a recording previously established was used. The test ended when the subjects were not able to maintain the speed to reach the finish line (Leger & Lambert, 1982) Figure 1.

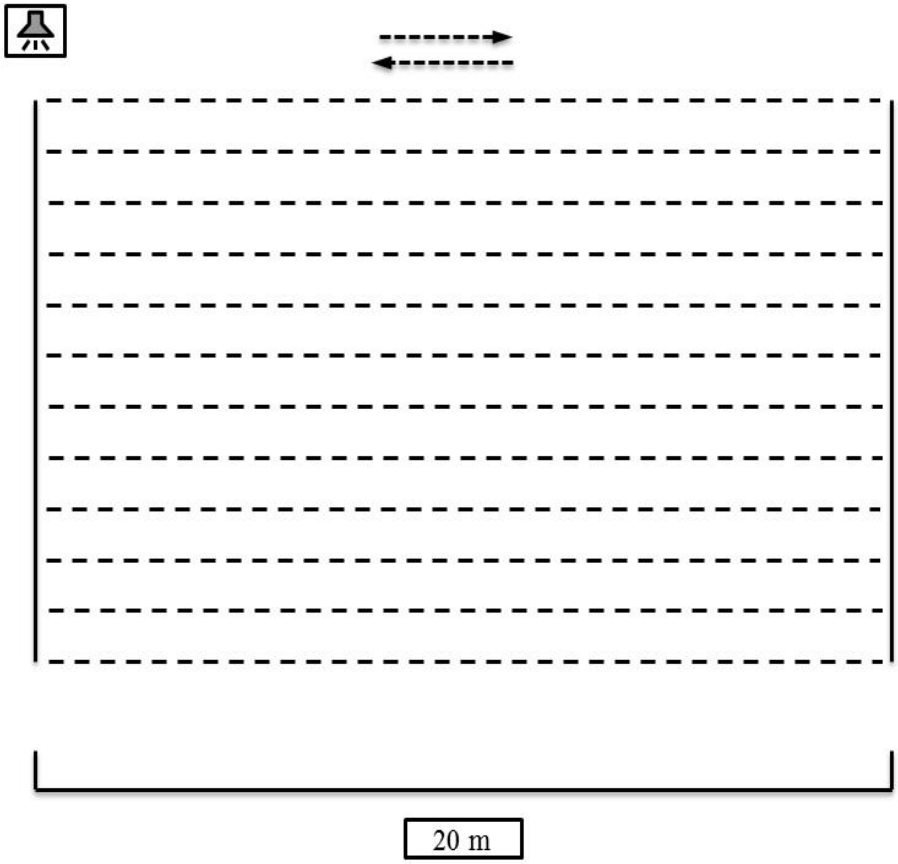

Figure 1. Diagram of the Course Navette test

Hoff test

After a warming up phase equal to that used in the Course Navette test, the participants walked a certain distance in order to get acquainted with the test and then we applied Hoff the test This is a test for the assessment of aerobic capacity which includes movements with the ball for a distance over 290 meters, Figure 2. The initial phase of the test is between a set of cones located 2 meters at a distance of 18 meters, then the participants have to jump three times 60 cm, with a distance of 7 meters each. In the next phase athletes must run 27 meters at full speed, and then they must dribble the ball back for a distance of 10 meters, and after running 45 meters the test starts again and it is done as many times as possible during the 10 minutes of its duration (Hoff et al., 2002).

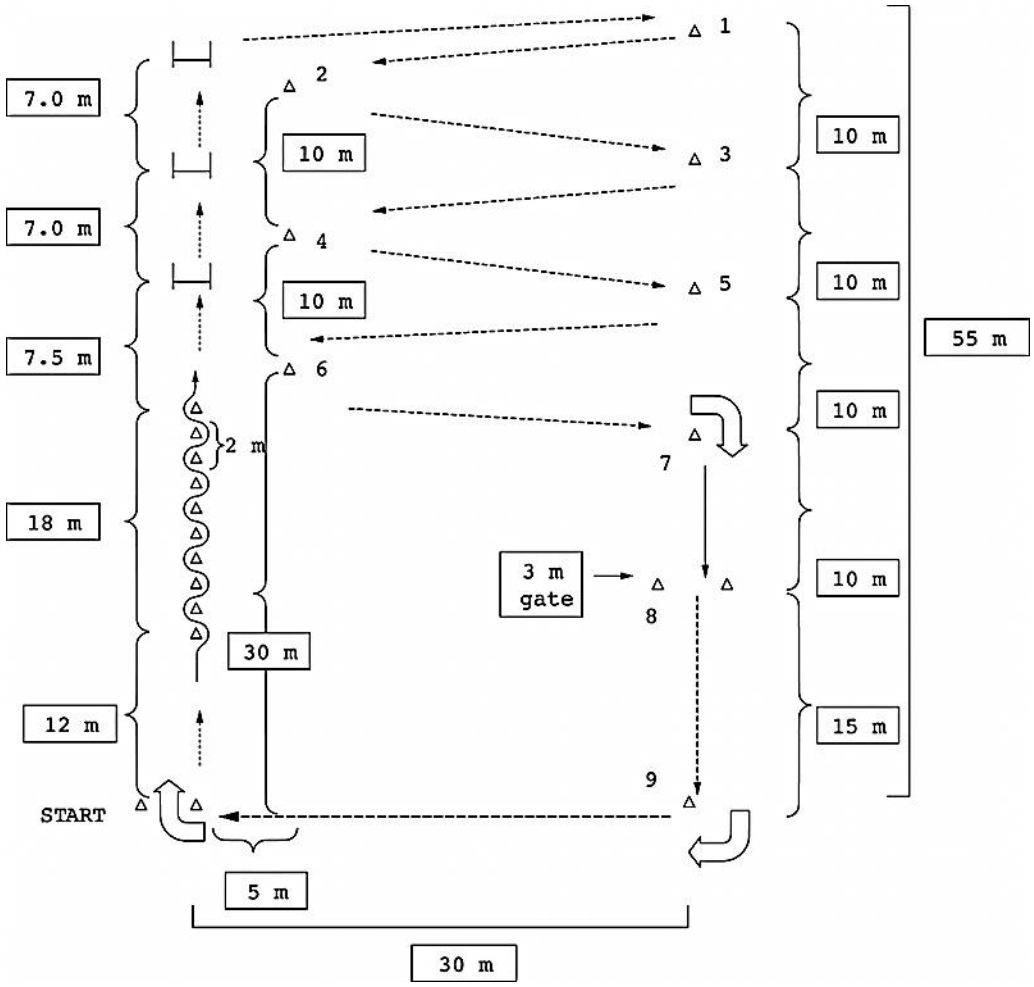

Figure 2. Diagram Hoff test, taken of Hoff et al., 2002

Statistical analysis

The descriptive presentation of the results was made by averages and standard deviations. The normality of each one of the results was evaluated by the Shapiro-Wilk test, and given the non-normality, the mean differences were assessed using Wilcoxon t for related groups considering the value of $p<0.05$ to obtain a relationship statistically significant Furthermore, with the data we also generated a linear regression analysis to evaluate the correlation. The analysis was done using IBM-SPSS Statistics Version 20.

RESULTS

In the Course Navette test the average of the initial lactate was 4.9 ± 2.1 mmol/L and 11.6 ± 3.3 mmol/L, at the end. The average speed reached was 12.8 km/h ± 0.8, for a calculation of VO2 of 48.9 ± 5.7 ml/kg/min, and the maximum heart rate was 193.8 ± 9.3 beats per minute. Final data for the Course Navette test are found in Table 2.

Table 2. Data Course Navette test n = 17

	Average	SD
Initial lactate (mmol/L)	4.9	± 2.1
Final Lactate (mmol/L)	11.6	± 3.3
Diference of lactate (mmol/L)	+6.6	± 3.7
Stage reached (min)	10.9	± 1.7
Maximum speed (km/h)	12.8	± 0.8
Calculated VO 2 (ml/kg/min)	48.9	± 5.7
Maximum heart rate	193.8	± 9.3

In the Hoff test, the average initial lactate was 4.2 ± 2.4 mmol/L and at the end of 12.4 ± 3.8 mmol/L, the maximum distance reached during the 10 minutes that the test lasts was 1597.6 ± 143.2 meters, with a maximum heart rate of 188.1 ± 7.6 beats per minute. The final data of the Hoff test and the progression of heart rate by the minute are found in Table 3.

Table 3. Final data Hoff n = 17

	Average	SD
Initial Lactate (mmol/L)	4.2	± 2.4
Final lactate (mmol/L)	12.4	± 3.8
Diference of lactate (mmol/L)	+8.2	± 4.3
Distance (m)	1597.6	±143.2
Maximum heart rate	188.1	± 7.6
Heart rates for test time		
1st Minute	165.2	± 9.6
2nd Minute	172.1	± 8.0
3rd Minute	175.1	± 7.9
4th Minute	179.1	± 6.6
5th Minute	179.6	± 7.7
6th Minute	181.2	± 9.2
7th Minute	181.8	± 9.5
8th Minute	183.1	± 9.7
9th Minute	185.5	± 7.9
10th Minute	187.8	± 7.3

The data of the initial and final lactate showed no statistically significant differences between the two tests, unlike the heart rate which was greater in the Course Navette test compared to the Hoff test and in which a statistical difference was found to be consider. Table 4. The Assessment of the maximum distance results Hoff test compared to the maximum speed reached in the Course navvette test allows a relationship of R2 = 0.55, Figure 3.

Table 4. Differences between the analyzed variables

	Hoff test	Course Navette	Z	*p*
pre Lactate	4.2 (± 2.4)	4.9 (± 2.1)	-1.397	0,162
post Lactate	12.4 (± 3.8)	11.6 (± 3.3)	-0,983	0.325
Lactate difference	+8.2 (± 4.3)	+6.6 (± 3.7)	-1.373	0.170
Maximum heart rate	188.1 (± 7.6)	193.8 (± 9.3)	-3.342	0.001*

*Statistically significant difference, data in parentheses (standard deviation)

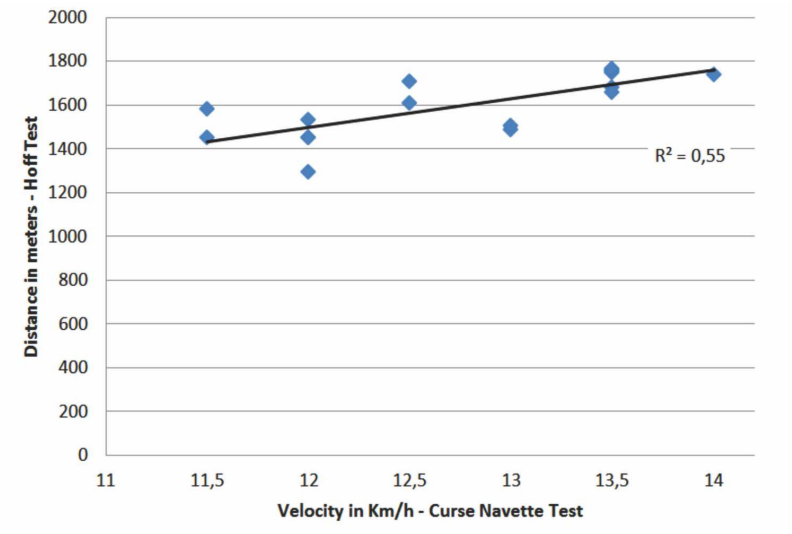

Figure 3. Relationship between the maximum velocity in the Course Navette Test and the distance in the Hoff Test

DISCUSSION

Indirect tests have been developed as a viable alternative in evaluating physiological assessment. The Course Navette test and its modifications as the Yo-Yo test have shown high reproducibility and a very good relationship with direct test of maximal oxygen consumption (Bangsbo et al., 2008), away from actual playing conditions. For this reason the Hoff test has been used as a valid alternative in the assessment of aerobic capacity of soccer players with valid results: Chamari et al. (2005) compared the results of laboratory VO2max vs. the distance reached in the Hoff test in soccer players under 15 and found ($r = 0.68$ $p<0.01$). Likewise, our research group applied the test in college athletes with even a higher correlation ($r = 0.88$ $p<0.01$) (ongoing Article), demonstrating its utility as predictor of maximum oxygen consumption.

Lactate is considered a marker of exercise intensity, like the adaptation to it. High values relate to high-intensity exercise and or mismatch (Rivera-Brown & Frontera, 2012) and maximal lactate values found in both tests showed no significant statistically differences 12.4 ± 3.8 and 11.6 ± 3.3, $p=0.325$, to a calculated VO2max of 48.9 ± 5.7 ml/kg/min. This lactate value is similar to that found in second division professional soccer players in Europe (11.5 ± 1.1 mmol/L), with the difference that they reported a VO2max of 59.5 ± 2.9 ml/kg/min (Mohsin et al., 2012), Likewise, these figures are higher than those reported in professional

footballers in the English first division whose maximum lactate value was 8.12 ± 1.15 mmol/L with a VO 2 max of 63.3 ± 5.8 ml/kg/min (Edwards et al., 2003). This relationship between lactate and VO2 max maximum leads to the conclusion that high levels of lactate in our sample of players is more associated with detraining than to higher levels of physical demand, something that should be taken into account in the fitness.

In our study, the maximum heart rate was higher in the Course Navette test (193.8 ± 9.3) compared with the Hoff test (188.1 ± 7.6). That for similar efforts in terms of time (Test Course Navette 10.9 min and Hoff test = 10 min), but these data are inconsistent with those presented by Nassis et al., who found no significant differences when assessing the test also: Course Navette: 190.4 ± 9.3 and 192.0 ± 7.6 to Hoff (Nassis et al., 2010). However, regarding the similarity in lactate levels, reduced heart rate could be associated with a lower speed of movement given by the need of dribbling the ball during the test.

CONCLUSIONS

The main finding of this study is the relationship between the Hoff test and Course Navette test to evaluate aerobic fitness of players, which further strengthens the use of tests that are closer to real game conditions for each one of the sports activities. However, it is necessary to strengthen the studies with a larger population and at different competitive levels in the process of validation of these tests.

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