

A Pilot Study of the Physiological Demands of Futsal Referees Engaged in International Friendly Matches

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Received December 31, 2013; Revised February 09, 2014; Accepted February 15, 2014

Abstract Futsal is a FIFA sanctioned form of 5-a-side football. It is controlled by two referees who run up and down the touchlines either side of the pitch ensuring the laws of the game are enforced. The match is played over two halves of 20 minutes, with the clock being stopped every time the ball goes out of play; so each half can last up to 40 minutes including stoppage time. To date there has been minimal research which has looked at the physiological demands of refereeing futsal. This pilot study was undertaken over consecutive days when two International futsal games took place involving four referees. Heart rate, core temperature, blood lactate and hydration status were monitored prior to the match, again at half time and at full time. The results showed that the referees operated at between 81 and 84% Heart Rate Maximum (HR_{max}). There was a marked difference between the first and second referee in both games and between the first and second halves. Core temperature increased during the game with the referees becoming progressively dehydrated towards the end of the game. Blood lactate was found on average to be higher at the end of the first half compared to the end of the second half (2.33 vs. 1.8 mmol.l⁻¹) and referees in the first game had readings higher than the second game (HT 2.8 vs. 1.9 mmol.l⁻¹; FT 2.4 vs. 1.2 mmol.l⁻¹). In conclusion, the major findings show that further investigation is needed into the physiological demands of Futsal Refereeing and that in future, activity profiling should also be considered.

Keywords: heart rate, blood lactate, futsal, referee, indoor soccer, physiology

Cite This Article: D. Dixon, "A Pilot Study of the Physiological Demands of Futsal Referees Engaged in International Friendly Matches." *American Journal of Sports Science and Medicine*, vol. 2, no. 3 (2014): 103-107. doi: 10.12691/ajssm-2-3-7.

1. Introduction

Futsal is the only 5-a-side form of football that is officially sanctioned by FIFA. It has been around since 1930, with the first world championships being played in 1971 under International Federation for Futebol de Sala, (FIFUSA) and finally coming under FIFA's umbrella, with the first World Cup being played in 1989 in Holland. The main differences between this version and 11-a-side soccer are that it is played indoors on a pitch that measures 40 x 20 metres and is played has an effective playing time of 20 minutes each way. The game itself is classed as an intermittent high-intensity sport with players changing directions / activity every 3.28 seconds [1] which is helped by the players being able to undergo unlimited substitutions without stopping play [2].

The Referee is responsible for enforcing the laws of the game in invasion type sports such as Futsal. However, unlike the 11 a side version of soccer, it employs two referees who operate up and down the touch lines. There is an increasing amount of research examining the physiological and psychological demands placed on the 11 a side soccer referee and assistant referees. Recently it has been reported that the demands of the futsal referee are similar to an FIFA Assistant Referee [4,13]. The research

of [3,6,7] have been reported that assistant referees, undergo intense brief bouts of forward and sideways running. Although to date, there has little research that has examined the physiological demands of futsal referees. However, Rebelo et al [5] examined the physiological demands of experienced Futsal referees from the Portuguese first division. The referees were subject to lactate testing, heart rate (HR) measurement and motion analysis through video. The results showed that the referees covered an average of 5.89 Kilometres (Km), which is less than the 6.76 Km (S = 0.83; range = 5.20–8.21) [6] and 7.28 (s = 0.17) Km [6] reported to be covered by Assistant Referees during a game of 11-a-side soccer.

Rebelo et al [5] reported the average heart rate of the futsal referees during the match was 146 b.min⁻¹, or 76% of their HR_{max}. This is higher than values measured by reference [6] for Danish assistant referees who recorded 137 b.min⁻¹ (s = 3) or 73% of the HR_{max} and 124 b.min⁻¹ (s = 15) for FIFA Assistant Referees found by Kustrup et al [6].

Reilly and Gregson [7] found that the assistant referees in professional games had blood lactate levels of 4.7 mmol.l⁻¹ at half time and 4.8 mmol.l⁻¹ at the end of their respective 11-a-side games, these lactate levels are in contrast to Kustrup et al [6] who reported values of 2.8 mmol.l⁻¹ at the end of both halves. Similarly, Rebelo et al

[5] reported levels of 1.0, 2.0 and 1.5 mmol.l⁻¹ in the Portuguese futsal referees when recorded before the match, at half time and at the end of the game respectively. These differences can be contributed to the futsal referees had sufficient breaks in play to allow sufficient recovery [5]. Therefore the suggestion would be that in these games there was limited use of the anaerobic glycolysis energy pathway and that the games in this particular research were not as intense as the games reported in previous player studies. Although another explanation may be that the lower values for heart rate and blood lactate were found in those officiating in their respective domestic leagues and as such the intensities found in International futsal may be similar to those found in the 11-a-side soccer games.

Humans attempt to maintain a constant core temperature (T_c) of 37°C [8] although core temperatures have been shown to be as high as 39.5°C in Swedish first division players at the end of their match [9]. This is thought to be a result of fluid loss as the lack of fluid will disrupt the cooling process. However, these games are usually played outdoors and futsal is played indoors during varying temperatures and as such core temperatures could be higher due to the lack of air velocity.

Therefore the purpose of this paper was to complete a preliminary investigation on whether the physiological demands of International futsal refereeing were more intense than refereeing futsal games in a professional domestic league. In addition the physiological demands will be compared to those undertaken by assistant referees in 11-a-side soccer.

2. Materials and Methods

Four high level futsal referees (3 FIFA and 1 National League) volunteered to participate in this study during two international friendly games. Prior to the data collection, the referees were informed about the procedures and the possible constraints before providing their informed consent.

Their mean height, body mass and age were 1.84m ($s = 0.13$), 82.15 Kg ($s = 19.95$) and 36 years ($s = 9.02$) respectively.

Heart rate was recorded continuously from each of the officials over the two matches every 5 seconds using Polar Team2 (version 1.4.5, Polar Electro Oy, Finland) from 1

hour before the game started and as such recorded heart rate values for the warm up, first half and the second half.

Core body temperature was measured via CorTemp monitoring System (CorTemp, HQInc, Palmetto, Florida) which consists of a ingestible thermometer which was consumed three hours before kick-off and the signal was then relayed to a hand held data recorder which was positioned against the lower back of the referee via a runners belt which was worn around the waist under the referees shirt. Data was recorded every 10 seconds starting about 1 hour before kick-off.

Blood lactate was collected from the referees via finger prick blood sample at rest and within 5 minutes of the end of the first and second halves in order to establish blood lactate concentration using a Lactate Pro (Arkray Global Business Inc, Japan).

Hydration status was monitored via the referees supplying a urine sample 1 hour before kick-off and then again at half time and full time. Urine samples were then marked and analysed with an Osmocheck (Vitech Scientific, West Sussex, England) which was calibrated with distilled water before and after each referees group of three samples.

The referees were instructed to continue with their normal pre-match routines and to drink fluid ad libitum before and during the matches.

For data analysis, periods of the match were divided into 10 minute segments as per the research of Rebelo et al. [5] Krustup et al. [9], as the effective playing time is usually longer than the prescribed 20 minutes for each half. The last time period (30+ and 70+) in each half corresponds to the time that elapsed from 30 and 60 minutes respectively until the end of each half [5,9].

Statistical data is presented as mean and standard deviation.

3. Results

Heart rate and core temperature from a representative participant is shown in Figure 1. The mean heart rate was 136 beats.min⁻¹ ($s=23.34$), 155 beats.min⁻¹ ($s=23.04$) and 149 beats.min⁻¹ ($s=21.49$) during the warm up, first half and second half respectively. This related to 74%, 84% and 81% of heart rate maximum (HRmax =184 beats.min⁻¹ ($s=9.02$)). The mean heart rate was higher in the first half compared to the second and the overall values were higher for the first referee compared to the second referee.

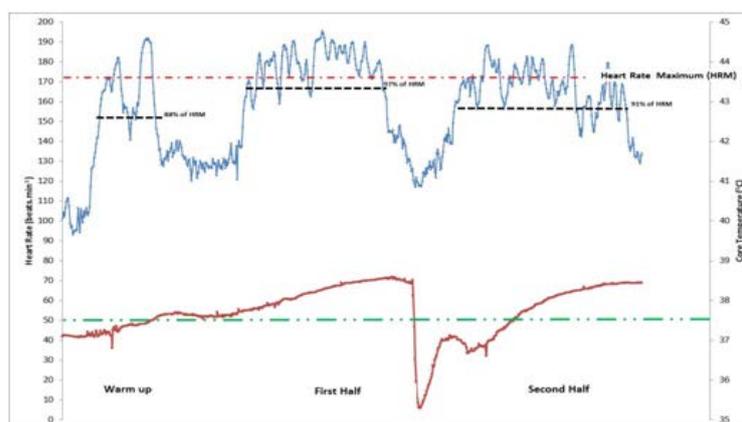


Figure 1. Heart Rate and Core Temperature Data

Also in Figure 1 is one of the referee's core temperature reading over the course of the match. The mean temperature over the course of the game was 38.58°C (s=0.6; range= 37.70 – 39.34). As can be seen from Figure

1 the core temperature of the referee gradually rose as each half went on, with the highest temperatures being recorded at the end of the match in each of the referees readings.

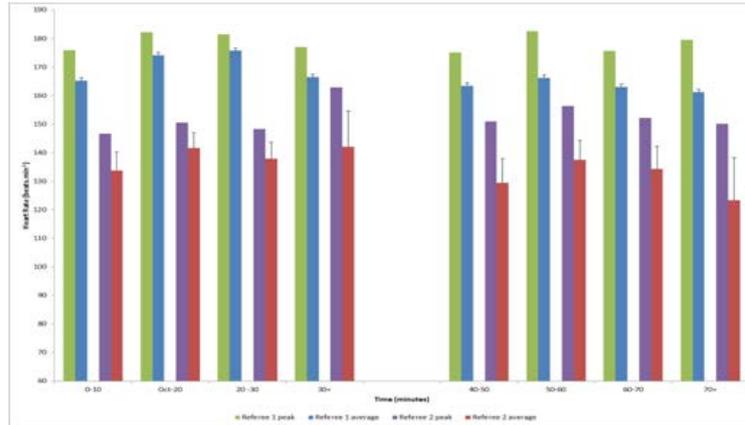


Figure 2. Peak and Average Heart rates of 1st and 2nd referees for each 10 minute spell of games

The above figure shows the peak and average heart rates from the 1st and 2nd Referees are shown over the two games. It can be seen that the 1st referees were operating at a high intensity than the 2nd referee in each

of the 10 minutes. Although the 1st referees intensity seems to drop in the second half whereas the heart rate intensity seems to stay the same.

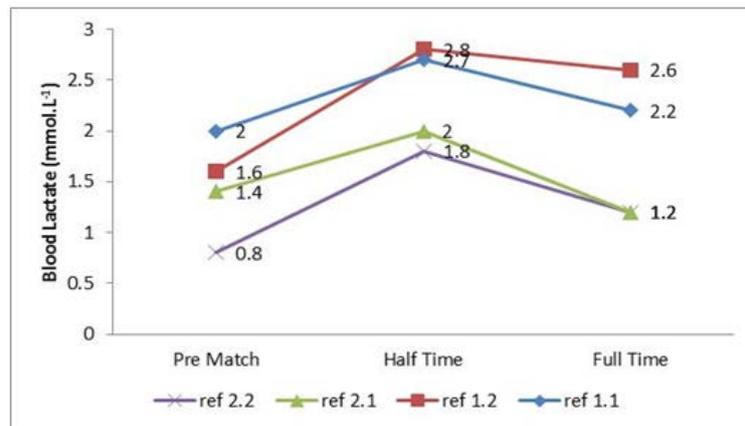


Figure 3. Blood Lactate readings of the Referees

As can be seen in Figure 3 above, blood lactate was 1.45 mmol.l-1 (s=0.50), 2.33 mmol.l-1 (s=0.5) and 1.8 mmol.l-1 (s=0.71) before, at half time and after the game

respectively. Both the after match and half time values were higher than the resting values (pre match range = 0.8 – 2.0 mmol.l-1).

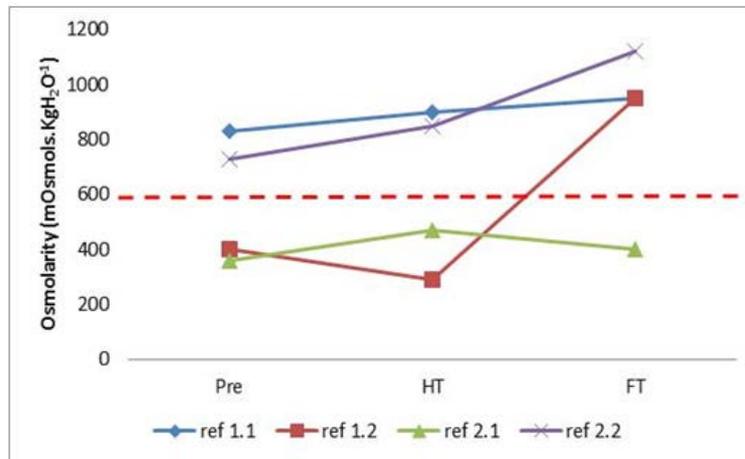


Figure 4. Osmolarity Readings of the Referees

Hydration status was found to be 580 mOsmols/kgH2O (range=360 – 830), 628 mOsmols/kgH2O (range=290-900)

and 855 mOsmols/kgH2O (range= 400-1120), pre match, half time and full time respectively. Only one referee

remained euhydrated throughout the match. Two referees were hypohydrated prior to the start of the match and as can be seen in [Figure 4](#) three of the referees were hypohydrated at the end of the game which equated to 1.1 – 3.3 % loss in body weight over the course of the match.

4. Discussion

The results of this pilot study have revealed some interesting results which are worthy of further investigation.

The mean heart rate for the two international games were 155 beats.min⁻¹ and 149 beats.min⁻¹ during the first half and second half respectively which is higher than the mean in Portuguese domestic games. This may indicate a higher intensity of international futsal, however, similar to previous research the mean heart rate was higher in the first half compared to the second [5] and it tended to be lower at the end of the second half compared to the rest of the match for both referees.

In contrast to previous research a difference was found between the heart rate intensity of the first referee and the second referee for each of the ten minute period of the match ([Figure 2](#)), this warrants further investigation as to establish if this was unique to these games or is reflective of all futsal games.

Similar to Rebelo et al. [5] blood lactate levels taken for the referees before, half time and after the game were 1.45 mmol.l⁻¹, 2.33 mmol.l⁻¹ and 1.8 mmol.l⁻¹ respectively, which suggests that the referees may not be reliant on anaerobic glycolysis metabolic system unlike their soccer colleagues in the 11-a-side version of the game where values of 5.1 mmol.l⁻¹ and 4.8 mmol.l⁻¹ have been reported in referees and in assistant referees respectively [5]. The heart rate data also supports the notion in that the first half elicited a greater heart rate response compared to the 2nd half. Blood lactate levels increased from resting levels and then showed a decline in the second half which is matched by the reduced HRmax of the referees in both halves and as such this may suggest higher workload in the first half compared to the second, which could be investigated further in future study's.

However, as illustrated by [Figure 2](#) the referee's heart rate in the second game demonstrated a marked rate of decrease when compared to the referees in the first game. This may be as a result of the intensity of the game as these games were played on consecutive days and as such the players may have been experiencing some fatigue.

The hydration status of the referees showed that the referees actively dehydrated over the course of the game, although more may need to be done with the education of the referees as two were already dehydrated before the game started. Although on an individual basis the 1st referees dehydrated less than the 2nd Referees (1% vs. 3%). This may be important as a weight decrease of 2% has been shown to impair performance [10]. Further investigation is warranted as the highest core temperatures (>39°C) were recorded by the referees who showed the most dehydration. Reference [11] reports that performance may be adverse affected at body temperatures around 38.3 - 38.5°C which is above the average core temperature found in the referees in these games and lower than the peak temperature of the referees. Reference [11] also

states that the performance would be exacerbated by progressive dehydration and that the performance included physical, cognitive and psychomotor aspects of skills. However, there is some debate as to whether dehydration has an impact performance. Although these arguments tend to revolve around wind speed, which is known to have has a cooling effect [12]. This would not be available in an indoor sport such as futsal. In addition to the authors knowledge there has been no investigation as to whether, hypohydration, core temperature and decision making are inter related in referees especially as normal cooling such as wind speed is not available.

Although this study offers a different examination of a futsal referees performance profile, it is not the full picture and as such future investigations should include video activity profiling. This would allow sport scientists to establish if there are different requirements between International and professional and non-professional domestic leagues and if there is a performance decline in movement and speed undertaking towards the end of the game [5,9].

5. Conclusions

To the authors knowledge only two studies have been completed examining futsal referees both of these examining referees operating in a professional league compared to over 10 years' worth of research into the referees operating in the 11 a side game.

This pilot study is based on 4 referees over two International matches and as such the results should be used with caution as the two previous studies have used 18 [5] and 16 [9] futsal referees respectively. Although having expressed this reservation there are a number of similarities with the previous studies. This study has also probably completed its role successfully in that more questions have been asked than have been answered and it would appear further investigation is required in this area, which should include time motion analysis of the activity profile of the futsal referees in domestic and international friendly matches which then allow better investigation to the workload of the futsal referee.

Acknowledgements

This study did not receive any funding. However we would like to thank the English Football Association and the effort from all the English Futsal referees involved in this study, without whose participation, this study would not have been possible.

Statement of Competing Interests

None.

List of Abbreviations

BASES	British Association of Sport and Exercise Scientists
beats.min ⁻¹	beats per minute
BMI	Body Mass Index

FIFA:	Fédération Internationale de Football Association
HRM	Heart Rate Maximum
HI	High Intensity
m	metres
mmol.l-1	millimoles per litre
mOsmols/kgH ₂ O	milliosmols per kilogram of water
PARQ	Physical Activity Readiness Questionnaire
UEFA	Union of European Football Associations

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