

Physiological stress of basketball referees during a national competition

Estresse fisiológico de árbitros de basquetebol durante uma competição nacional

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Abstract – The aim of this study was to examine the physiological demands of seven referees during a national basketball competition. We recorded heart rate (HR), relative exercise intensity as a percentage of age – predicted maximum HR (HRmax), proportion of playing time within the exercise intensity categories defined by the ACSM during each of the tournament matches for each referee per period, as well as the entire game. None of the variables shows significant differences between periods. Based on a format of three referees per match, referees worked with an average HR of 150 bpm (range 110–181 bpm) for each quarter of the match, which equals a relative intensity > 70% of HRmax for most (~76%) of each quarter. Other studies will assist in developing appropriate training programs for elite basketball referees to maintain and / or maximize performance.

Key words: Physiological stress; Motor activity; Heart rate.

Resumo – O objetivo deste estudo foi examinar as demandas fisiológicas de sete árbitros durante uma competição nacional de basquete. Durante cada uma das partidas do torneio, frequência cardíaca (FC), intensidade relativa do exercício como porcentagem da FC máxima prevista pela idade (FCmax), proporção de tempo de jogo dentro das categorias de intensidade de exercício definidas pelo ACSM foram registradas para cada árbitro em cada período e todo o jogo. Não houve diferenças significativas entre os períodos para nenhuma variável. Árbitros, usando um formato de três árbitros por partida, trabalhavam com uma FC média de 150 bpm (intervalo de 110–181 bpm) para cada quarto da partida, o que equivale a uma intensidade relativa > 70% da FCmax para a maioria (~76%) de cada trimestre. Outros estudos ajudarão no desenvolvimento de programas de treinamento apropriados para árbitros de basquete de elite para manter e / ou maximizar o desempenho.

Palavras-chave: Estresse fisiológico; Atividade física; Frequência cardíaca.

INTRODUCTION

Although prior studies have addressed the physiological effects of competition on referees in sports such as football and rugby, very limited information is available on the physiological demands of competition in

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referees. Some studies have examined football referees and assistants mostly concluding that elite football competition imposes a high physiological demand on officials¹⁻³; however, very little is known on this scope for basketball referees.

Holland and Cherry⁴ reported that high school basketball officials achieved 79% of FC max during high school games, while Leicht⁵ described that a national basketball official arbitrated at a high intensity of exercise (73% FC max) during most national competitions. As far as we are concerned, only a few studies have examined the physiological demands of the basketball officer, which leads to a lack of specific conditioning programs to guide nationally and internationally ranked basketball officials when preparing for competitions.

Previous studies have highlighted the importance of identifying the physiological demands of officers to assist in the development of specific training programs for officers during elite competitions in other sports³. Similar studies for basketball officials are also needed, particularly with the level of fitness of basketball referees.

Preparing for the low season was classified as a high priority for national and international leagues worldwide⁶. Considering the lack of information on the physiological requirements of basketball refereeing, the goal of this study is to document these demands by elite officials. The hypothesis is that basketball referees experience the same high physiological demand during international competition as elite officials of national/international competition in other sports.

METHOD

Seven (female) basketball referees volunteered to participate in this study (formalized in a written consent), with average age \pm SD, height, mass, and body fat percentage of 29.1 ± 3.9 years, 179.1 ± 6.1 cm, 75.9 ± 11.4 kg, and $21.2 \pm 4.8\%$, respectively. All references are based on official national classification (national experience from 1 to 12 years). Participants completed a general health pre-assessment questionnaire indicating no medication was being taken that could influence HR. All procedures were conducted upon the approval of the Physical Fitness control of the Brazilian Basketball Confederation, in accordance with the code of ethics of the World Medical Association.

We gathered the information during the Brazil National feminine Under-16 Championship in 2019. During the tournament, each referee worked between four and seven games. During each match, HR was monitored in real time using Polar Team PRO HM10. The total time for each period of the match and the entire match were recorded using a stopwatch from the system itself. Before the first match, the referee's height (to the nearest 0.5 cm) was determined using a measuring tape, while body mass and fat percentages were determined using bioelectric impedance scales (Omron).

Data were expressed as mean \pm standard deviation and analyzed using the Statistical Package for Social Sciences (SPSS v11, SPSS Inc., Chicago, IL). Average HR, relative exercise intensity expressed as a percentage of the expected HRmax for age (22 years) and the proportion of time lived by referees within the ACSM9 exercise intensity categories – very difficult ($> 90\%$ HRmax), difficult (70 - 89% of HRmax), moderate (55-69% of HRmax) and light (35-54% of HRmax) – were examined at every quarter and throughout the game. Significant differences ($p < 0.05$) for the variables between the quarters were examined through unidirectional ANOVA and Tukey's post hoc tests.

RESULTS

Each game period lasted approximately 17 to 20 minutes with an average HR of approximately 150 ± 18 bpm at an exercise intensity of $79 \pm 9\%$ of the HRmax predicted by age. Referees practiced within the high intensity category (70-89% HRmax) for the majority (~ 59%) of each quarter with approximately similar proportions of time at intense ($\pm 18\%$) and moderate (~ 20%) intensities. None of the variables showed significant differences between quarters. Table 1 presents all of the aforementioned information.

Table 1. Physiological response during games.

	1 quarter	2 quarter	3 quarter	4 quarter	games
Time (minutes: seconds)	19:02±2:57	18:19±1:34	17:03±1:29	19:31±2:19	74:05±6:56
HR (bpm)	149.0±17.4	150.4±19.1	150.2±20.3	149.0±17.8	149.7±18.2
%HR max.	78.8±8.2	79.0±9.4	78.9±10.0	78.3±8.6	78.7±8.8
Proportion time (%) relation to HR					
Very difficult (> 90% HR max.)	18.1±20.9	19.9±23.8	17.7±23.8	16.8±20.9	17.9±21.4
Difficult (70-89% HR max)	58.1±23.0	57.9±25.2	58.6±30.7	59.9±22.5	58.8±24.5
Moderate (55-69% HR max)	21.7±24.5	19.3±22.2	20.4±26.7	21.5±22.1	21.1±23.9
Easy (35-54% HR max)	2.0±3.4	2.9±6.8	3.4±8.0	1.9±6.7	2.3±5.6

Note. Values are given as mean \pm standard deviation; Where: HR - Heart rate / max. - Maximum / bpm - Beats per minute.

DISCUSSION

This study suggests that basketball referees experience similar (stable) high-intensity work rates in all four periods of a match. These results corroborate previous findings for referees of various sporting codes^{1,4,5}, showing that basketball referees present significant physiological demands (73-89% HR max) during the competition that deserves specific attention in the preparation (for example, preseason or training plan) and physical maintenance.

Currently, assessing the Brazilian and international physical aptitude of basketball referees consists of determining aerobic capacity (VO₂ max.) through the multi-stage test (beep test) with the minimum level for national and international referees appointed without a scientific basis. All referees participating in this research met the minimum Brazilian / international requirements (66 beets) with high aerobic capacity comparing with normative data⁷. Current exercise training for basketball referees is largely designed to meet this arbitrary criterion. While this level of training can assist referees in maintaining high-intensity work rates during competition and passing the necessary test, this specific assessment tool does not take into account the intermittent nature of basketball. Therefore, other important components of aptitude, such as anaerobic capacity, speed, power, reaction time, laterality, and agility, have been extensively worked on by referees and physical aptitude coordinators to enhance referees' performance. Although these components have been reported to contributing significantly to the performance of referees in football², no studies have addressed whether they apply to basketball referees; however, our findings confirm that they actually do. As far as we know, the specific patterns of intermittent motion associated with basketball refereeing have not been scrutinized. Such studies are necessary to provide the appropriate physiological conditioning of basketball referee references.

It is worth noting that these results are limited to a small number of referees and to a tournament that is unlikely to imply the same intensity or psychological stress level as major international tournaments, such as the Olympic Games and the World Championship. Consequently, the physiological demands displayed by the referees in this study may in fact underestimate the demands felt by the referees during international tournaments. Despite the potential for greater stress during major international tournaments, our results provided an estimate of the relevant national game, as all participating teams participated in the biggest competition in this category in Brazil.

CONCLUSION

This study demonstrated that basketball referees experience significant physiological demands during national grassroots competition. Further studies should include national and international referees, mainly at a professional level, in order to document the movement patterns of referees, thus complementing our results and allowing to develop appropriate training and referee assessment for national and international competitions.

Compliance with ethical standards

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Ethical approval

This research is in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

RMI & AV conceived and designed the experiments; RMI, PMB, GAL, AV & FRA performed the experiments; RMI & AV analyzed the data. RMI, PMB, GAL & FRA contributed with reagents/materials/analysis tools; RMI, PMB, GAL & FRA edited the paper.

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