Influence of the Game Context and Levels of Physical Activity on the Behavior of Basketball Coaches

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Abstract

Coaches can exert a significant influence on players and games. The aim of this study is to assess behavior in the form of heart rate (HR) responses and distance traveled of basketball head coaches during matches considering the different match contexts faced as a score differences and time outs during the game direction and levels of physical activity and coaches experience. Four basketball head coaches are recruited in this case report. Mean and maximal absolute and relative HR are determined across matches. Scoring streaks (±6 consecutive points) and time outs are considered as influence value. The in-match distance traveled measured using microsensors, coaching experience, and daily activity on HR responses is also determined. Higher HR are evident across matches compared to periods prior to and following matches. HR is significantly ($P < .05$) elevated during later time-outs compared to earlier time-outs, with positive scoring streaks yielding a tendency towards higher HR compared to negative and no scoring streaks. Experience ($r_s = -0.91$, $P < .001$), daily activity levels ($r_s = -0.83$, $P < .001$), and weekly METS ($r_s = -0.78$, $P = .002$) are negatively associated with match HR, while in-match distance ($r_s = 0.69$, $P = .013$) is positively associated with match HR. These data indicate that matches elevate the cardiovascular stress imposed on basketball head coaches, with later time-outs and positive scoring streaks promoting heightened HR. Moreover, in-match activity and personal characteristics (less experience and lower physical activity) further augment match HR in coaches.

Keywords: coaches, behavior, cardiovascular, physiology, team sport.

Introduction

Coaches can exert a substantial influence on player performance through their behaviors, communication, and decision-making during basketball matches (Foulds & Hoffmann, 2019). Given the potential relationship between coaching skills and player performance, promoting situations that optimally allow coaches to impart positive actions to the benefit of the team are fundamentally sought by basketball organizations (Bateman & Jones, 2019). In turn, stressful situations during different match contexts may influence decision-making processes in basketball coaches and potentially alter the outcome of play sequences during key match scenarios. (Schultchen et al., 2019) Therefore, an understanding of the stress placed on coaches during different match contexts with appropriate tools likely yields valuable insights for informing coaching management strategies that may benefit wider team performance in basketball.

Measurement of physiological parameters during matches provides objective evidence regarding different stress-related responses of coaches. Physiological responses can be influenced by various internal (e.g., fitness) (Abdelkrim et al., 2010) and external (e.g., activity) (Scanlan, Wen, Tucker, & Dalbo, 2014) factors, and should be closely considered when attempting to quantify the stress placed on coaches (Bourdon et al., 2017). Specifically, reporting heart rate (HR) relative to the maximal HR response (HR_{max}) is one of the most widespread methods for determining physiological responses in basketball (Berkelmans et al., 2018; O'Grady, Fox, Dalbo, & Scanlan, 2020). In this regard, HR monitoring is user-friendly, comfortable, and does not restrict movement, all of which may contribute to its popularity for monitoring among basketball teams.

The typical HR responses encountered during basketball matches have been extensively provided for different roles including players (Berkelmans et al., 2018) and referees (Vaquera, Mielgo-Ayuso, Calleja-GONZáLEZ, & Leicht, 2016) and represents the physiological stress imposed in response to match stimuli (Scanlan et al., 2014). Specifically, players and referees have been observed to experience mean HR responses of 169 ± 9 beats·min^{-1} (88 ± 3%HR_{max}) (Berkelmans et al., 2018) and 163 ± 9 beats·min^{-1} (82 ± 5%HR_{max}) (Vaquera et al., 2016) during matches, respectively, suggesting they experience high cardiovascular stress (Bourdon et al., 2017). However, data pertaining to the HR responses experienced by basketball head coaches during matches is scarce. Available data suggests that basketball head coaches experience HR responses between 135-162 beats·min^{-1} (69-82%HR_{max} (Porter & Allsen, 1978). Given the only previous study on this topic has been conducted >40 years ago, a contemporary analysis of HR responses during matches in basketball head coaches is warranted.

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While quantifying HR during match-play is important, understanding the mediating effects of various factors on HR also offers practical value. Considering the dynamic nature of basketball match-play, basketball head coaches are stochastically engaged throughout different match phases in administering important team tactical plans, delivering feedback and instructions to players, and interacting with play on the sidelines (Lee, Chelladurai, & Kang, 2018). In turn, basketball head coaches likely experience extensive stress from various sources and match scenarios, emphasizing the need to investigate how HR may fluctuate temporally during matches and in different situations. Furthermore, given that activity workloads are significantly related to the physiological responses experienced in players during basketball games (Scanlan et al., 2014), it may be of interest to ascertain the impact of in-match activity on HR responses in basketball head coaches. Finally, head basketball coaches possess varied levels of experience, and there is no requirement of minimal levels of fitness for head coaching roles. Consequently, it may be useful to better understand the cardiovascular demands imposed on basketball head coaches considering personal characteristics, such as coaching experience and daily activity levels. Therefore, the aims of this study are to: (i) quantify the HR responses of basketball head coaches during matches, (ii) examine temporal changes in HR responses of basketball head coaches across matches, and (iii) investigate the impact of different match scenarios (positive and negative scoring streaks), activity demands, and personal characteristics (experience and daily activity levels) on the HR responses of basketball head coaches during matches.

Material and Methods

Subjects

Head coaches (n = 4, males, age: 39.0 ± 2.5 years, professional experience: 16.5 ± 6.5 years) from all teams competing in the final-four phase of the under-23 Spanish National Basketball Championship have participated in this study. Coaches are informed about the benefits and risks of participation before providing written informed consent. A medical checkup is performed on all coaches to ensure absence of metabolic alterations, chronic diseases, or medication use that could potentially affect study results. An institutional research ethics committee (Aragon Ethics and Investigation Committee) has approved all procedures in this study with the reference number 06/2018.

Heart Rate and Distance Measurement During Matches

The HR response of each coach is analyzed using a Polar Team Pro® system (Polar Electro; Helsinki, Finland) (Fox, O'Grady, Scanlan, Sargent, & Stanton, 2019). HR is detected via chest straps worn on the anterior surface of the body at the level of the xiphoid process (5 kHz). Data are collected and processed using the system software (Polar Team Pro®). Total distance (m) covered during matches is also estimated using the accelerometer component (200 Hz) contained in the same devices.

Coaches are monitored from approximately 40 min before each match until 5 min following each match, including all live play, stoppages, and breaks. HR data are divided into pre-match, five different intervals for each quarter (0-2:30, 2:30-5:00, 5:00-7:30, 7:30-9:00, and 9:00-10:00), breaks between quarters, and post-match segments. HR responses during time-outs are also analyzed but given that time-outs varied among matches, they are treated independently. Age-determined HR_{max} was calculated indirectly as: 208-0.7*age in years (Cicone, Holmes, Fedewa, MacDonald, & Esco, 2019). Accordingly, HR-based outcome measures are determined for each time interval as mean and peak absolute (beats·min^{-1}) and relative (%HR_{max}) values.

Scoring Streak Analysis

HR data are also analyzed during positive (scoring 6+ consecutive points) and negative (conceding 6+ consecutive points) scoring streaks. These data are determined with aid of play-by-play reports provided by the official referees using software of the International Basketball Federation (FIBA) European Statistics pack (FIBA LiveStats applications, Genious Sports Group©; London, England).

Physical Activity Assessment

Each coach completes the International Physical Activity Questionnaire (IPAQ), previously validated (Craig et al., 2003), to assess weekly volume (min) of physical activity. The weekly Metabolic Equivalent of Task (MET) are also calculated for each coach following established methods (Rütten et al., 2003).

Analysis

Mean ± standard deviation (SD) are calculated for each outcome measure. Normality is violated for all outcome measures as indicated using the Shapiro-Wilk test. Consequently, differences in HR responses between different match periods (pre-match, quarter intervals, inter-quarter breaks, and post-match), time-outs, and scoring streaks (positive streak, no streak, and negative streak) have been assessed using the Friedman test, and post-hoc pairwise comparisons are made using the Wilcoxon signed rank test. Correlations between HR responses and in-match distance covered, coaching experience, daily physical activity, and weekly METs were assessed with Spearman's correlation (r_s). Correlation magnitude is interpreted as: trivial = 0-0.10; small = 0.11-0.30; moderate = 0.31-0.50; large = 0.51-0.70; very large = 0.71-0.90; nearly perfect = 0.90-0.99; and perfect = 1. Statistical significance is accepted when $P < .05$. All statistical tests are performed in R Studio (v3.5.1, R Foundation for Statistical Computing; Vienna, Austria).

Results

The mean ± SD relative HR responses across different match periods are provided in Figure 1. A mean HR of 67

± 4%HR_{max} is obtained during matches with minimal fluctuations between quarters (Quarter 1: 67 ± 4%HR_{max}, Quarter 2: 66 ± 6%HR_{max}, Quarter 3: 66 ± 6%HR_{max}, Quarter 4: 67 ± 8%HR_{max}). No significant differences in HR responses are evident across time periods; however, there is a general tendency ($P = .08$) towards a higher mean relative HR during matches (67 ± 4%HR_{max}) compared to before (55 ± 8%HR_{max}) and following matches (64 ± 9%HR_{max}). HR responses during time-outs are 69 ± 5%HR_{max}, with temporal comparisons revealing significantly ($P < .05$) higher relative HR during time-outs 7-9 compared to time-outs 1-6 across matches (Table 1). Regarding scoring streak analysis, there is a tendency ($P = .35$) towards higher HR when experiencing positive streaks compared to negative streaks and no streaks (Table 1).

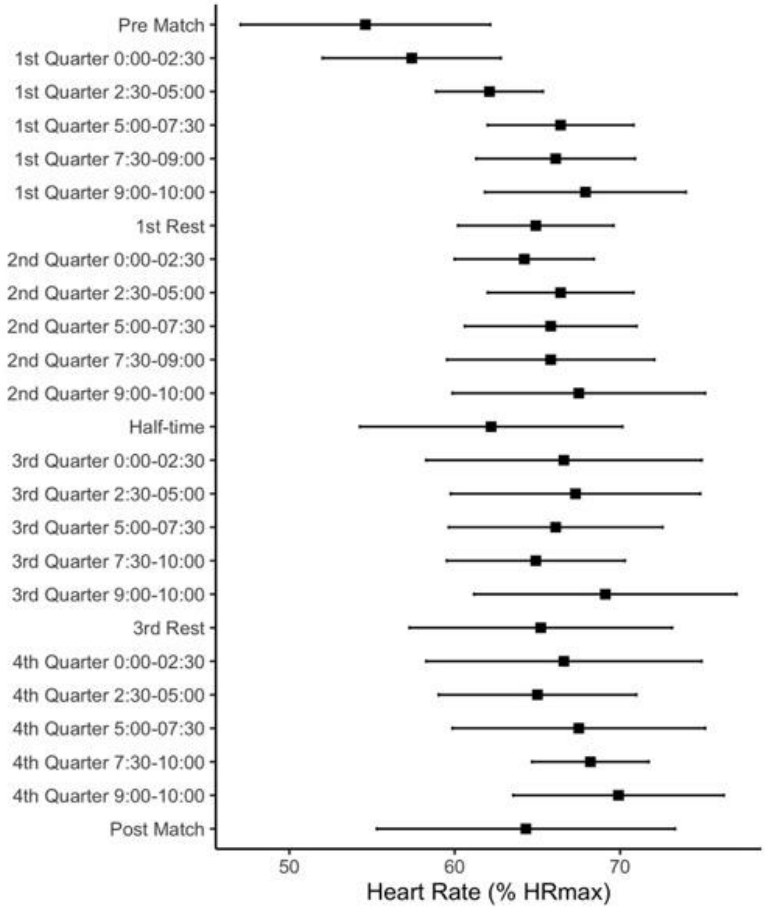

Figure 1. Mean ± standard deviation relative heart rate responses (%HR_{max}) of basketball head coaches during different periods prior to, during, and following matches.

Table 1

Absolute (beats·min-1) and relative (%HR_{max}) heart rate (HR) responses (mean ± standard deviation) of basketball head coaches during different time-outs across matches and when experiencing positive and negative scoring streaks.

Match situation	Absolute HR (beats·min^{-1})	Relative HR (%HR_{max})
Time-out		
1	117 ± 6	64 ± 5
2	119 ± 7	65 ± 7
3	117 ± 7	64 ± 6
4	122 ± 10	67 ± 8
5	120 ± 13	66 ± 9
6	121 ± 13	67 ± 8
7	137 ± 7†	76 ± 5†
8	134 ± 18†	74 ± 9†
9	140 ± 15†	76 ± 7†
Scoring streak		
Positive	125 ± 11	69 ± 8
None	122 ± 9	67 ± 6
Negative	119 ± 10	66 ± 8

Note: † significantly (P < .05) higher than time-outs 1-6; positive streak = scored 6+ consecutive points; negative streak = conceded 6+ consecutive points.

The calculated Spearman's correlation coefficients between different HR responses and distance covered during matches as well as personal characteristics of head coaches are shown in Table 2. Coaching experience is found to be positively associated with HR during positive scoring streaks (r_s = 0.58, P = .048) and negatively associated with HR during matches (r_s = -0.83, P < .001) and breaks (r_s = -0.60, P = .039). Distance covered (r_s = 0.69, P = .013) is found to be positively associated with HR during matches, while daily physical activity levels (r_s = -0.83, P < .001) and weekly METS (r_s = -0.78, P = .002) seem to be negatively associated with HR during matches.

Table 2

Spearman's correlation coefficients between relative heart rate responses (%hr$_{max}$) and distance covered as well as personal characteristics in basketball head coaches during different match scenarios.

	Match distance	Experience	Physical activity	METs
Pre-match peak %HR$_{max}$	.17	-.32	-.41	-.57
Post-match mean %HR$_{max}$	-.22	-.12	-.31	-.45
Match %HR$_{max}$	.69*	-.91**	-.83**	-.78**
Positive streak %HR$_{max}$	.51	.58*	.41	.33
Negative streak %HR$_{max}$	.22	.37	.37	.27
Break %HR$_{max}$	.44	-.60*	-.43	-.37
Post-match peak %HR$_{max}$	.47	-.25	-.49	-.41
Post-match mean %HR$_{max}$	.52	-.31	-.47	-.32

Note: METs: weekly metabolic equivalent of task determined using the International Physical Activity Questionnaire (IPAQ); physical activity: weekly volume (min) of physical activity completed determined using the IPAQ; *P < .05; **P < .001.

Discussion

The current study provides novel data regarding the HR responses of professional basketball head coaches during contemporary matches. Furthermore, the study observes higher HR responses in professional basketball head coaches: (i) during matches compared to before and after matches; (ii) during positive scoring streaks compared to negative and no scoring streaks; (iii)) during later time-outs compared to earlier time-outs; and (iv) with less coaching experience, lower daily physical activity, and more distance covered during matches. To the best of the authors' knowledge, only one previous descriptive study examines the HR responses of basketball head coaches (Porter & Allsen, 1978) Specifically, in a case study, a HR of 135 beats·min^{-1} (67.8%HR$_{max}$) is reported in a male professional head coach of a National Collegiate Athletic Association (NCAA) Division I team, which is similar to the mean response observed in the present sample of professional coaches. Taken together, current data combined with previous research indicates that little change in the cardiovascular stress encountered by basketball head coaches during matches has occurred since foundation analysis conducted >40 years ago. However, the single coach analyzed previously limits the evidence base for these comparisons. Furthermore, temporal changes and the impact of match situations and personal characteristics on HR responses are not explored in this previous study (Porter & Allsen, 1978).

Temporal analyses in our study reveals a drop in HR post-match, which may be a natural response when cognitive (e.g. decision-making) and physical (e.g. moving to give signals to players) stressors associated with coaching during matches cease and a more relaxed state commences (Garber et al., 2011). Furthermore, time-outs are frequently taken to reduce fatigue in players and change match dynamics temporally across matches. The higher HR in coaches during later time-outs seems logical given they are taken at a higher frequency towards the end of the matches to strategize, which corresponds to more critical time-sensitive situations occurring. Therefore, development of coach-oriented stress management strategies for implementation towards the end of matches may benefit head coach responses during critical match situations for optimal decision-making and actions to be taken (Thelwell, Wagstaff, Chapman, & Henttä, 2017). When considering team scoring streaks, the higher HR observed when experiencing a positive streak could be explained by an increase in sympathetic activation in onlookers when teams are in favorable positions during matches (Mücke, Ludyga, Colledge, & Gerber, 2018)

The finding that more experienced coaches exhibit lower cardiovascular stress during matches might be related to their high fitness level, which is supported by a higher reported daily physical activity level in more experienced coaches (r_s = 0.89, P < .001). Indeed, performing physical activity can reduce perceived stress, alpha-amylase activity, and unpleasant emotions in daily life (Yoshino, Matsumoto, Someya, & Kitajima, 2011). Furthermore, given that a dose-response relationship appears to exist between distance covered and HR response during matches, more experienced coaches may be less active on the sidelines (supported by the current data showing the relationship between experience and distance covered, r_s = -0.72, P < .001) given their greater exposure to different match scenarios across their careers, which may lead to a more relaxed demeanor (Mücke et al., 2018) Therefore, given the negative relationships between habitual activity (daily physical activity and weekly METs) and HR during matches (r_s = -0.78 to -0.89, P < .001), training or lifestyle interventions aimed at increasing daily activity in coaches could reduce HR across matches, particularly in less experienced coaches, and may promote improved stress management (Thelwell et al., 2017).

Quick and effective decision-making during key match moments is fundamental to optimally manage players, incorporate relevant strategies, and achieve team success (Attali, 2013; Suárez-Cadenas, Courel-Ibáñez, Cárdenas, & Perales, 2016). The ability to make such decisions may be threatened under stressful situations, in which the response of the cardiovascular system is manifested as an autonomous modulation of the perceptual cognitive system that is involved in the final decision made by the coach (Chang & Haemi, 2019). In this way, given the varied levels of cardiovascular stress, the study observes basketball head coaches to encounter during matches, the management of stressful situations should be a priority for basketball head coaches via appropriate strategies such as coach-oriented physical conditioning plans (Serpell, Young, & Ford, 2011). While this study increases the evidence base regarding the demands imposed on basketball head coaches during matches, some notable limitations in the small sample size and the indirect estimation of HR_{max} should be acknowledged. In this regard, the study is a case series designed to provide an exploratory analysis in a previously neglected area of the literature given the limited opportunity to recruit professional basketball head coaches from various teams and monitor them directly during matches.

Conclusion

The present study provides a current analysis of HR responses, and the impact of mediating factors on HR responses, in basketball head coaches during matches. In turn, the study shows that basketball head coaches experience higher HR during matches than prior to and following matches, during latter time-outs compared to initial time-outs, and when their team is undergoing positive scoring streaks. Furthermore, higher HR are evident with less coaching experience, less activity in daily life, and more distance covered during matches.

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