Cardiocirculatory Stress in Professional Football (Soccer) Coaches

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Abstract

Objective: It was intended to quantify cardiocirculatory stress and risk of professional football (soccer) coaches during competition. **Design:** Descriptive cross-sectional study. **Setting:** Medical screening examination and measurements during match. **Participants:** Seventeen coaches and 11 assistant coaches of the 2 highest German football leagues (male coaches; 46 ± 7 years; 8 ± 7 years in job). **Independent variables:** Professional football matches with highly competitive character were chosen and monitored for elicited cardiocirculatory stress and possible damage. **Main Outcome Measures:** Indicators of general health status, occurrence of arrhythmias, and course of heart rate and cardiac biomarkers (brain natriuretic peptide [BNP], troponin I) during the match. **Results:** Besides a few preexisting cardiovascular diseases, medical screening revealed a risk factor profile similar to the general population and above-average maximal/submaximal cycle ergometry performance: P_{max} 2.9 ± 0.5 W*kg^{-1}; PWC_{130} 1.9 ± 0.5 W*kg^{-1}. No match-induced changes were detected for BNP (20.5 ± 9.4 to 19.7 ± 10.7 pg/mL; $P = 0.48$) and troponin I (12.6 ± 16.5 to 10.5 ± 14.1 ng/L; $P = 0.31$). Maximal heart rate during the first and second half was 127 ± 15 and 132 ± 19 beats per minute, respectively. No match-induced arrhythmias of higher degree were detected. **Conclusions:** Head and assistant coaches of German professional football teams do not show any match-induced cardiac damage, despite considerable cardiocirculatory stress. Possibly, their above-average fitness level saves them from more detrimental outcomes.

Key Words: arrhythmia, health, match, cortisol, troponin, BNP

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INTRODUCTION

In contrast to players, football coaches have rarely been subject to scientific studies with regard to (clinical) exercise physiology, although they represent an exceptional group exposed to unique situations and stressors. In today's professional sport, football coaches are among the ones with the highest public attention and, thus, potentially with the largest individual pressure. Besides organization and supervision of training and match play, coaches have to balance influences from officials, journalists, players, and their advisors. Several studies have indicated considerable resulting psychological stress,[1,2] and it seems likely that this results in sympathetic activation at least during matches. Repeated stressors of this kind may even lead to long-term atherosclerotic change.[3]

When coaches are former players, this typically means a shift from physical work during a few hours of the day to cognitive work for much longer periods and under several additional stressors (media, sponsors, internal club requirements, communication, etc). Although medical surveillance is tight in players, it is much looser in coaches, which means that cardiac conditions that may be preexistent or arise from chronic stress (or simply aging) can remain undetected and, thus, represent a health hazard for them. Sympathetic stimulation during matches might aggravate these conditions and lead to arrhythmias, ischemia, and myocardial wall stress.[4] Therefore, this study aimed at describing the cardiocirculatory response of professional football coaches to match-induced stress.

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The authors report no conflicts of interest.

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MATERIALS AND METHODS

This was a descriptive cohort study carried out in accordance with the Helsinki Declaration from 1975 and approved by the local ethics committee. It included the following:

1. a cardiovascular medical examination
2. examinations on a match day with venous blood samples before and after match as well as ambulatory electrocardiogram (ECG) recording.

All coaches and assistant coaches from all 36 clubs of the 2 highest German professional leagues (Bundesliga and Bundesliga 2) were asked to participate during the season 2014/15. The German Football League organization (DFL) wrote a letter to all clubs asking for participation. Also, team doctors were contacted by the main investigator and asked to forward the request to their coaches.

Cardiovascular Screening Examination

A comprehensive medical examination, including history, physical examination, measurement of blood pressure,

echocardiography, resting ECG, and exercise testing, was carried out before the investigated match.

Examinations on Match Day

Coaches were asked to give access to an "important" match to increase the likelihood of psychological stress. They were visited on match day within the last 2 hours before the match. At this time point, venous blood was sampled from an antecubital vein to determine cortisol, troponin I (both on a Beckman Coulter ACCESS 2 immunoassay system), and brain natriuretic peptide (BNP) (Triage BNP test, Inverness Medical). Another sample was taken when the ECG shirt was collected after the match (see below).

Coaches received a shirt that enabled recording an ambulatory ECG (1-channel ECG; SenseCore company, Switzerland) during the entire prematch period and the match itself until the device was taken off within 30 minutes after the match. The shirt was worn under normal clothes and invisible for all spectators (5 different sizes available).

Statistics

Statistical analysis was performed with Statistica software. Data are presented as means and SDs (ranges where appropriate) throughout. Prematch versus postmatch differences were investigated by a *t* test for dependent samples. An α-error of $P < 0.05$ was considered significant.

RESULTS

Seventeen head coaches and 11 assistant coaches agreed to participate. Table 1 shows their league affiliation and their past as professional players. All of them were male, and average age was 46 ± 7 years (range, 35-62 years). Mean duration of employment as a coach/assistant coach was 8 ± 7 years (range, 1-23 years).

Cardiovascular Medical Examination

Mean height, weight and body mass index was 1.82 ± 0.05 m (range 1.70-1.92 m), 88 ± 11 kg (65-112 kg), and 26.3 ± 2.4 $kg*m^{-2}$ (22.5-31.0 $kg*m^{-2}$), respectively. At rest, average heart rate was 63 ± 11 $minute^{-1}$ (46-94 $minute^{-1}$), and systolic and diastolic blood pressure were (n = 25) 123 ± 18 mm Hg (100-190 mm Hg) and 78 ± 10 mm Hg (60-90 mm Hg), respectively. Table 2 illustrates results from the cycle ergometry.

Findings from history included known coronary artery disease, a transitory ischemic episode in the past, chronic hepatitis B, and gonarthrosis after patella fracture (n = 1 each). Clinical examinations revealed new diagnoses of coronary artery disease, atrial fibrillation, and arterial hypertension (n = 1 each) and also 2 cases of borderline resting blood pressure and 1 exercise-induced hypertension. Only 5 participants were without cardiovascular risk factors as defined in the Framingham study.

Examinations on Match Day

Cortisol increased numerically from 10.0 ± 4.0 to 11.5 ± 5.0 μg/dL ($P = 0.11$). No such changes were detected for BNP (20.5 ± 9.4-19.7 ± 10.7 pg/mL; $P = 0.48$) and troponin I (12.6 ± 16.5-10.5 ± 14.1 ng/L; $P = 0.31$). Prematch to postmatch courses in each individual for both cardiac parameters are depicted in Figure 1A, B.

Arrhythmias and Heart Rate

Nine of 15 available ECGs remained free from arrhythmias. One coach showed permanent atrial fibrillation already known from initial screening. Another participant had frequent supraventricular extra beats up to 10 per minute. In the remaining participants, only isolated supraventricular and ventricular extra beats were detected without any arrhythmias of higher degree. No complaints were reported. The remaining ECG traces from 13 participants were unavailable for detailed analysis because they were deleted from the company's cloud before analysis (due to bankruptcy of the company). Heart rate (HR) values (n = 24) were clearly increased during both halves of the match and reached average values over 130 beats per minute (bpm) during the second half (Figure 2). Peak HR during the first and second half was 127 ± 15 and 132 ± 19 bpm equal to 77 ± 9% (range 63%-92% HR_{max}) and 82% ± 9% HR_{max} (68%-101%), respectively. Average HR was 102 ± 14 bpm (62% ± 9% HR_{max}; 52%-78%) during the first half and 103 ± 15 bpm (63% ± 9% HR_{max}; 50%-81%) during the second.

DISCUSSION

Our results indicate considerable cardiocirculatory stress for coaches and assistant coaches of professional football teams

TABLE 1. Numbers of Participating Coaches and Assistant Coaches, Their League Affiliation (Bundesliga = First; Bundesliga 2 = Second), and Their Past As a Professional Player

	Total		Head Coach		Assistant Coach	
	n	%	n	%	n	%
Total	28	100	17	61	11	39
League						
1st	10	36	5	29	5	46
2nd	18	64	12	71	6	55
Former player						
Yes	19	68	13	76	6	55
No	9	32	4	24	5	46

TABLE 2. Performance Data From Cycle Ergometry With Distinction for Maximal Parameters Between Participants Who Reached Maximal Effort Criteria and Those Who did Not

	Exhaustion Criteria Fulfilled, n = 18			Exhaustion Criteria Not Fulfilled, n = 6		
	Mean	SD	Range	Mean	SD	Range
Maximal parameters						
HR_{thmax} (min^{-1})	154	7	138-165	155	5	150-162
HR_{peak} (min^{-1})	167	11	148-192	147	9	134-158
P_{max} (W)	260	49	180-333	217	31	175-269
P_{max} ($W*kg^{-1}$)	2.9	0.5	2.0-3.7	2.6	0.4	2.1-3.3
Independent From Exhaustion Criteria (n = 18)						
Submaximal parameters						
PWC_{130} ($W*kg^{-1}$)	1.9		0.5		1.1-3.0	
PWC_{150} ($W*kg^{-1}$)	2.4		0.6		1.5-3.8	

HF_{thmax}, 200 minus age; HR_{peak}, peak heart rate reached during cycle ergometry; P_{max}, maximal power output; $PWC_{130/150}$, physical work capacity (power output at a heart rate of 130/150 bpm).

during their teams' matches without concrete match-related cardiac damage. However, preexisting cardiovascular disease was documented in a relevant number of coaches, which may give additional relevance to the documented match-induced sympathetic activation.

There are indications that chronic job stress, as it can be expected in coaches,[1] may lead to secondary cardiovascular impairment or even damage.[3] This is probably part of the explanation why the health of former athletes has not uniformly been found unchallenged in their later life.[5,6] Acute stressors for professional coaches during football matches mainly arise from the psychological pressure and–besides other mechanisms–might be expressed biochemically by a catecholamine release. Detrimental cardiac effects from such an activation are more likely in coaches with preexisting diseases.[4] Probably, our cohort has been too small and the observation period was too short to detect clinically meaningful events as they have been documented in football spectators[7] who are probably exposed to a similar albeit lower stress.

It is noteworthy that the participants of this study showed above-average ergometric performance most likely resulting from their earlier career and/or active lifestyle. Although prognostically advantageous, this obviously does not render them immune to cardiovascular diseases of which relevant ones were documented at least in 4 individuals (14%). Also, the presence of cardiovascular risk factors did not relevantly differ from the general population. This may give rise to the consideration whether coaches should undergo screening examinations to identify unknown (job-associated?) health risks, particularly cardiac conditions, and mitigate them, for example, by appropriate medication or lifestyle recommendations.

It is expected that stress-related sympathetic activation leads to the documented mean HR values slightly above 100/min (>60% HR_{max}) and maximal ones above 130/min in the second half (>75% HR_{max}), although this was only accompanied by a tiny (nonsignificant) increase in serum cortisol. Maximal heart rate during matches was equal to the one elicited by power outputs above 150 W. Although no blood pressure measurements were conducted because devices had to be invisible throughout the match, it can be assumed that relevant increases were present. We consider it beneficial for

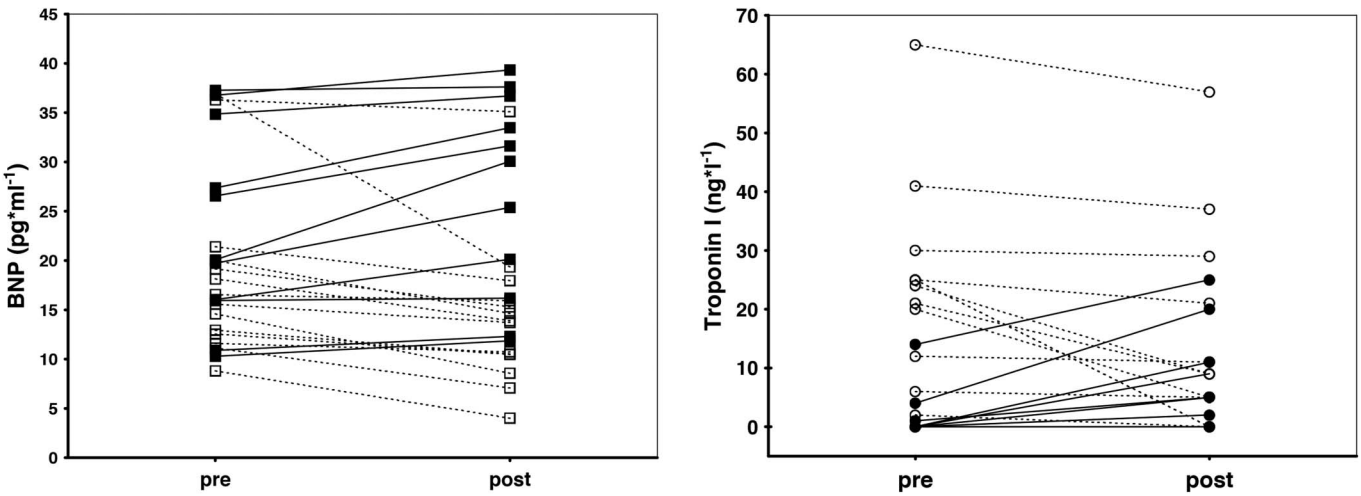

Figure 1. Individual courses of BNP (A; squares; left side) and troponin I (B; circles; right side). Filled squares/circles indicate a numerical increase whereas open ones stand for a decrease.

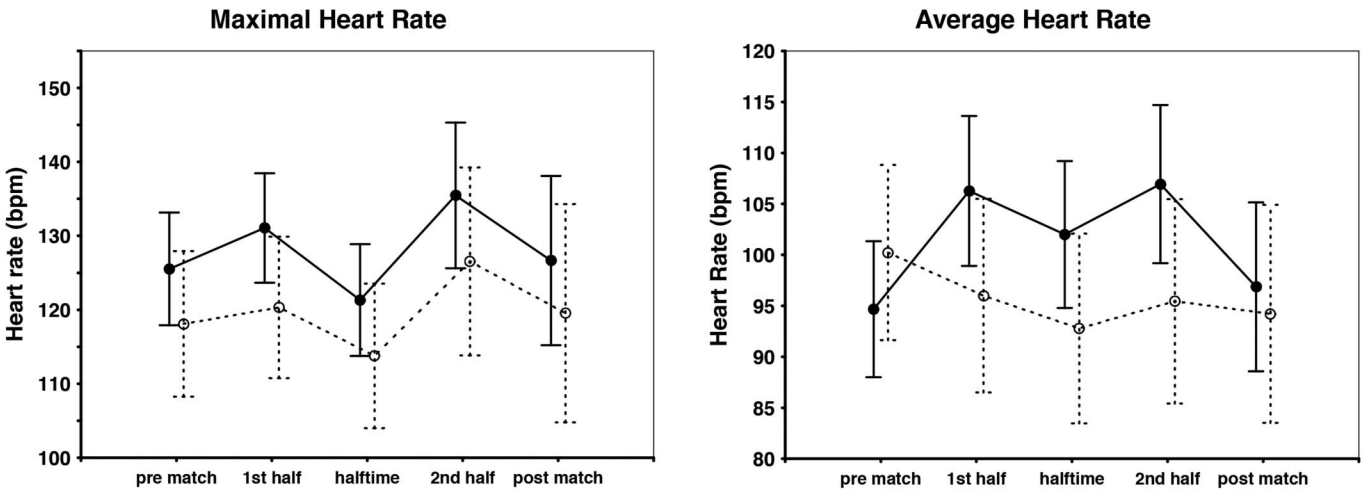

Figure 2. Maximal (A; left side) and average (B; right side) HR values for coaches (filled circles) and assistant coaches (open circles). Means and SDs.

the coaches that they are allowed to move within their coaching zone because this potentially leads to a lowered total peripheral resistance as compared with a sitting position. In this regard, assistant coaches (and spectators) may be more limited.

No suspicious match-induced changes were documented for troponin I and for BNP, which indicates that there were no immediate negative cardiac effects from sympathetic arousal or other factors. This could, theoretically, have been documented for ischemia and impaired myocardial integrity (troponin) as well as for increased myocardial wall stress (BNP). These findings are underscored by lacking arrhythmias of higher degree. Stressors of more physical character have been shown to lead to an increase in cardiac markers.[8] However, these findings have mostly been interpreted as a physiological side phenomenon during physical exercise instead of indicating cardiac damage.[9]

A major strength of the study was access to an extraordinary target group with special requirements during professional football matches. This explains the relatively low sample size, although all coaches from the highest 2 national leagues were asked to participate. The descriptive nature of the study may justify a lacking control group (eg, lower leagues' coaches) or control condition (same individuals under different stressors).

Immediate stress from matches would have been better reflected by the determination of catecholamines. However, their biological half-life is too short to be meaningfully measured at reasonable time points after the match. Thus, they were "replaced" by cortisol, a more long-term indicator for physical and psychological stress.[10] Earlier time points for blood sampling right after the match would have interfered with coaches' compliance. Finally, 2 coaches on beta-blockers might have led to a slight underestimation of heart rates during the matches. Future studies should integrate a validated stress questionnaire when stress from football matches is to be described.

CONCLUSIONS

A professional football match represents a relevant stressor for coaches and their assistants with regard to sympathetic activation as demonstrated by heart rate measurements. No indicators of immediate cardiac damage were found. However, the combination of preexisting cardiac conditions (as they were detected in some participants) and match-related stress may put affected coaches at risk and justify screening examinations.

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References

1. Fletcher D, Scott M. Psychological stress in sports coaches: a review of concepts, research, and practice. *J Sports Sci*. 2010;28:127–137.
2. Olusoga P, Butt J, Hays K, et al. Stress in elite sports coaching: identifying stressors. *J Appl Sport Psychol*. 2009;21:442–459.
3. Kivimäki M, Virtanen M, Elovainio M, et al. Work stress in the etiology of coronary heart disease: a meta-analysis. *Scand J Work Environ Health*. 2006;32:431–442.
4. James PR, Taggart P, McNally ST, et al. Acute psychological stress and the propensity to ventricular arrhythmias; evidence for a linking mechanism. *Eur Heart J*. 2000;21:1023–1028.
5. Kontro TK, Sarna S, Kaprio J, et al. Mortality and health-related habits in 900 Finnish former elite athletes and their brothers. *Br J Sports Med*. 2018;52:89–95.
6. Turner AP, Barlow JH, Heathcote-Elliott C. Long term health impact of playing professional football in the United Kingdom. *Br J Sports Med*. 2000;34:332–336.
7. Lin LL, Gu HY, Yao YY, et al. The association between watching football matches and the risk of cardiovascular events: a meta-analysis. *J Sports Sci*. 2019;37:2826–2834.
8. Scharhag J, George K, Shave R, et al. Exercise-associated increases in cardiac biomarkers. *Med Sci Sports Exerc*. 2008;40:1408–1415.
9. Shave R, Baggish A, George K, et al. Exercise-induced cardiac troponin elevation: evidence, mechanisms, and implications. *J Am Coll Cardiol*. 2010;56:169–176.
10. Pruessner JC, Wolf OT, Hellhammer DH, et al. Free cortisol levels after awakening: a reliable biological marker for the assessment of adrenocortical activity. *Life Sci*. 1997;61:2539–2549.