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INFLUENCE OF DIURNAL PATTERNS ON RESTING HEART RATE OF FOOTBALL PLAYERS

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ABSTRACT

The present study was intended to examine the influence of diurnal patterns on resting heart rate of football players. To accomplish the purpose of the study, thirty-five male football players in the age group of eighteen (18) and twenty-two (22) years from the colleges affiliated to Acharya Nagarjuna University, Guntur, Andhra Pradesh, India during the academic year 2014-2015, were considered as subjects. These subjects were classified into three groups based on their level participation in football tournaments as college level (12), inter-collegiate level (12) and inter-university level (11). The criterion variables selected in this study is resting heart rate. To monitor the diurnal pattern tests were conducted at 06:00, 09:00, 12:00, 15:00, and 18:00 hours. The cosinor win software was used to examine the rhythm with regard to the criterion variable. The experimental design used for the present investigation was 3 x 5 ANOVA with repeated measures on last factors. Whenever the interaction is significant, simple effect was used as a follow up test. The level of confidence was fixed at 0.05 to test the significance. Based on the findings of the study, it is inferred that a time of day effect do exist on resting heart rate of football players, beside there is significant difference on the diurnal rhythm among groups.

Key Words: *Diurnal patterns, Resting heart rate, Football players*

INTRODUCTION

Football tournaments are organized at various times in the day, ranging from morning to night. Competitive performance of football players depend on a certain factors, including physiological and psychomotor variables. The work-rate of athletes which correlates with maximal aerobic power, and sprint performance is influenced by anaerobic power, explosive power, flexibility and strength endurance. Because these performance measures are affected by diurnal variation in association with changes in body temperature (Reilly & Down, 1992), it is likely that some components of physical performance are affected by the time (with reference to circadian rhythms) they take place. Moreover, competition times are often out of synchrony with the typical time for training, and this separation might affect performance in competition and also apply to training at a typical times. An awareness of the existence of circadian variation in sports performance would have practical relevance for coaches, both in preparing players for competition at different times of day and in optimizing training programs. Furthermore, a coach or trainer might make allowances for below par execution of performance at times of day demonstrated to be outside of the period at which performance was demonstrated to be at its diurnal peak.

All life on earth evolved under both a light and dark cycle. As the sun rises and reaches its peak at noon, the spectrum it emits is smooth throughout the visible spectrum with a high intensity in the blue region [400 - 500 nm]. As the sun sets, blue visible light is preferentially scattered (removed) from sunlight, leaving an emission appearing orange-red [600 - 700 nm]. At night, there is darkness with limited visible light emitted from the stars, with the exception of when there is a full moon. During the full moon, there is five times the amount of visible light emitted from the sky, and significant light emitted in the blue visible range (Czeisler & Gooley, 2007).

Humans evolved being exposed to different spectra of light in the morning, the late afternoon and evening. So it should not be surprising that human physiology is profoundly affected by the daily and seasonal changes in the visible light spectrum. Exposure to the appropriate spectrum of light during the day and evening enhances human health and well being, immune response and productivity. However, exposure to light sources that do not match the natural solar spectrum to the time of day or evening, is hazardous to human health (Stevens *et al*., 2007; Rea *et al*., 2008; Arendt, 2010). The reason visible

light has such a powerful effect on human health is that light exposure through the eye modifies circadian rhythm (Gaddy *et al*., 1993; Roberts, 1995; Czeisler *et al*., 1995).

In the world of competitive sports, performance is probably the most sought after individual characteristics an athlete can possess. However, the consistency of performance could possibly be affected by the time of day effects. As the time of exercise and sports performance varies from day to day, every athlete is interested in the work of scientists who are studying the proverbial internal clock that determine what time of day is the best time to exercise, and needs to know their most productive time to perform exercise and follow a routine that works best for them. Hence, the investigator made an attempt to study the diurnal variation of resting heart rate among football players.

METHODOLOGY

Subjects and Variables

Thirty-five male football players in the age group of eighteen (18) and twenty-two (22) years from the colleges affiliated to Acharya Nagarjuna University, University, Andhra Pradesh, India during the academic year 2014-2015, were considered as subjects. These subjects were classified into three groups based on their level participation in football tournaments as college level (12), inter-collegiate level (12) and inter-university level (11). All the subjects were non smokers and also they were free from injuries for 2 months before the commencement of the study. The criterion variables selected in this study is resting heart rate.

Collection of Data

To monitor the diurnal pattern on resting heart rate of college level, inter-collegiate level and inter-university level football players tests were conducted at 06:00, 09:00, 12:00, 15:00, and 18:00 hours.

Statistical Techniques

The data collected from the football players (college level, inter-collegiate level & inter-university level) at five different time of the day were statistically analyzed to examine the changes on resting heart rate. The cosinor win software was used to examine the rhythm with regard to the criterion variable. The experimental design used for the present investigation was 3 x 5 ANOVA with repeated measures on last factors. In which, the first factor denotes different levels of football players (college level, inter-collegiate level & inter-university level) and the second factor indicated different times (*06:00, 09:00, 12:00, 15:00, and 18:00 hours*) of a day whenever the interaction is significant, simple effect was used as a follow up test. The level of confidence was fixed at 0.05 to test the significance.

RESULT

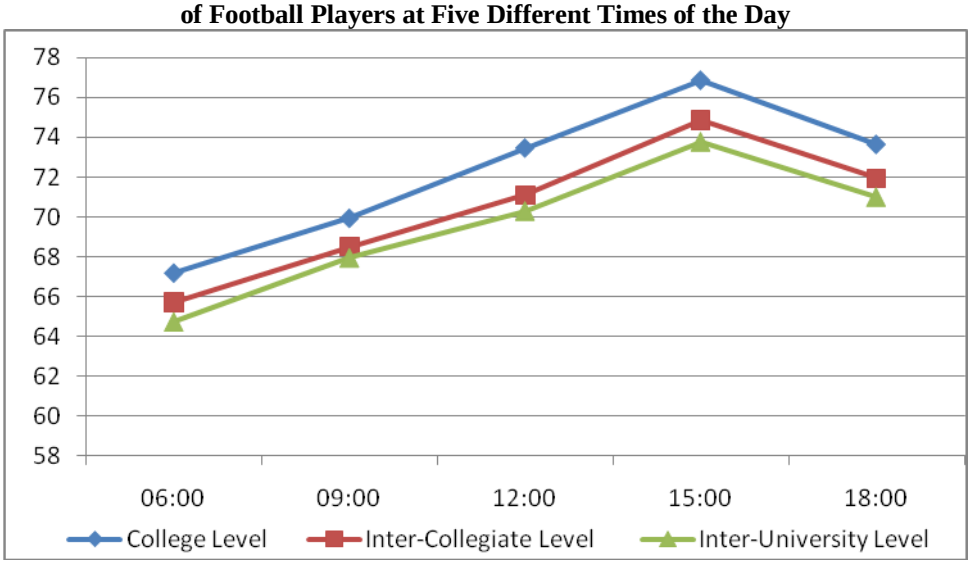
The descriptive statistics on resting heart rate of college level, inter-collegiate level and inter-university level football players at five different times of the day is shown in table-I.

Table-I: **Descriptive Statistics on Resting Heart Rate of Football Players at Five Different Times of the Day**

Time	Group Mean		
	College Level	Inter-Collegiate Level	Inter-University Level
06:00	67.20	65.72	64.73
09:00	69.94	68.50	67.95
12:00	73.46	71.09	70.31
15:00	76.85	74.85	73.79
18:00	73.64	71.93	71.01

Table-I shows the mean value on resting heart rate at different times of the day is ranged between 67.20 and 76.85 for college level football players, 65.72 and 74.85 for inter-collegiate level football players, and 64.73 and 73.79 for inter-university level football players. The data on resting heart rate of college level, inter-collegiate level and inter-university level football players at different times of the day was graphically illustrated in figure-I.

Figure-I: **Graphical Representation of Data on Resting Heart Rate of Football Players at Five Different Times of the Day**



The Diurnal rhythm on resting heart rate of college level, inter-collegiate level and inter-university level football players at five different times of the day is shown in table-II

Table-II: **Diurnal Rhythm on Resting Heart Rate**

Rhythm	Group Mean		
	College Level	Inter-Collegiate Level	Inter-University Level
Acrophase	15:09	15:22	15:14
Amplitude	5.1	4.7	4.8
MESOR	71.60	70.12	69.13
Trough	03:21	03:26	03:19
r value	-0.64	-0.68	-0.65

The acrophase of resting heart rate was reached at 15:09, 15:22, and 15:14 hours respectively by college level, inter-collegiate level and inter-university level football players. Amplitude (*1/2 peak to trough difference*) is 5.1, 4.7, and 4.8. The MESOR of resting heart rate of college level, inter-collegiate level and inter-university level football players are 71.60, 70.12, and 69.13 respectively. The correlation coefficient of -0.64, -0.68 and -0.65 were obtained for the respective group of football players.

Additionally, the data on resting heart rate was analyzed for significant difference among groups at different times of the day using repeated measures. The results thus obtained were given in table-III.

Table-III: **Two way ANOVA with Last Factor Repeated Measures on Resting Heart Rate**

Source of Variation	SS	df	MS	F
Between *Ss*				
A *(college, inter-collegiate & inter-university level football players)*	183.06	2	91.53	18.54*
Ss w. groups (Error I)	157.97	32	4.937	
Within *Ss*				
B (*Different times of Day*)	1205.86	4	301.465	969.34*
AB (*Interaction*)	5.25	8	0.656	2.11*
B × *Ss w.* groups (Error II)	39.76	128	0.311	

**Significant at 0.05 level*

The table value required for significance at 0.05 level of confidence for the df of 2 and 32, 4 and 128, 8 and 128 are 3.29, 2.44 and 2.01 respectively.

Table-III reveals that there is a significant difference on resting heart rate among football players irrespective of different times of day as the obtained 'F' ratio of 18.54 is greater than the required table value of 3.29 for df 2 and 32 at 0.05 level of confidence. The finding also reveals a significant difference on resting heart rate among different times of day, irrespective of groups as the obtained 'F' ratio of 969.34 is greater than the required table value of 2.44 for df 4 and 128 at 0.05 level of confidence.

The findings of the study disclose that there is a significant difference on resting heart rate for the interaction of groups and different times of the day as the obtained F ratio of 2.11 is greater than the required table value of 2.01 for the df of 8 and 128 at 0.05 level of confidence. Since, interaction is significant the simple effect was applied and the results thereto are given in table-IV.

In order to quantify the diurnal rhythm and its variation among groups, the data on resting heart rate was subjected to simple effect test, the findings thus derived was depicted in table-IV.

Table-IV: **Simple Effect Test on Resting Heart Rate of Football Players at Five Different Times of the Day**

Variable	SS	df	MS	F
Football Players at 06:00 hours	17.43	2	8.715	28.02*
Football Players at 09:00 hours	11.56	2	5.78	18.59*
Football Players at 12:00 hours	29.01	2	14.51	46.64*
Football Players at 15:00 hours	17.86	2	8.93	28.71*
Football Players at 18:00 hours	19.26	2	9.63	30.96*
College Level Football Players at Different Times of the Day	139.28	4	34.82	111.96*
Inter-Collegiate Level Football Players at Different Times of the Day	128.32	4	32.08	103.15*
Inter-University Level Football Players at Different Times of the Day	154.38	4	38.60	124.10*
Error	39.76	128	0.311	

**Significant at 0.05 level*

The table value for significance at 0.05 level of confidence with df 2 and 128 is 3.07 and df of 4 and 128 is 2.44.

Table-IV demonstrated a significant difference of the diurnal rhythm on resting heart rate among groups (college, inter-collegiate & inter-university level football players) at 06:00, 09:00, 12:00, 15:00 and 18:00 hours as the obtained F ratio of 28.02, 18.59, 46.64, 28.71, and 30.96 respectively are greater than the required table value of 3.07 for df 2 and 128 at 0.05 level of confidence.

Furthermore, it is found that significant diurnal variation subsists on resting heart rate at different times of the day of college, inter-collegiate and inter-university level football players as the obtained F ratio of 111.96, 103.15 and 124.10 respectively are lesser than the required table value of 2.44 for df 4 and 128 at 0.05 level of confidence.

Table- V: **Scheffe's Post Hoc Test for the Paired Mean Differences on Resting Heart Rate of Football Players at Five Different Times of the Day**

	College Level	Inter-Collegiate Level	Inter-University Level	Mean Difference	Confidence Interval
Football Players at 06.00	67.20	65.72		1.48*	0.49
	67.20		64.73	2.47*	0.49
		65.72	64.73	0.99*	0.49
Football Players at 09.00	69.94	68.50		1.44*	0.49
	69.94		67.95	1.99*	0.49
		68.50	67.95	0.55*	0.49
Football Players at 12.00	73.46	71.09		2.27*	0.49
	73.46		70.31	3.05*	0.49
		71.09	70.31	0.78*	0.49

Football Players at 15.00	76.85	74.85		2.00*	0.49
	76.85		73.79	3.06*	0.49
		74.85	73.79	1.06*	0.49
Football Players at 18.00	73.64	71.93		1.71*	0.49
	73.64		71.01	2.63*	0.49
		71.93	71.01	0.92*	0.49

**Significant at 0.05 level*

Table-V demonstrates that each of the paired mean differences have significant deviation among groups on resting heart rate at different times of the day. It implies that inter-university level football players possess better resting heart rate at all the times of testing confined to this study.

Table-VI: **Scheffe's Post Hoc Test for the Paired Mean Differences on Resting Heart Rate of College Level Football Players at Five Different Times of the Day**

Football Players at					Mean Difference	Confidence Interval
06.00	**09.00**	**12.00**	**15.00**	**18.00**		
67.20	69.94				2.74*	0.58
67.20		73.46			6.26*	0.58
67.20			76.85		9.65*	0.58
67.20				73.64	6.44*	0.58
	69.94	73.46			3.52*	0.58
	69.94		76.85		6.91*	0.58
	69.94			73.64	3.70*	0.58
		73.46	76.85		3.39*	0.58
		73.46		73.64	0.18	0.58
			76.85	73.64	3.21*	0.58

**Significant at 0.05 level*

Table-VI confirms that the paired mean difference on resting heart rate of college level football players varied considerably all through the time of day. It implies that the college level football players resting heart rate increases gradually with ambient temperature related to time of day effect. However, the resting heart rate gets reducing at noon and at 18.00 hours which might be the result of easing of ambient temperature.

Table-VII: **Scheffe's Post Hoc Test for the Paired Mean Differences on Resting Heart Rate of Inter-Collegiate Level Football Players at Five Different Times of the Day**

Football Players at					Mean Difference	Confidence Interval
06.00	**09.00**	**12.00**	**15.00**	**18.00**		
65.72	68.50				2.78	0.58
65.72		71.09			5.37	0.58
65.72			74.85		9.13	0.58
65.72				71.93	6.21	0.58
	68.50	71.09			2.59	0.58
	68.50		74.85		6.35	0.58
	68.50			71.93	3.43	0.58
		71.09	74.85		3.74	0.58
		71.09		71.93	0.84	0.58
			74.85	71.93	2.92	0.58

**Significant at 0.05 level*

Table-VII shows that the paired mean difference on resting heart rate of inter-collegiate level football players varied considerably all through the time of day. It implies that the inter-collegiate level football players resting heart rate increases gradually with ambient temperature related to time of day effect. However, the resting heart rate gets dropping at 18.00 hours which might be the result of easing of ambient temperature

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Table- VIII: **Scheffe's Post Hoc Test for the Paired Mean Differences on Resting Heart Rate of Inter-University Level Football Players at Five Different Times of the Day**

Football Players at					Mean Difference	Confidence Interval
06.00	**09.00**	**12.00**	**15.00**	**18.00**		
64.73	67.95				3.22*	0.58
64.73		70.31			5.58*	0.58
64.73			73.79		9.06*	0.58
64.73				71.01	6.28*	0.58
	67.95	70.31			2.36*	0.58
	67.95		73.79		5.84*	0.58
	67.95			71.01	3.06*	0.58
		70.31	73.79		3.48*	0.58
		70.31		71.01	0.70*	0.58
			73.79	71.01	2.78*	0.58

**Significant at 0.05 level*

Table-VIII shows that the paired mean difference on resting heart rate of inter-university level football players varied considerably all through the time of day. It implies that the inter-university level football player's resting heart rate improved gradually with ambient temperature related time of day effect. However, the resting heart rate gets falling at 18.00 hours which might be the result of reduction of ambient temperature.

DISCUSSION

The resting heart rate level is sensitive to such things as infections, recent physical activity, anxiety and stress, yet the role of environmental climate plays a major role in the daily variations of resting heart rate. In humans, there is an endogenous circadian rhythm in resting HR (Krauchi & Wirz-Justice, 1994; Kerkhof et al., 1998) and a time-of-day-dependent stimulation of resting HR by moderate light intensities (Scheer et al., 1999). In the present investigation, it is found that the resting heart rate elevated at 15:00 hours. This finding is in par with research observations made in the earlier studies.

CONCLUSION

Based on the findings of the study, it is inferred that a time of day effect do exist on resting heart rate of football players, beside there is significant difference on the diurnal rhythm among groups. The present study reveals that low resting heart rate has been found to occur in the morning, and the high resting heart rate has been found in the evening. The findings of the study exhibits that there is significant variation in resting heart rate among college, inter-collegiate and inter-university level football player's.

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