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Effect of Gender Difference and Circadian Rhythm on Systolic Blood Pressure in Volleyball Players

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ABSTRACT

Rajagopal I. Effects of Gender Difference and Circadian Rhythm on Systolic Blood Pressure in Volleyball Players. **JEPonline** 2011;14(2):46-54. The purpose of the study was to determine if there are differences in gender and circadian rhythm that affect the systolic blood pressure (SBP) of volleyball players. Thirty volleyball players (15 men and 15 women) between 19 and 22 years of age were selected as subjects. The two independent variables of gender and circadian rhythm and the dependent variable of SBP were evaluated. The experimental design used was a static group factorial design. The SBP data were collected at 02:00, 06:00, 10:00, 14:00, 18:00 and 22:00 hours during the academic year of 2009-2010. The data were statistically analyzed using a two-way factorial (2 x 6) Analysis of Variance (ANOVA) and Cosinor analysis. There was no difference between genders, significant difference at different times of the day and insignificant circadian rhythmicity exists on SBP. However, there were significant differences at different times of the day. But, given that the size of the differences in mm Hg is very small (4 mm Hg), it is reasonable to conclude that the variation in SBP at different times of the day would have little to no effect on the performance of athletes or others planning to improve sports skills.

Key Words: Gender, Circadian Rhythm, Volleyball, Systolic Blood Pressure

INTRODUCTION

All forms of life on earth respond rhythmically to the regular cycles of the sun, moon, and seasons. As night turns into day, vital body functions, including heart rate and blood pressure, speed up in anticipation of increased physical activity. These and other predictable fluctuations in human function, taking place during specific time cycles, are biologic rhythms or circadian rhythms. They are regulated by specific "biologic clock" mechanisms located in the brain [10].

Blood pressure determines the force exerted on the walls of the blood vessels as blood is distributed throughout the body. Blood pressure does not stay constant throughout the day or throughout one's life and changes in accordance to an individual's daily activities, eating habits, medical health, and emotional condition [13]. An average blood pressure reading is 120/80 mm Hg. Systolic blood pressure (SBP) is the peak pressure in the arteries. This occurs near the end of the cardiac cycle when the ventricles are contracting. Diastolic blood pressure (DBP) is the minimum pressure in the arteries, which occurs near the beginning of the cardiac cycle when the ventricles are filled with blood.

Exercise physiologists have found that biologic rhythms affect physical, physiological, psychological, and biochemical variables of players and athletes [13]. Gender differences also play a vital role in sports and games. The purpose of the study is to determine if there are differences in gender and circadian rhythm that affect the SBP of volleyball players.

METHODS

Participants

Thirty volleyball players [15 men and 15 women] between 19 and 22 years of age were selected as subjects from Einstein College of Engineering, Tamil Nadu, India. They were in a good state of fitness, and they regularly took part in physical activities and game practice both morning and evening during the 2009-2010 academic year.

Measures

Men and women volleyball players were selected as one categorical variable. Circadian rhythms usually form sinusoid within a period about 24 hours. Six different times of the 24-hour day, 02:00 hours, 06:00 hours, 10:00 hours, 14:00 hours, 18:00 hours, and 22:00 hours were selected as another categorical variable. Systolic blood pressure was selected as the dependent variable. The SBP data were collected using Erkameter during the six different times.

Statistical Procedure

The experimental approach consisted of a static group factorial design. The first factor consisted of gender status as men and women volleyball players. The second factor consisted of circadian variation measured at six different times of the day. Two factor analysis of variance with the second factor a repeated (2 x 6) measure to find out the influence of each of the factors independently and also their combined influence on the dependent variable of SBP.

Three “F” ratios were computed; one for rows to assess the gender status on the dependent variable, and the second F-ratio was calculated for columns to assess the circadian variations on the dependent variable. The third F-ratio was calculated for gender status and different times of the day. If the obtained F-ratios were significant, the Scheffe’s post-hoc test was used for columns to find out the significant difference if any among the paired means. If interactions were significant, the simple effect follow up technique was used for testing the differences among cells. Then, the Scheffe’s test was used as a test of significant difference between each cell. The $p = 0.05$ level of significance was

used to test the hypotheses. The mean value from each cell was subjected to cosinor analysis to find out parameters of circadian rhythm, the percentage Rhythm with Probability level, the mesor value, the amplitude and Acrophase for systolic blood pressure in the men and women subjects. Circadian rhythm was considered statistically significant when $p = 0.05$.

Testing Procedure

The subject assumed a relaxed position either lying down with arm on the bed or sitting with the arm supported on the table at heart level to ensure an accurate reading. The subject was told that the application of cuff might cause discomfort for a very short period of time. The deflated cuff was smoothly and evenly applied with the rubber bladder over the brachial artery with the lower edge about 2 inch (5 cm) above elbow. The screw on the rubber bulb of the apparatus was tightened. Using a stethoscope, the pulse of brachial artery was located. The diaphragm was kept lightly but firmly in place. The pulse was felt on the inner side or the bend of the elbow. The cuff was inflated until the pulse disappeared, then it was inflated about 20 mm Hg higher. All blood pressure readings were recorded.

RESULTS

The mean and standard deviation of SBP of men and women volleyball players at six different times of the day are presented in Table 1.

Table I. Systolic Pressure is expressed mm Hg. Mx -Combined mean of men and women volleyball players irrespective of different times of the day. My -Combined mean of different times of the day irrespective of men and women volleyball players.

Status	Mean ± Standard Deviation						
	Times of the day						
	02:00	06:00	10:00	14:00	18:00	22:00	Mx
Men	116.53 ± 3.66	118.00 ± 2.00	118.13 ± 2.45	119.00 ± 0.93	120.87 ± 3.00	117.73 ± 4.33	118.38
Women	114.33 ± 1.91	116.93 ± 2.40	117.40 ± 2.32	118.20 ± 1.57	120.00 ± 3.02	116.53 ± 3.34	117.23
My	115.43	117.47	117.77	118.6	120.44	117.13	

The systolic blood pressure data (see Table 2) have been analyzed by two factor ANOVA with repeated measure on the second factor. Table 2 shows that the F-ratio for factor – A (Gender Status - Men and Women volleyball players) is 2.33; it is not significant at the .05 level of confidence as the required table value for significance is 4.20 (df 1 and 28). The 'F' ratio for Factor – B (different times of the day) is 6.95; it is significant at the .05 level of confidence as the required table value for significance is 2.28 (df 5 and 140). The interaction F-ratio for Factor – A x B (Gender status x different times of the day) is 5.30; it is significant at the .05 level of confidence as the required table value for significance is 2.28 (df 5 and 140).

Table 2. *Significant at .05 level of confidence. Table values required for significance at .05 level for df (1, 28) and (5, 140) are 4.20 and 2.28, respectively.

Source of Variance	Sum of Squares	df	Mean of Squares	F-ratio
Men and Women (Gender)	15.61	1	15.61	2.33
Error I	187.76	28	6.71	
Different times of the day (Time)	264.63	5	52.93	6.95*
Interaction (Gender & Time)	201.83	5	40.37	5.30*
Error II	1066.38	140	7.62	

Since the obtained F-ratio for men and women volleyball players is not significant, there is no difference in the SBP of men and women volleyball players. The F-ratio obtained for the six different times of the day is significant. There is a significant difference in SBP among the six different times of the day. The difference between times of the day in SBP is presented in Table 3.

Table 3. *Significant at .05 level of confidence. Confidence interval value required for significance at .05 level is 2.41

Different Times of the Day						Mean Difference
02:00	06:00	10:00	14:00	18:00	22:00	
115.43	117.47					2.04
115.43		117.77				2.34
115.43			118.60			3.17*
115.43				120.44		5.01*
115.43					117.13	1.70
	117.47	117.77				1.30
	117.47		118.60			1.13
	117.47			120.44		2.97*
	117.47				117.13	0.34
		117.77	118.60			0.83
		117.77		120.44		2.67*
		117.77			117.13	0.64
			118.60	120.44		1.84
			118.60		117.13	1.47
				120.44	117.13	3.31*

The results indicate that SBP differs at different times throughout the day. This difference is found to be significant in 5 paired means out of 15 paired means. The significant difference obtained in the interaction indicates that the difference in SBP may vary for men and women volleyball players, and also among different times of the day. Hence, the simple effect test has been used for further analysis and results are presented in Table 4 that shows the F-ratios obtained for men and women at 6:00 hours, 18:00 hours, and 22:00 hours are significant at .05 level of confidence. This means that

regardless of the gender status, various times of the day significantly affect SBP. The results of Scheffe's test for men volleyball players at different times of the day have been presented in Table 5, and the results of the Scheffe's test for difference between the paired means of SBP of women volleyball players at six different times of the day are presented in Table 6.

Table 4. Simple effect for mean SBP for men and women volleyball players at six different times of the day. *Significant at .05 level with df (5,140) is 2.28 and df (1, 140) is 3.84

Source of Variance	Sum of Squares	df	Mean of Squares	F - ratio
Men and Women Volleyball players				
at 02:00 Hours	8.53	1	8.53	1.12
at 06:00 Hours	36.30	1	36.30	4.77*
at 10:00 Hours	4.03	1	4.03	0.53
at 14:00 Hours	4.80	1	4.80	0.63
at 18:00 Hours	73.63	1	73.63	9.67*
at 22:00 Hours	90.13	1	90.13	11.83*
Men volleyball players at different times of the day	93.30	5	18.66	2.45*
Women volleyball players at different times of the day	373.16	5	74.63	9.80*
Error	1066.38	140	7.62	

Table 5. Scheffe's test for difference between the paired means of SBP of men volleyball players at six different times of the day. *Significant at .05 level of confidence. Confidence interval value required for significance at .05 level is 3.40

Different Times of the Day						Mean Difference
02:00	06:00	10:00	14:00	18:00	22:00	
116.53	118.00					1.47
116.53		118.13				1.60
116.53			119.00			2.47
116.53				120.87		4.34*
116.53					117.73	1.20
	118.00	118.13				0.13
	118.00		119.00			1.00
	118.00			120.87		2.87
	118.00				117.73	0.27
		118.13	119.00			0.87
		118.13		120.87		2.74
		118.13			117.73	0.40
			119.00	120.87		1.87
			119.00		117.73	1.27
				120.87	117.73	3.14

Table 6. Scheffe's test for difference between the paired means of SBP of women volleyball players at six different times of the day. *Significant at .05 level of confidence. Confidence interval value required for significance at .05 level is 3.40

Different Times of the Day						Mean Difference
02:00	06:00	10:00	14:00	18:00	22:00	
114.33	116.93					2.60
114.33		117.40				3.07
114.33			118.20			3.87*
114.33				120.00		5.67*
114.33					116.53	2.20
	116.93	117.40				0.47
	116.93		118.20			1.27
	116.93			120.00		3.07
	116.93				116.53	0.40
		117.40	118.20			1.20
		117.40		120.00		2.60
		117.40			116.53	0.87
			118.20	120.00		1.80
			118.20		116.53	1.67
				120.00	116.53	3.47*

The results of the post hoc analysis indicate there is a significant difference in SBP of women volleyball players among different times of the day in 3 paired means out of 15 paired means. Circadian rhythmicity of SBP and its parameters are explored using the best fitting curve procedure. The mean value from the data is subjected to cosinor analysis. The results are presented in Table 7.

Table 7. Cosinor analysis of circadian rhythmicity of SBP of men and wormen volleyball players.

Category	Percent Rhythm	Probability Level	Mesor ± S.E	Acrophase ± S.E	Amplitude ± S.E	% Amplitude of Mesor
Men	62.17	0.23	118.38 ± 0.362	17:4 hours ± 0:52 hours	1.14 ± 0.511	0.96
Women	76.83	0.11	117.23 ± 0.566	16:66 hours ± 1:21 hours	2.52 ± 0.800	2.15

The results of the cosinor analysis confirm the existence of circadian rhythm in SBP for men volleyball players (62.17%) and women volleyball players (76.83%) which are statistically not significant ($p > .05$). The amplitude of the rhythm in men and women volleyball players is 1.14 and 2.52, respectively. The time of peak performance (acrophase) in SBP for men and women volleyball players is calculated by means of cosinor analysis to be 17:4 hours and 16:66 hours, respectively. The mesor value (mean) for men and women volleyball players is 118.38 mm Hg and 117.23 mm Hg, respectively.

Discussion

This study indicates that SBP is not significantly difference between men and women volleyball players. Although this finding is in agreement with Landazuri et al. [12] who reported that there was no significant difference in mean SBP between the boys and girls, it disagrees with several other studies. Dimkpa et al. [6] concluded that males have higher SBP response than females during and after exercise, which appears to support the work of Welsh et al. [17] who reported that the finger SBP are lower in females than in males at 30°C. Similarly, Ganong [7] concluded that SBP is lower in young women than in young men until age of 55 to 65, after which they become comparable. This thinking is in agreement with Overfield [15] that women have lower SBP than men before 45 years of age and higher SBP after 65 years.

The present study indicates there is a significant difference in SBP during different times of the day irrespective of gender status. The mean SBP is significantly higher at 18:00 hours (119.30) than at 06:00 hours (115.43) with a difference of 3.87 mm Hg. This finding is in agreement with other studies [1,3,5] that reported significant time of the day differences SBP. Blood pressure is typically the lowest in the early morning, gradually rises during the morning and afternoon, and peaks in late afternoon or evening. Cosinor analysis indicates that SBP does confirm a circadian rhythm for both men and women volleyball players. Systolic blood pressure shows variability, even though it was not statistically significant different between the men and women volleyball players. This finding is in agreement with the Rahnama et al. [14]. It also agrees with the earlier findings of van de Luit and colleagues [16]. Men volleyball players have lower percentage rhythm in SBP (62.17) than women volleyball players (76.83). The rhythm amplitude of men volleyball players is lower (1.14) than that of women volleyball players (2.52). This supports earlier researcher [10] who reported that the circadian amplitude of SBP is larger in women athletes than men athletes.

Men and women volleyball players have their peak SBP at 17:4 hours and 16:66 hours, respectively. This is a little earlier phases than body temperature phases. This result supports the findings of Kanabrocki et al. [11] who indicated that significant circadian variations in SBP is evident with peak levels, on average, occurring in the evening hours. This report is also in agreement with the findings of Hermida et al. [8], where the circadian double product (systolic blood pressure multiplied by heart rate) was the highest in the afternoon, roughly 7 hours after the commencement of diurnal activity. This result may be based on the notion of Chervenak et al. [2] that generally, blood pressure rises in the early morning (06:00 hours), reaching the first peak in the midmorning (10:00 hours), and has a second peak in the early evening (18:00 hours), and after that it falls progressively.

This response pattern may be due to the circadian rhythm of body temperature and resting heart rate; both peak at the evening (18:00 hours). The result may also be based on the notion of Culver et al. [4] that marked variability in blood pressure is normal. It varies from minute to minute and from day to day like the waves of the sea, fluctuating with force of the prevailing winds. Blood pressure is different at night, during sleep, and the early morning, fluctuating considerably during the day. Day time blood pressure is mainly determined by the degree of physical and mental activity and is under the control of baroreflexes that operate through adjustments in heart rate and peripheral vascular resistance. The usual fall in blood pressure at night is a result of sleep and inactivity rather than the time of the day. Blood pressure may decrease 10 to 20 mm Hg during sleep as the baroreflex sensitivity decreases sympathetic nervous activity.

CONCLUSIONS

The purpose of the study is to determine if there are differences in gender and circadian rhythm that affect the SBP of men and women volleyball players. The statistical findings indicate that there were

no significant differences SBP values between genders. However, there were significant differences at different times of the day. But, given that the size of the differences in mm Hg is very small (4 mm Hg), it is reasonable to conclude that the variation in SBP at different times of the day would have little to no effect on the performance of athletes or others planning to improve sports skills.

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