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STUDY OF DAY-NIGHT VARIATION OF HEART RATE IN SPORTS PERSONS

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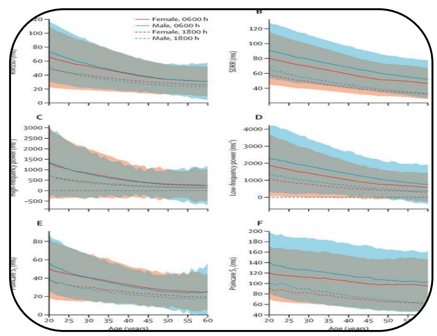
ABSTRACT :-

Resting heart rate is the classical indicator of health and fitness. Coaches and players use resting heart rate to evaluate their training. Present study aimed to measure the day-night changes in the heart rate of sports persons. Total 10 subjects were taken in the study. Data was collected with the help of Actiheart-2 at one minute epoch length. Result indicated significant day-night variation in the heart rate of sports persons. Three sports persons were found extreme dippers and two non-dippers. In conclusion, all the sports persons exhibited significantly circadian rhythm in heart rate.



KEYWORDS : *heart rate, sports persons, circadian rhythm, day-night variation, actiheart.*

INTRODUCTION:-

Reduced basal heart rate is a classic effect of functional adaptation to endurance exercise training (McArdle *et al*., 2000). On the contrary, elevated morning heart rate may be accompanied in overreaching and may reflect an early stage in the development of the overtraining state (Dressendorfer et al., 1985) Kuipers and Keizer, 1988; Dressendorfer et al., 2000). At rest, the HR depends on complex neurohumoral interactions (Dressendorfer et al., 1985). In addition, local temperature and pH, substrate utilization for energy metabolism could modify heart rate (Rousses and Buguet, 1982; Dressendorfer et al., 1985). The initial changes in HR after standing up are solely mediated by withdrawal of vagal tone (Ewing et al., 1980).

The ambulatory heart rate monitors were manufactured in 1982. This is helpful to monitor sporting activities. The heart rate monitors have been used tomonitor heart rate and exercise intensity. However, despite the ability of heart rate monitors to measure heart rate accurately during physical activity, scientists are still sceptical as regards the impact of heart rate monitoring on physical performance (Burke et al.,1994). This scepticism is based on the fact that the oxygen consumption and heart rate relationship dippers according to the mode of exercise performed (Londeree et al., 1995).

On the basis of a number of reviews (Barnard, 1975) it is widely accepted that heart rate during steady-state submaximal exercise decreases at the same submaximal work rate after endurance training. This is in contrast to the relatively small decreases in resting heart rate described after long-term endurance training. For example, in the study of (Wilmore et. al. 1996), subjects experienced small decreases in resting heart rate (about 3 beats min- 1) in contrast to the relatively large decreases (16 beats min- 1) in heart rate during a standard submaximal bout of exercise.

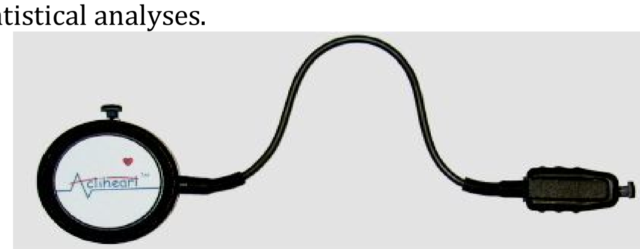
Regular physical activity and good physical fitness are widely accepted as factors that improve a number of health outcomes and reduce all-cause mortality (Ekelund et al.1988). Previous studies have shown that physical fitness is related to cardiac autonomic regulation, providing evidence that aerobic training improves cardiovascular autonomic function (Goldsmith et al. 1992). Aerobic exercise has been suggested to protect the heart against harmful cardiac events by increasing parasympathetic tone and also by decreasing cardiac sympathetic activity (Billman et.al, 2002). Therefore, physical training has been proposed to reduce harmful cardiac events by improving aerobic capacity. Substantial heterogeneity in the responsiveness to physical training, assessed by the change in maximal oxygen uptake ($\dot{V}o2max$), has been observed even in highly standardized training programs.

METHODOLOGY

Total 10 sports persons from DCPE, HVPM has been selected as subject.The subject were selected for the study from those who represented inter-university tournament of Sant Gadge Baba Amravati University Amravati. Changes in heart rate and day – night variation in heart rate were measured with Actiheart -2.0 (Mini Mitter Co. Inc., USA).

Assessment of heart rate Rhythm

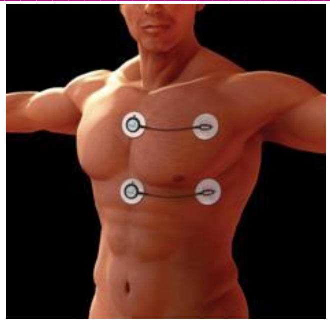
Circadian rhythm in heart rate was monitored with the help of Actiheart -02 (Mini Mitter Co. Inc., USA). The actiheart monitor is a larger, round, main sensor, and lead to the positive electrode lead worn on the left side of the chest over the heart which was affixed to the ECG electrode's male snap. The Actiheart is a physical activity and heart rate monitor for long term monitoring of gross motor activity in human subjects. It is an electrometer (a piezo-electric element capable of converting voltage signal into binary signal by sampling into an 8-bit A/D converter). The device detect the vertical movement by selectively registering values only in the 1.0 to 7.0 Hz range, a programmable memory into which it stores the resulting values, and a user interface program that allows for its configuration. Data were collected at 1 minute epoch. Recordings were made with sampling epochs of one-minute over a period of 3 consecutive days in Sports Persons and non-sports Persons. After monitoring each subject the data were transferred to the computer for further statistical analyses.



Actiheart (2.00, Mini Mitter Co. Inc., USA).

ECG electrode positioning:

Accurate lead positioning is important to get data. Each electrode was placed in specific location. In addition to acquired good ECG signal, the main sensor (lead I) electrode was placed left of the sternum at the fourth intercostals space (the space between the ribs). The ribs were counted from top to bottom. The left lead was placed at the fifth intercostals space in the mid-clavicular line.



Site for the actiheart to be placed

Site preparation:

Both sites were shaved to remove the hair from site. It not only allows the electrodes to be affixed more securely, but removing the hair allowed better contact and less resistance. Both sites were cleaned with alcohol to remove excessive skin oils which allowed better contact of the electrodes. The protective layer of the ECG sensors were peeled away from the electrode pad and placed on the above said sites.

Statistical Analysis:

Data from Actiheart was retrieved and analyzed by using specific Actiheart (version 2.0, Mini Mitter Co. Inc., USA) software. Actograms for visual inspection was obtained with the help of this software.

The circadian rhythm characteristics, such as average of the rhythmic function (Mesor, M: rhythm-adjusted mean), amplitude (A, one-half of the difference between the highest and the lowest value of the rhythmic function) and peak or acrophase (Ø, timings of the highest value of the rhythmic function) were estimated from the data at fixed windows, τ = 24 h using Cosinorrhythmometry (Nelson et al., 1979).

The circadian rhythm in heart rate was also estimated by one more non-parametric methods, such as autocorrelation coefficient at 24 h

Autocorrelation coefficient (r24): Autocorrelation is the measure of the regularity of the activity pattern over 24 h from one day to the next. It is depicted by a graphic display of correlation coefficients between time series staggered by given time lags, according to the following procedure. In the case of a 3-day time series (72 hours), if Xi is the measurement at time i, the correlation coefficient rk between Xi and Xi + k is computed for lags k, with k = 1 to 4320 minutes (72 hours). When circadian variation is present, the correlation coefficient increases to its highest value with lags at or near 24 hours (1440 minutes). This coefficient can range from -1 to +1. In the case of a prominent circadian rhythm, r24 can reach the value of 1.

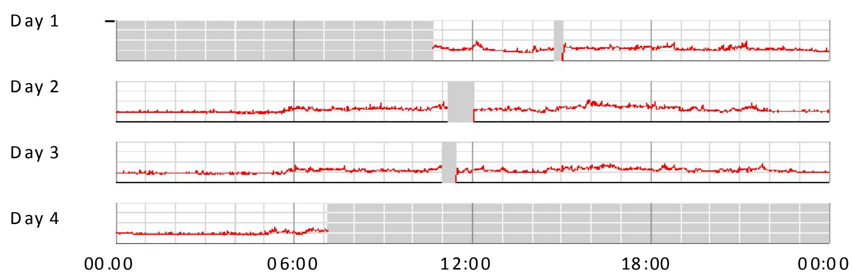
Other conventional statistical techniques, such as descriptive analysis, was also used. Data was analyzed with the help of software, namely SPSS, and Analysis Tool Pak (Microsoft Excel).

Results

Table 1: Characteristics of circadian rhythm of physical activity in Sports persons

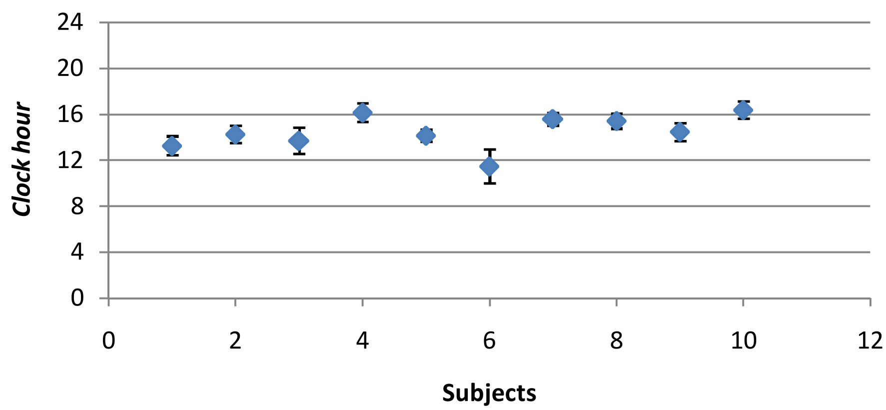
S. No	Sub. Code	Data points	Rhythm detection	Rhythm M ± SE adjusted mean,	Amplitude, A (95% CL)	Acrophase, Ø in h (95% CL)
1	SP1	3850	0.001	63.52±0.23	13.46±0.81	15.84±0.23
2	SP2	4047	0.001	71.65±0.28	12.96±0.97	16.09±0.29
3	SP3	3842	0.001	66±0	9.63±0.72	14.8±0.27
4	SP4	4217	0.001	88.19±0.2	4.76±0.71	18.08±0.57
5	SP5	4592	0.001	79.05±0.24	4.87±0.83	17.73±0.67
6	SP6	3598	0.001	81.89±0.39	3.4±1.3	13.08±1.63
7	SP7	4214	0.001	88.19±0.2	4.76±0.71	18.08±0.57
8	SP8	4291	0.001	32.54±1.21	27.49±4.18	16.14±0.57
9	SP9	3146	0.001	70.45±0.33	13.26±1.18	16.14±0.33
10	SP10	5140	0.001	75.75±0.13	12.3±0.46	15.94±0.14

Figure 1: Showing the actogram of heart rate



Illustrative examples of heart rate profile (actogram) in sports persons. Abscissa depicts clock hour. Each row represents a single 24-h span. The red line shows the heart rate for the corresponding time in the abscissa.

Figure 2: Peak map illustrates location of acrophases of the circadian heart rate rhythm in sport persons (SP)



Heart rate rhythm

All subjects displayed a distinct and regular day-night pattern in h, i.e., more heart rate was displayed during day time than that of the night hours (Figures 1).In all subjects regularity in the pattern of day-night heart rate was discerned.

Rhythm detection: Results of Cosinorrhythmometry of the time series on heart rate rhythm in sports persons are summarized in Tables 1. Results indicated a statistically ($p<0.001$) significant circadian rhythm (τ = 24 h) in heart rate in the sports persons.

Circadian 24-h average (Mesor): Tables 1 depict summary of Cosinorrhythmometry based on variability in heart rate in each subject belonging to sports persons. The analyses of data were performed at fixed windows with τ = 24 h. The averages of all three rhythm parameters, such as Mesor, amplitude and acrophase, were computed for both groups (Table 1).The results of Cosinorrhythmometry indicated inter-individual differences in the level of 24-h average heart rate among individuals of groups. The lowest circadian Mesor (63.52 ± 0.23) was observed in SP#1 and the highest (88.19) in SP#4 and SP#7 among individuals of SP group (Tables 1).

Circadian amplitude: Inter-individual variation (Tables 1) in circadian amplitudes of heart rate was observed. The lowest circadian amplitude in heart rate (3.40) was noticed in SP#6 and the highest (27.49) was in SP#8 among the individuals of the SP group (Table 1). The greater amplitude indicate robust rhythmisity in the rhythm parameters.

Circadian peak (Acrophase): The inter-individual variations in acrophases for heart rate at individual (Tables 1). The acrophase spread for heart rate circadian rhythm was between 13.08 h to 18.08 h in SP group (Table 1). The acrophase occurred at the earliest (13.08 h) in SP#6, and at the latest (18.08) in SP#4 and SP#7.

Peak map: The peaks of heart rate rhythm in 10 subjects are plotted in Figures 2. The maps reveal inter-individual variability in peaks of heart rate rhythm in within the studied groups.

Table 2	**Autocorrelation coefficient (*r*24) of heart rate in Sports persons**	
Code	Heart Rate (*r*-value)	*P-value*
SP1	0.505	0.001
SP2	0.39	0.001
SP3	0.394	0.001
SP4	0.453	0.001
SP5	0.602	0.001
SP6	0.58	0.001
SP7	0.69	0.001
SP8	0.617	0.001
SP9	0.364	0.001
SP10	0.42	0.001

Autocorrelation coefficient (*r*24): The autocorrelation coefficient at τ = 24 h was computed for each subjects (Tables 2). In each subject, the value of *r*24 of heart rate rhythm in SP groupswas statistically ($p < 0.001$) significant.

Day – Night Variation heart rate

Table 3 Showing the day night variation in heart rate of sports persons

Daytime	Nighttime	Dipping
92.66	65.97	28.81
102.51	75.09	26.74
91.92	77.96	15.18
91.40	82.39	9.85
83.49	69.94	16.24
78.62	71.32	9.29
89.79	79.58	11.38
82.84	71.42	13.79
90.63	64.62	28.69
82.92	71.25	14.07

Table 3 depicts the day and night variation in heart rate of sports persons. The percentage change in day and night is the dipping. Dipping showed that only 5 subjects were found dippers, two were found non dippers and three were the extreme dippers.

Conclusions

On the basis of the above results the following conclusions can be drawn:

1. All the sports persons exhibited significantly circadian rhythm in heart rate.
2. The autocorrelation of heart rate patterns are significant, it indicate regularity and consistency
3. Day-night variability of heart rate was observed in all the studied subjects
4. Results of the present study indicate that the 5 sports personnel are non-dippers and extreme dippers which may have higher risk of cardiovascular diseases (Minutolo et.al, 2011).

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