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SHORT-TERM HEART RATE VARIABILITY MEASURE IN SUBJUNIOR ATHLETES AND NON-ATHLETES

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INTRODUCTION

Heart rate variability (HRV) is an established non invasive tool to study cardiac autonomic activity. HRV is also used as an objective measure to evaluate the mental stress¹. It provides an opportunity to study an association between psychological processes and physiological reactions². HRV expresses the balance between the regulation of sympathetic and parasympathetic nervous system.

School children encounter many stressors and experience stress. Moreover, the children involved in sports (subjunior athletes) experience more stress due to pressure from coach demanding good performance and school teachers and parents as well for better academic achievement. High stress can have detrimental effects on the children's health³. Chronic stress may leads to anxiety, depression, poor memory and lower academic achievement⁴. It can also affect the task performance during the sports competition.

Stress increases the sympathetic activity and decreases the parasympathetic dominance⁵. Stress leads to cardiovascular disease and a key factor for this development is an increase in sympathetic activity⁶. Studies have also shown an association between chronic life stresses and, physical and mental diseases⁷⁻⁹. Currently, no documented studies on HRV and stress in subjunior athletes were available and hence the present study was conducted to assess the heart rate variability as a stress index in subjunior athletes.

METHODS

A cross sectional study was conducted on healthy subjunior cyclists (n=21) of Sports School and age matched non-athletes (n=21) as control of Government School, Bijapur District, Karnataka. The ages of subjects ranged from 11-13 years. Subjects on any medications, subjects suffering from any acute or chronic diseases were excluded from the

study. Informed consent was obtained for participation in the study. The study was approved by the institutional ethical committee.

Data acquisition:

All the recordings were taken in the morning between 8 am to 10 am at room temperature following supine rest for 10 minutes. Blood pressure was measured by using the sphygmomanometer. A 5 minute ECG was recorded in the standard limb lead II configuration using a four channel digital polygraph (Medicaid systems Pvt Ltd, Chandigarh, India). The recorded data were visually inspected off-line and only noise free data were included for analysis. No ectopic beats were found on offline scrutiny. The subjects were asked to breathe normally during the ECG recording.

Data analysis:

HRV assessment was done using the HRV analysis software version 2.0, developed by the Biomedical Signal Analysis group, University of Kuopio, Finland¹⁰. Time domain and frequency domain methods were used for analysis of HRV. Mean of all the RR intervals (Mean RR), mean of the heart rate (Mean HR), standard deviation of the normal to normal RR intervals (SDNN) and root mean square of successive differences between adjacent RR intervals (RMSSD) were calculated in the time-domain. A non parametric Fast Furrier Transform (FFT) technique was used to obtain Power spectral density of the RR Series. Total power in the frequency range (0-0.40Hz) was divided into very low frequency (VLF: 0-0.04), low frequency (LF: 0.04-0.15Hz) and high frequency (HF: 0.15-0.40Hz). LF/HF ratio was calculated to assess overall balance between the sympathetic and parasympathetic systems. HRV analysis was done as per the guidelines of Task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology¹¹.

Statistical analysis:

The obtained data was expressed in mean and standard deviation. To determine the statistical significance between subjunior athletes and non-athletes an unpaired 't' test was applied. Statistical significance was established at $p < 0.05$. Data was analyzed using SPSS software.

RESULTS

The demographic characteristics of subjunior cyclists and non-athletes were shown in table 1. The time domain measures of SDNN and RMSSD were significantly less in subjunior athletes as compared to non-athletes, but meanRR and meanHR shown no significant difference. There was no significant difference in frequency domain measures between athletes and non-athletes (Table 2).

Variable	Subjunior Cyclists	Non-athletes
	(n=21)	(n=21)
Sex (Male/Female)	11/10	12/9
Age (Years)	11.83 ± 0.67	11.72 ± 0.62
BMI (kg/m ²)	17.48 ± 3.4	17.56 ± 2.6
Systolic BP (mmHg)	106.23 ± 5.72	105.82 ± 5.05
Diastolic BP (mmHg)	71.04 ± 3.75	70.84 ± 3.88
Pulse Pressure (mmHg)	39.63 ± 2.68	39.2 ± 2.17
MAP (mmHg)	80.62 ± 4.92	81.02 ± 3.29

Table 1. Demographic characteristics of subjunior cyclists and non-athletes.

BMI- Body mass index; MAP-Mean arterial pressure; Values are expressed in Mean ± SD

Parameters	Subjunior cyclists		Non-athletes		t-Value	p-Value
	Mean	SD	Mean	SD		
Mean RR (ms)	687.628	74.710	711.271	83.251	0.969	0.339
Mean HR (bpm)	88.527	10.157	85.325	9.185	-1.072	0.29
SDNN (ms)	25.361	12.967	37.676	20.63	2.316	0.026*
RMSSD (ms)	19.814	10.974	30.061	16.755	2.345	0.024*
LF (nu)	68.838	8.348	65.638	12.343	0.984	0.331
HF (nu)	31.147	8.350	34.123	12.520	0.906	0.37
LF/HF ratio	2.415	0.845	2.26	1.0037	0.542	0.591

Table 2. Comparison of time domain and frequency domain parameters of heart rate variability in subjunior cyclists and non-athletes

Mean RR-mean of all the RR intervals; Mean HR-mean heart rate; SDNN-standard deviation of the normal to normal RR intervals; RMSSD-root mean square of successive differences between adjacent RR intervals; LF-low frequency component; HF-high frequency component; LF/HF ratio-low frequency to high frequency ratio. * $p < 0.05$

DISCUSSION

We compared short-term HRV measures in subjunior cyclists and age matched non-athletes. In the time domain measures Mean RR, SDNN and RMSSD were recommended for short-term HRV analysis¹². The mean RR interval is an indicator of the ratio of the cardiac sympathetic to parasympathetic tones. The mean RR interval was less in subjunior cyclists as compared to non-athletes, but was not statistically significant. This decrease in mean RR interval in subjunior cyclists indicates a shift in the autonomic balance towards the sympathetic side. SDNN reflects all the cyclic components responsible for variability in the period of recording. RMSSD reflects an estimate of parasympathetic regulation of the heart. The significant decrease in SDNN reflects a decreased total HRV and the significant decrease in RMSSD reflects decrease in parasympathetic activity in subjunior cyclists as compared to non-athletes. The decrease in Mean RR interval, SDNN and RMSSD indicates a shift in the autonomic balance towards the sympathetic side suggesting a mental stress in the subjunior athletes. Though not statistically significant but mean HR was more in subjunior cyclists as compared to non-athletes. This change may be explained by shift in an autonomic balance towards the sympathetic side.

LF measure reflects both sympathetic and parasympathetic activity. HF measure reflects an estimate of parasympathetic activity. LF/HF ratio expresses the balance between the regulation of sympathetic and parasympathetic nervous system. A decrease in HF component of HRV and, an increase in mean LF component and LF/HF ratio were

observed, but were not statistically significant in subjunior cyclists as compared to non-athletes. Again, these changes indicate a shift in the autonomic balance towards the sympathetic dominance indicating a mental stress in subjunior cyclists. Studies have shown that mental stress decreases Mean RR interval, SDNN, RMSSD, HF component and, increases LF component of HRV and LF/HF ratio^{5,13}.

Studies on HRV in an athletes above 18 years shown that cycling practice and endurance training increases parasympathetic activity and improves HRV^{14,15}. The contradictory findings in our study might be due to: first, a busy academic schedule and extra coaching classes in addition to the cycling practice; second, residing in the hostel away from their parents. These might contribute to eminent mental stress than a physical one in an individual.

It may be concluded from the finding of the study that children practicing sports under the age of fourteen were under mental stress. The factors causing stress in these children must be explored in the future studies. These children necessitate a proper relaxation technique to overcome inordinate mental stress.

Acknowledgment:

We express sincere thanks to the coach and head of the sports school, and Head Master of Government School, Bijapur, Karnataka, India for support and co-operation. We also thank to the children, both cyclists and non-athletes who volunteered to be subjects in this study.

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