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Autonomic functions of college boys and girls (A comparative study)

Pawan Kumar, Anil Bali, Lalit Kapur and Dhananjoy Shaw

Abstract
The objective of the study was to compare between college boys and girls in regard to the special reference to advance sportsperson (who plays games/sports at national level), inter-mediate sportsperson (who plays games/sports at inter-college level) and non- sportsperson (those who don't play any sports at all). It was hypothesised that different level of games/sports participation / non-participation will have sex difference in regard to selected autonomic function variables. Sample comprises advance sports boys= 22, advance sports girls= 6, inter-mediate boys= 37, inter-mediate sports girls= 20, non-sports boys= 27 and non-sports girls= 22. Ages of the sample ranged from 17 to 21 years of same socio-economic status belonging to different games/sports. Students were asked to come with two hours fasting before the test. No medication was taken before 48 hours of the testing. Subjects rested for 30 minutes before the commencement of the test and then heart rate variability (HRV) was recorded, which quantifies autonomic drive to the myocardium variables were extracted by computing time domain analysis and frequency domain analysis. Collected data was computed with Mean, Standard Deviation, Levene's Test for Equality of Variances ('t' test). The hypothesis was tested at 0,05 level of significance. The study concluded that Mean heart rate for advance sports (boys and girls) and SDNN, Mean Heart Rate, RMMSD, pNN50 count and Total (Absolute Power) for non- sports (boys and girls) with different level of games/sports participation had sex differences.

Keywords: HRV advance sports inter-mediate sports SDNN RMMSD

Introduction
The autonomic nervous system (ANS) is a controlled and complex neural network maintaining internal physiologic homeostasis that acts largely unconsciously. This system is the primary mechanism in control of the flight-or-fight response and its role is mediated by two different components sympathetic and parasympathetic nervous system. The sympathetic nervous system main function is to activate the physiological changes that occur during the fight or flight response. This component of the autonomic nervous system utilizes and activates the release of norepinephrine in the reaction. The parasympathetic nervous system works in concert with the sympathetic nervous system. Its main function is to activate the "rest and digest" response and return the body to homeostasis after the fight or flight response. This system utilizes and activates the release of the neurotransmitter acetylcholine [1].

Autonomic testing [2]
Autonomic tests measure how the systems in the body that are controlled by the autonomic nerves respond to stimulation. The data collected during testing will indicate if the autonomic nervous system is functioning as it should, or if nerve damage has occurred. Autonomic tests are conducted to see if the autonomic nervous system is functioning normally. All testing is non-invasive and painless.

Analysis of autonomic function activity (Heart rate variability) [3]
Analysis of heart rate variability (HRV) has become one of the most popular methods of autonomic nervous system (activity) evaluation. Even at rest the duration of RR intervals is not constant but continually fluctuates around the mean value. The fluctuations are caused by the complex neural mechanisms happening in the nervous system. They are based mainly on interactions between the sympathetic and parasympathetic nervous system. Some of the

autonomic neurons and fibres, apart from the transient phasic activity are initiated by particular stimuli from high-frequency oscillations characteristic of heart or respiratory rate to extremely slow oscillations whose rhythm is circadian, monthly or even seasonal.

HRV is assessed based on time-domain or frequency-domain analysis. Indices of time-domain analysis derive from either direct RR interval measurements or the differences between successive RR intervals. Spectral analysis does not express heart rate as a function of time but as a function of frequency. It concentrates on revealing the cyclical nature hidden in the series of changing RR intervals. The frequency and magnitude of these oscillations are measured, which allows the calculation of the power density for separate frequency ranges[4,5].

The most widely used methods can be grouped under time-domain and frequency-domain [6].

a) **Time domain analysis:** These are based on beat to beat or NN intervals. The selected variables are viz. SDNN, RMSSD, NN50 count, pNN50 count, HRV triangular index and mean heart rate.
b) **Frequency domain analysis:** These methods assign bands of frequency and then count the number of NN intervals that match each band. The selected variables are viz. LF (Normalized Power), LF/HF ratio, LF (Absolute power), TP (Absolute Power), HF (Normalized Power) and HF (Absolute Power).

Known research data suggests that autonomic function activity (HRV) measurement is relevant for the early identification of overreaching states and fatigues in professional athletes. The finding further suggests that HRV parameters are relevant in the analysis of stress that the body experiences during training and to increase insight into physiological recovery after training. Referring to athletes, changes in the patterns of their ANS reflected by altered HRV may serve as useful parameters for managing their physical fatigue and establishing their exercise intensity[7].The researchers were convinced to see the comparison between the college students (boys and girls) advance sports (who plays games/sports at national level), intermediate sports (who plays games/sports at inter-college level) and non- sports (those who don't play any sports at all).

Hypothesis

It was hypothesised that different level of games/sports participation / non-participation will have sex difference in regard to selected autonomic function variables.

Materials and methods

Table- 1: Sample Statistics

S. No.	Level of sports	No. of samples- boys	No. of samples- girls
1	Advance Sportsperson	22	6
2	Inter-mediate Sportsperson	37	20
3	Non-sports Sportsperson	27	22

Note: Advance Sportsperson - who plays games/sports at national level; Inter-mediate Sportsperson - who plays games/sports at inter-college level; Non- Sportsperson- who don't play sports at all.

Ages of the sample ranged from 17 to 21 years of same socio-economic status belonging to different games/sports.

Students were asked to come with two hours fasting before the test. No medication was taken before 48 hours of the testing. Subjects rested for 30 minutes before the commencement of the test and then heart rate variability (HRV) was performed, which quantifies autonomic drive to the myocardium. The ECG analog were filtered and quantified using the software namely HRV Software, Biomedical Signal Analysis Group, Department of Applied Physics, University of Kupio, Finland. Variables were extracted by analysing frequency domain and time domain analysis. Both sympathetic and parasympathetic drives to myocardium were assessed by SDNN, LF (Normalized Power), LF/HF ratio, LF (Absolute power), TP (Absolute Power), NN50 count, pNN50 count, SDSD, RMSSD, HF (Normalized Power), HF (Absolute Power), and SDSD with regard to HRV variables (sympathetic and parasympathetic activity).

Collected data was computed with Mean, Standard Deviation, Levene's Test for Equality of Variances ('t' test). The hypothesis was tested at0.05 level of significance.

Results

Table-2 shows that the variable namely Mean Heart Rate (t= -2.66) found to be statistically significant (different) at .05 level between in advance sports boys and girls, whereas, variables namely SDNN (t= -0.14), RMMSD (t= .45), NN50 count (t= .02), pNN50 count (t= .44), HRV Triangular Index (t= .34), Low Frequency (Normalized Power) (t= -0.52), High Frequency (Normalized Power) (t= .06), Total (Absolute Power) (t= -0.28),LF: HF ratio (t= .82), LF (Normalized Unit) (t= 1.24) and HF (Normalized Unit) (t= -1.24) were found to be statistically indifference (Not different)at .05 level between advance sports boys and girls.

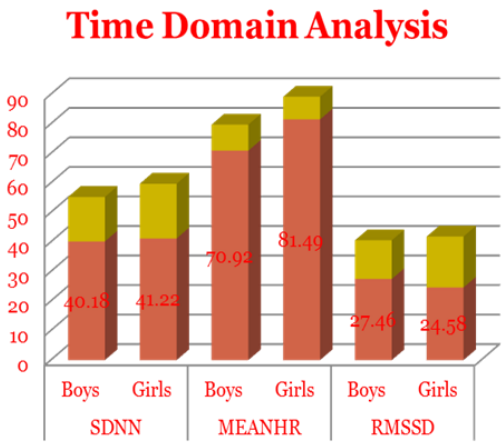
Table 2: Comparison Between (Advance Sports) and Girls (Advance Sports) in Regard to Heart Rate Variability (HRV)

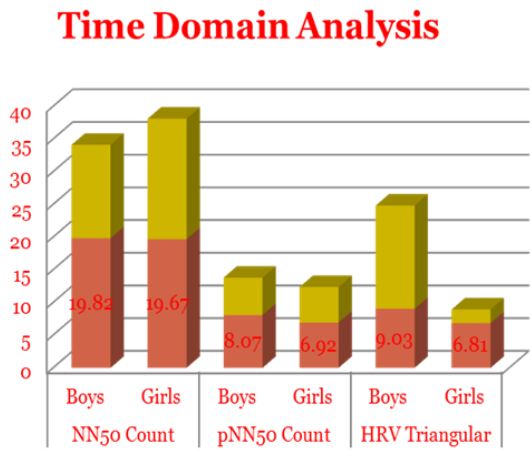
Variable		Mean	SD	Levene's test for equality of variances		MD	SED	't'	α
				F	Significance				
SDNN	Boys	40.18	15.07	0.72	0.41	-1.03	7.27	-0.14(NS)	0.89
	Girls	41.22	18.52						
MEANHR	Boys	70.92	8.82	0.03	0.86	-10.57	3.97	-2.66*	0.01
	Girls	81.49	7.69						
RMSSD	Boys	27.46	13.10	0.21	0.65	2.88	6.45	0.45(NS)	0.66
	Girls	24.58	17.27						
NN50 Count	Boys	19.82	14.29	0.43	0.52	0.15	6.99	0.02(NS)	0.98
	Girls	19.67	18.43						
pNN50 Count	Boys	8.07	5.72	0.01	0.92	1.15	2.61	0.44(NS)	0.66

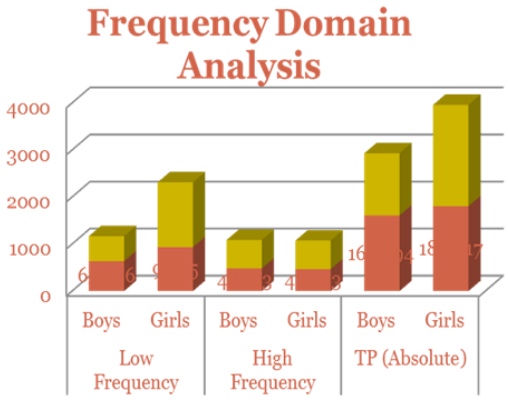
	Girls	6.92	5.43						
HRV Triangular	Boys	9.03	15.78	0.65	0.43	2.21	6.54	0.34(NS)	0.74
	Girls	6.81	2.11						
Low Frequency	Boys	635.86	531.02	5.08	0.03*	-296.64	574.80	-0.52(NS)	0.63
	Girls	932.50	1380.38						
High Frequency	Boys	481.73	603.10	0.00	0.95	16.39	278.21	0.06(NS)	0.95
	Girls	465.33	608.07						
TP (Absolute)	Boys	1606.94	1321.91	0.98	0.33	-197.22	699.21	-0.28(NS)	0.78
	Girls	1804.17	2155.36						
LF:HF	Boys	2.04	0.79	0.07	0.79	0.31	0.39	0.82(NS)	0.42
	Girls	1.72	1.00						
LF (N.U)	Boys	65.67	11.00	0.22	0.65	6.92	5.59	1.24(NS)	0.23
	Girls	58.75	16.10						
HF (N.U)	Boys	34.30	11.00	0.22	0.65	-6.92	5.59	-1.24(NS)	0.23
	Girls	41.22	16.06						

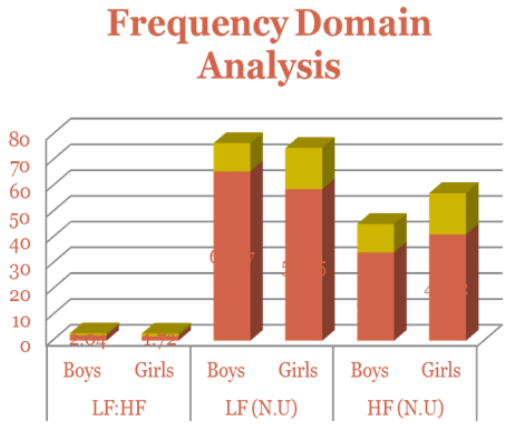
*= significant at .05 level; NS= Not significant; N= 28 (N1= Boys (Advance Sports) + N2= Girls (Advance Sports): N= N1 + N2, N1= 22, N2=6); SD-Standard Deviation; MD- Mean Difference; SED- Standard Error Difference; TP- Total Power

Graphical representation of comparison between boys (Advance Sports) and girls (Advance sports) in regard to heart rate variability (HRV)









According to table-3,variables namely SDNN (t= -0.4), Mean Heart Rate (t= -60), RMMSD (t= -21), NN50 count (t= .76), pNN50 count (t= .1), HRV Triangular Index (t= .92), Low Frequency (Normalized Power) (t= -0.89), High Frequency (Normalized Power) (t= -56), Total (Absolute Power) (t= -0.44),LF: HF ratio (t= .04), LF (Normalized Unit) (t= -.57)and HF (Normalized Unit) (t= .75) were found to be statistically insignificant (Not different) at .05 level of significance (not different) between intermediate sports boys and girls.

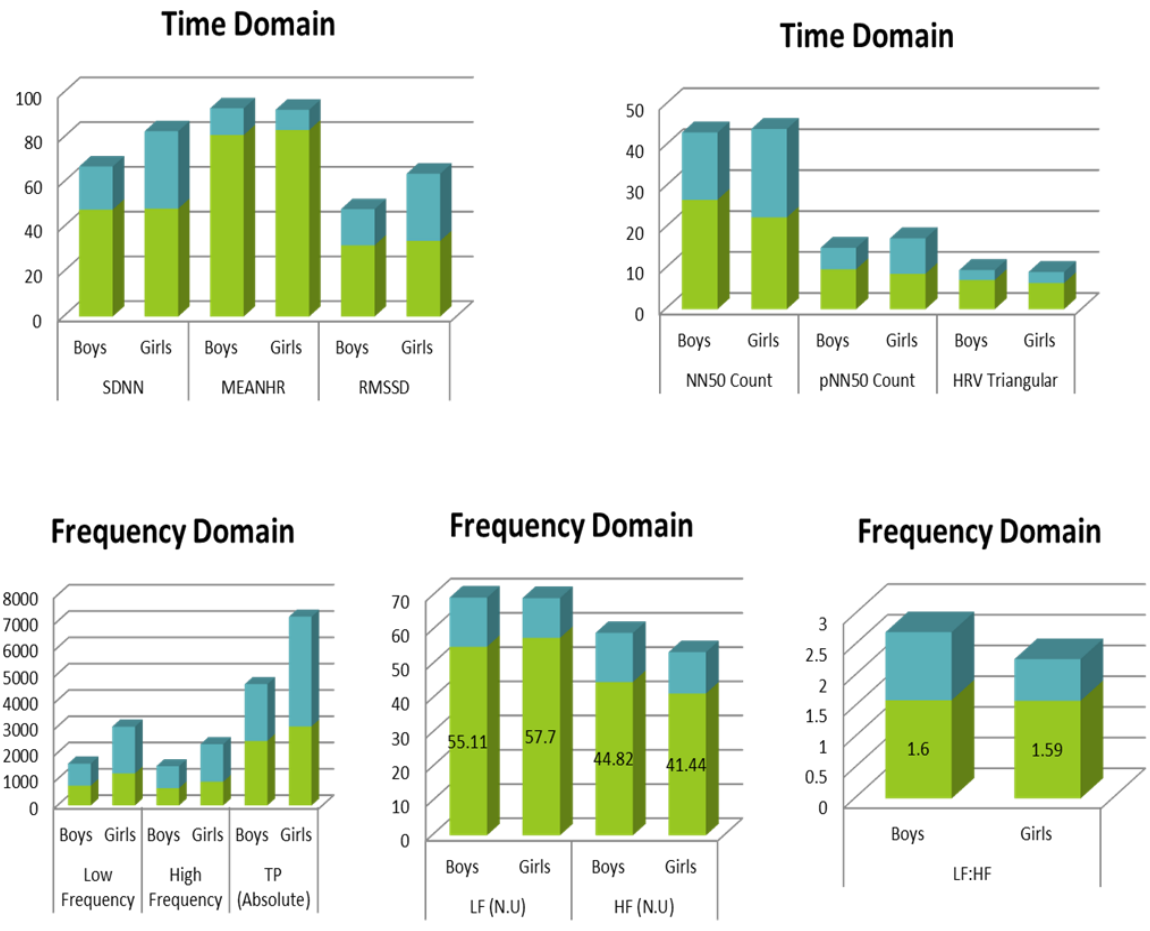
Table 3: Comparison BetweenBoys (Inter-mediate Sports) and Girls (Inter-mediate Sports) in Regard to Heart Rate Variability (HRV)

Variable		Mean	SD	Levene's test for equality of variances		MD	SED	't'	α
				F	Significance				
SDNN	Boys	47.80	19.26	6.14	0.02*	-0.40	10.41	-0.04(NS)	0.97
	Girls	48.19	34.63						
MEANHR	Boys	81.08	11.97	1.98	0.17	-2.25	3.73	-0.60(NS)	0.55

	Girls	83.33	9.09						
RMSSD	Boys	31.86	16.17	7.28	0.01*	-1.90	9.01	-0.21(NS)	0.84
	Girls	33.76	30.06						
NN50 Count	Boys	26.75	16.42	1.74	0.19	4.33	5.73	0.76(NS)	0.45
	Girls	22.42	21.63						
pNN50 Count	Boys	9.77	5.23	7.76	0.01*	1.08	2.61	0.41(NS)	0.69
	Girls	8.69	8.62						
HRV Triangular	Boys	7.14	2.42	0.91	0.34	0.74	0.81	0.92(NS)	0.36
	Girls	6.40	2.70						
Low Frequency	Boys	748.25	845.07	13.27	0.00*	-471.75	529.07	-0.89(NS)	0.39
	Girls	1220.00	1778.84						
High Frequency	Boys	657.84	836.94	4.93	0.03*	-242.83	432.55	-0.56(NS)	0.58
	Girls	900.67	1433.22						
TP (Absolute)	Boys	2457.61	2156.27	6.67	0.01*	-548.97	1247.55	-0.44(NS)	0.67
	Girls	3006.58	4172.36						
LF:HF	Boys	1.60	1.11	2.63	0.11	0.01	0.34	0.04(NS)	0.97
	Girls	1.59	0.68						
LF (N.U)	Boys	55.11	14.36	2.45	0.12	-2.59	4.51	-0.57(NS)	0.57
	Girls	57.70	11.64						
HF (N.U)	Boys	44.82	14.34	1.59	0.21	3.38	4.53	0.75(NS)	0.46
	Girls	41.44	12.09						

*= significant at .05 level; NS= Not significant; N= 57 (N1= Boys (Inter-mediate Sports) + N2= Girls (Inter-mediate Sports): N= N1 + N2, N1= 37, N2=20); SD-Standard Deviation; MD- Mean Difference; SED- Standard Error Difference; TP- Total Power

Graphical representation of comparison between boys (Inter-mediate sports) and girls (Inter-mediate sports) in regard to heart rate variability (HRV)



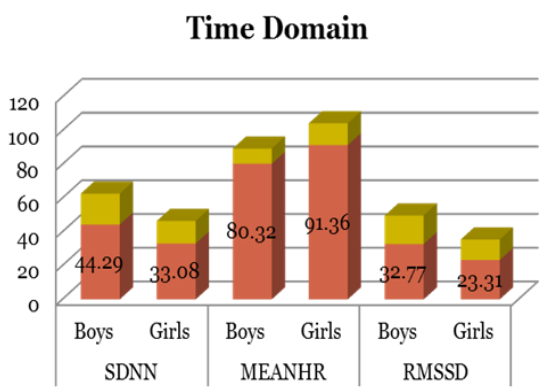
According to table-4, the variable namely SDNN (t= 2.41), Mean Heart Rate (t= -3.78), RMMSD (t= 2.21), pNN50 count (t= 2.20)and Total (Absolute Power) (t= 1.68) found to be statistically significant at .05 level of significance (different) in non- playing sports boys and girls, whereas, variables namely, NN50 count (t= 1.60), HRV Triangular Index (t= .97), Low Frequency (Normalized Power) (t= 1.19), High Frequency (Normalized Power) (t= 1.26), LF: HF ratio (t= .58), LF (Normalized Unit) (t= .7) and HF (Normalized Unit) (t= -.71) were found to be statistically insignificant (not different) at .05 level between significance in advance non-playing sports boys and girls.

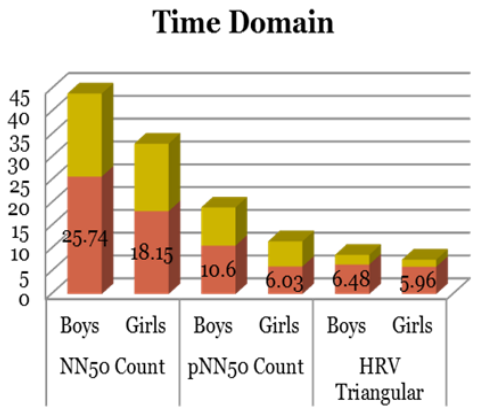
Table 4: Comparison Between of Boys (Non- Sports) and Girls (Non- Sports) in Regard to Heart Rate Variability (HRV)

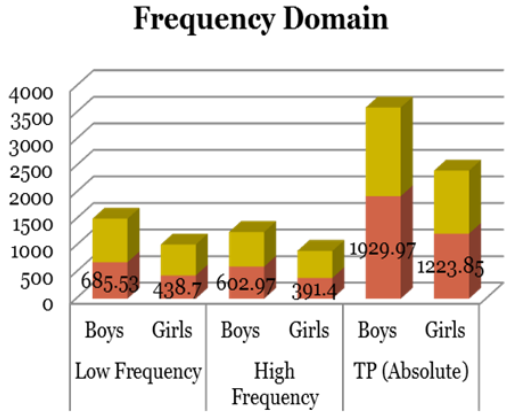
WA		Mean	SD	Levene's test for equality of variances		MD	SED	't'	α
				F	Significance				
SDNN	Boys	44.29	18.37	2.34	0.13	11.21	4.65	2.41*	0.02
	Girls	33.08	13.36						
MEANHR	Boys	80.32	9.09	3.42	0.07	-11.04	2.92	-3.78*	0.00
	Girls	91.36	12.97						
RMSSD	Boys	32.77	16.96	3.53	0.07	9.47	4.28	2.21*	0.03
	Girls	23.31	12.19						
NN50 Count	Boys	25.74	18.22	0.31	0.58	7.59	4.74	1.60(NS)	0.12
	Girls	18.15	14.82						
pNN50 Count	Boys	10.60	8.39	2.44	0.12	4.58	2.08	2.20*	0.03
	Girls	6.03	5.52						
HRV Triangular	Boys	6.48	2.11	1.07	0.31	0.52	0.54	0.97(NS)	0.34
	Girls	5.96	1.57						
Low Frequency	Boys	685.53	820.67	0.80	0.38	246.83	206.79	1.19(NS)	0.24
	Girls	438.70	583.02						
High Frequency	Boys	602.97	653.20	2.05	0.16	211.57	167.97	1.26(NS)	0.21
	Girls	391.40	508.69						
TP (Absolute)	Boys	1929.97	1670.11	2.54	0.12	706.12	420.86	1.68*	0.05
	Girls	1223.85	1187.01						
LF: HF	Boys	1.44	0.89	0.92	0.34	0.13	0.23	0.58(NS)	0.57
	Girls	1.30	0.75						
LF (N.U)	Boys	55.32	14.14	0.43	0.52	2.85	3.89	0.73(NS)	0.47
	Girls	52.47	13.96						
HF (N.U)	Boys	44.64	14.14	0.47	0.50	-2.77	3.88	-0.71(NS)	0.48
	Girls	47.41	13.91						

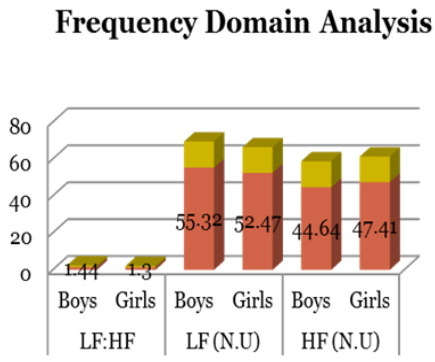
*= significant at .05 level; NS= Not significant; N= 59 (N1= Boys (Non- Sports) + N2= Girls (Non- Sports): N= N1 + N2, N1= 37, N2=22); SD-Standard Deviation; MD- Mean Difference; SED- Standard Error Difference; TP- Total Power

Graphical representation of comparison between boys (Non-sports) and girls (Non- sports) in regard to heart rate variability (HRV)









Discussion

There is now convincing evidence that some of the protective and therapeutic effects of chronic exercise training are related to the impact on the autonomic nervous system [12-14]. Additionally, training induced improvement in vascular function, blood volume expansion, cardiac remodelling, insulin resistance and renal-adrenal function may also contribute to the protection and treatment of cardiovascular, metabolic, respiratory functions and autonomic disorders. Exercise training also improves mental health, helps to prevent depression, and promotes or maintains positive self-esteem. Moderate-intensity exercise at least 30 minutes per day and at least 5 days per week is recommended for the vast majority of people. Supervised exercise training is preferable to maximize function capacity, and may be particularly important for patients with autonomic disorders [8]. Our experimental data indicate that sports activity has positive effect on heart rate and autonomic functions [9-11]. This has been demonstrated through time domain, frequency domain and respiratory variables analysis. Further the data suggests comparison between boys and girls, the girls showed significant difference in cardio functions of the students who were playing advance and intermediate sports and students not playing sports at all. The data further suggests there is significant difference in regard to autonomic functions as well as cardio functions of boys and girls playing no sports at all. The hypothesis was proven that different level of games/sports participation / non-participation hade sex difference in regard to selected autonomic function variables.

Conclusions

1. Girls are having more Mean heart ratethan that of boys as far as advance sportsperson are concerned and are found to be statistically significant at .05 level. Rest of the autonomic variables for advance sportsperson is not significant at 0.05 level of significance.
2. There was no significant difference between boys and girls of inter-mediate level in regard to variables namely SDNN, Mean Heart Rate, RMMSD, NN50 count, pNN50 count, HRV Triangular Index, Low Frequency (Normalized Power), High Frequency (Normalized Power), Total (Absolute Power),LF: HF ratio, LF (Normalized Unit) and HF (Normalized Unit)at 0.05 level of significance.
3. There was significant difference between boys and girls of non- sportsperson level in regard to the variables namely SDNN, Mean Heart Rate, RMMSD, pNN50 count and Total (Absolute Power). Rest of the autonomic variables for advance sportsperson is not significant at 0.05 level of significance.

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