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COMPARISON OF ANTHROPOMETRIC PARAMETERS, HEART RATE VARIABILITY AND RESTING BLOOD PRESSURE AMONG ATHLETES

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ABSTRACT

Aim: To compare and assess the anthropometric parameters, heart rate variability and resting blood pressure among athletes in Puducherry. **Materials and Method:** This study was conducted in the Department of Anatomy and Physiology, JIPMER, Puducherry. 60 participants [(athletes (n=45), non –athletes (n=15)] were recruited. Parameters such as height, weight, waist /hip ratio, BMI, skin fold measurements, body fat% (BF%) and Lean body mass, Heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP), mean arterial pressure (MAP), rate pressure product (RPP), Pulse pressure (PP) along with short term Heart rate variability (HRV) parameters such as Time domain [RMSSD, NN50, pNN50] and frequency domain parameters [Total power (TP), Low frequency (LF), High frequency (HF), normalized LF (LFnu), normalized HF (HFnu)] were measured. **Results**: Our study observed significant decrease in mean body weight (63.33±5.26) and BF% (10.13±1.91) in athletes when compared to non-athletes. We also observed significantly lesser resting DBP (70), HR (65.69±6.14), MAP (85.84±6.43) and RPP (8128±876) in athletes. Significant decrease in HR and DBP demonstrates better adaptability and more influence on parasympathetic activity. HRV analysis demonstrated an increased in RMSSD (68.94±41.9), SDNN (58.20±31.62) and pNN50 along with higher TP (2021), HFnu (58.24±16.94) and decreased LFnu (40.80) and LH/HF (0.68) in athletes. Increased TP in athletes shows better ability of Autonomic modulation. RMSSD, SDNN, HFnu indicates better parasympathetic tone and lower LFnu indicates decreased sympathetic activity in athletes. **Conclusion:** Athletes had better body compostion marked by lesser BF% and had significantally better sympatho-vagal balance than Non-athletes.

KEYWORDS: Heart rate variability, physical activity, anthropometric parameters, autonomic tone.

INTRODUCTION

Long term structured physical activity brings about significant changes in the body composition and cardiovascular system, both at the structural and functional level, thereby influencing the autonomic nervous system. Some studies have shown that lower physical fitness is strongly associated with risk for developing cardiovascular disease[1,2,3] hypertension,[4] and type 2 diabetes mellitus.[5] Structured physical activity leads to lesser resting heart rate and blood pressure and thereby increasing the parasympathetic activity.[6] Body composition plays a major role in assessing the effects of training and the competitive performance in athlete.[7] Moreover the body composition of our Indian population varies significantly when compared to that of the western data.[8,9] Heart rate variability (HRV), the beat-to-beat alteration in heart rate, is a non-invasive indicator of autonomic activity.[10] Structured physical activity not only decelerates the aging process, but also improves the HRV, thereby increasing the vagal tone. Higher HRV is an indicator of better adaptability and efficient autonomic activity while lower HRV is associated with increased risk of cardiac ailments.[11,12] Spectral analysis of HRV, which is a widely employed and recommended method[13] is used to measure the normalised high-frequency power, reflecting the parasympathetic system, and the ratio of low-to-high frequency band powers, which indicates the sympathetic balance. Hence, our study was aimed to study the effect of athletic level physical activity on the anthropometric parameters, heart rate variability and resting blood pressure among athletes in a South Indian population and compare it with non-athletes.

MATERIALS AND METHOD

Study design and participants

The study commenced after obtaining approval from the JIPMER Scientific Advisory Committee and JIPMER Institute Ethics Committee for human studies. Participants for the athlete group was recruited based on the American College of Sports Medicine (ACSM) recommendations. Active men, from Sports Athority of

India, Puducherry, who play or train for 30 – 40 mins/day for 4-5 days/week and had represented State or National level events and in the age group between 18 – 30 were recruited into the Athlete group (n=45). Men who are not individualized in any regular form of physical activity training, but may practice recreational exercise with BMI between 18 -25, in the same age group were recruited as Non-athletes (n=15). After explaining the study procedure, written consent from the participants was obtained.

Anthropometric measurements

All the parameters were recorded in the Obesity Research lab, Department of Physiology, JIPMER, Puducherry, between 8 AM to 11 AM. Participants were asked to refrain from heavy physical activity for 24 hours and from consumption caffeinated beverages or any stimulant drinks for 12 hours before the recording. Anthropometric measurements were measured by following the instructions given in the Heath-Carter Anthropometric Somatotype Instruction Manual [14]. Height was measured using a wall-mounted stadiometer accurate to the nearest 0.1 cm. Weight using a digital weighing scale accurate to the nearest 0.1 kg with minimal clothing. Waist and Hip circumference was measured using flexible tape. Skinfold thickness was measured from four sites (triceps, subscapular, supraspinale, and abdomen) on the right side, using a Harpenden skinfold Caliper. All measurements were taken thrice, accurate to the nearest 0.1 mm, and the average of the three recordings was used for analysis. Body fat % was calculated using Jackson and Pollock's 4 site skin fold equation[15], Lean mass was calculated using the formula:

Lean mass= Weight in Kg x (1.0 – (Body fat%/100)).

Blood pressure measurement

Heart Rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) was recorded in the sitting posture three times after a period of comfortable rest, with 5-minute interval between the recordings. Automated BP monitor, Omron, HEM 7203 model (omron Healthcare Co., Kyoto, Japan) was used for the recording. The average of these three recordings was taken as final. Rate Pressure product (RPP) and Mean arterial pressure (MAP) was calculated using the formula,

RPP=SBP x HR.

MAP= ((2*dbp) +sbp) /3

HRV recording

Short term HRV was recorded following the recommendations of the Task Force on HRV.[16] After ten miutes of supine rest, lead II ECG was acquired using Bioharness,at the rate of 200 samples/second for 10 minutes. The artefacts and ectopic from the RR interval series were excluded. Five-minute RR interval series was selected and analysed for HRV using Kubios HRV (Version 2.0 software,Bio-signal analysis Group, Finland. The frequency spectrum components were analysed using fast Fourier transformation and the results were given as spectral power in ms^2. The frequency spectrum parameters such as Total spectral power, Very low frequency (VLF: 0.003 Hz to 0.04 Hz), low frequency (LF: 0.04 Hz to 0.15 Hz) and high frequency (HF: 0.15 Hz to0.4 Hz) were obtained. Calculated parameters like normalized units of low frequency power (LFnu = LF X 100/ (TP–VLF), normalized units of high frequency power (HFnu = HF X 100/ (TP–VLF) and LF/HF ratio (ratio of LF power to HF power) were obtained.[17] Time domain components were analysed for the RR time interval and the results were given as the standard deviation of RR intervals (SDNN), root mean square of successive RR intervals (RMSSD), successive RR interval differing more than 50 ms (NN50).

Statistical analysis

Continuous variables such as age, BMI, Anthropometric parameters, Heart rate variability and blood pressure were expressed as Mean with Standard deviation or Median with a range based on the normality of the data. The Normality of the distribution was tested by using the Kolmogorov Smirnov test. The comparison of Anthropometric parameters, Heart rate variability and blood pressure between the groups was carried out by using Independent student's t test or Mann Whitney U test. The linear relationship of Anthropometric parameters, Heart rate variability and blood pressure with age, BMI and Body fat was carried out by using Pearson's and Spearman's correlation analysis. All statistical analysis was carried out at 5% level of significance and P<0.05 was considered as significant.

RESULTS

The autonomic function was assessed by the time domain (SDNN, RMSSD, pNN50 and Mean HR), frequency domain (HF, LF, LFnu, HFnu, TP and LF/HF) and blood pressure (SBP, DBP, MAP, RPP, PP) variables. The body composition parameters like BMI, BF%, Lean mass, waist/hip ratio, were also evaluated. Anthropometric parameters (Table1) showed statistically significant difference between athletes and non-athletes for the body height (P<0.05), BF % (P<0.01) and BMI (P<0.01) but not for body weight and lean body mass.

Table 1: Comparison of Anthropometric parameters between athletes and non-athletes.

Variables	Athletes(n=45) Mean±S.D.	NonAthletes (n=45) Mean±S.D	P value
Age(years)	22.11±4.09	23±3.65	0.459
Height(cms)	175.16±8.07	167±8.33	0.003
Weight(kgs)	63.33±5.26	66.13±5.47	0.082
B.F.%	10.13±1.91	16.34± 2.58	0.000

Lean body mass	60.93± 7.70	57.98± 8.4	0.244
WHR	0.84 ± 0.40	0.88 ± 0.24	0.001
BMI(kg/m^2)	20.698± 1.80	23.52± 1.17	0.000

Data presented here are in Mean± S.D. (P<0.05) was considered stastically significant. WHR- Waist Hip Ratio. BMI- Body Mass Index.

Results from table 2 shows that, athletes displayed significant decrease in HR(65.69±6.14), DBP(70), MAP(85.84±6.43), RPP(8128±876) with P<0.05. In Time domain indices of HRV there was a significant increase in SDNN (58.20±31.62), RMSSD (68.94±41.9), NN50(121), pNN50 (36.80) with P<0.05. In frequency domain parameters, athletes recorded a much higher TP, VLF, LF, HF and HFnu (p<0.05) Significantly lower LFnu and LF/HF ratio was also observed in athletes compared to non-athletes.

Table 2: Comparison of Blood pressure and HRV indices between athletes and non-athletes.

Variables	Athletes(n=45) Mean±S.D.	NonAthletes (n=45) Mean±S.D	P value
HR(/min)	65.69± 6.14	70.06± 6.70	0.036
SBP(mmHg)	120*	120*	0.589
DBP(mmHg)	70*	75*	0.003
MAP	85.84± 6.43	90.42 ±5.89	0.018
RPP(mmHg/min)	8128.49 ±876.27	8444±895.76	0.246
PP	50*	46*	0.145
SDNN	58.20 ±31.62	31.16 ±17.30	0.003
RMSSD(ms)	68.94 ±41.9	24.03± 13.07	0.000
NN50	121*	4*	0.000
pNN50	36.80*	4*	0.000
TP(ms^2)	2021*	1551*	0.001
VLF(ms^2)	69*	142*	0.044
LF(ms^2)	752*	238*	0.002
HF(m^2)	1163*	138*	0.000
LFnu	40.80*	60.20*	0.000
HFnu	58.24± 16.94	36.62 ±15.10	0.000
LF/HF	0.68*	1.44*	0.000

Data expressed are Mean±SD, * -Median. P<0.05 was considered statistically significant. HR- Heart rate. SBP- Systolic blood pressure, DBP- Diastolic blood pressure, MAP –Mean arterial pressure, RPP- Rate pressure product, PP- Pulse pressure, SBNN- Standard deviation of normal to normal interval, RMSSD-The square root of the mean of the sum of the squares of normal interval, NN50 –The number of interval differences of successive NN interval>50, pNN50 – The proportion derived by dividing NN50 by the total number of NN intervals. TP- Total power, LF- Low frequency power, HF- High frequency power, LFnu- Normalised LF power, HFnu- Normalised LF Power, LF/HF- Ratio of LF to HF power.

Pearson's and Spearman's Correlation analysis (table 3) revealed significant correlation of. BF% and BMI only for HF power (P<0.05). No significant correlation was observed in non- athletes with respect to BF% and BMI (table 4).

Table 3: Correlation of Body fat%, and BMI with Heart rate variability indices of athletes.

Variables	BF(N=45)		BMI (N=45)	
	Correlation	Statistical Significance	Correlation	Statistical Significance
SDNN¥	-.136	.373	-.089	.560
RMSSD¥	-.182	.232	-.111	.469
NN50¥	-.256	.090	-.159	.298
PNN50¥	-.264	.080	-.170	.264
TP□	-.254	.092	-.281	.062
VLF□	-.262	.082	-.208	.171
LF□	-.188	.216	-.285	.058
HF□	-.323*	.030	-.295*	.049
LFnu¥	.197	.195	.101	.509
HFnu¥	-.251	.096	-.139	.363
LF_HF□	.285	.058	.185	.223

*- Correlation is significant at the 0.05 level of significance

¥ - Pearson correlation; □ - Spearman correlation

Table 4: Correlation of Body fat%, and BMI with Heart rate variability indices of non- athletes.

Variables	BF(N=15)		BMI (N=15)	
	Correlation	Statistical Significance	Correlation	Statistical Significance
SDNN¥	.340	.215	.008	.978
RMSSD¥	.312	.257	.014	.960
NN50¥	.317	.249	-.023	.935
PNN50¥	.315	.254	-.015	.958
TP□	.193	.491	-.113	.689
VLF□	.232	.405	-.309	.262
LF¥	.312	.258	.100	.723
HF□	.011	.970	-.340	.216
LFnu□	-.039	.889	.236	.397
Hfnu¥	.027	.925	-.271	.328
LF_HF¥	.149	.597	.206	.461

*.- Correlation is significant at the 0.05 level of significance
¥ - Pearson correlation; □ - Spearman correlation

DISCUSSION

Our study demonstrates that there was a decrease in body weight and BF% in athletes when compared to that of non-athletes. This observation goes in accordance with a study which has demonstrated that, PA positively affects body composition and produce statistically significant changes in body fat percentage.[18,19] This significant reduction in BF% could be due to the rigorous PA by the athletes. We observed a significant decrease in DBP, HR, MAP and RPP, in athletes compared to that of non-athletes. Similar results were also observed in earlier studies which found a significant decrease in BP and HR.[20] Resting HR is mainly determined by the parasympathetic nervous system (PNS) and DBP which are the function of peripheral vascular resistance (PVR).[21] Decrease in HR and DBP demonstrates a better adaptability and more influence on parasympathetic activity, thereby indicating an improved autonomic tone.[22] MAP refers to the mean arterial pressure throughout the cardiac cycle. In our study the athletes exhibited a decrease in DBP, MAP, and HR, which indicates an increase in parasympathetic actaivity and decrease in sympathetic activity. When compared to non-athletes, athletes had better PP which is an indication of better tissue perfusion.[23-24] In our study the athletes exhibited decreased sympathetic activity and an increased parasympathetic activity, indicating a better parasympatho-dominance.

Athletes displayed higher RMSSD, SDNN and pNN50 in time domain analysis of HRV. In frequency domain analysis, higher TP, HFnu and a lower LFnu and LH/HF ratio was observed. This goes in concordance with a study in athletes of different sports, which has demonstrated that athletes exhibit a better HRV and parasympathetic cardiac adaptation.[25-26] Higher TP in athletes is indicative of a better Autonomic modulation. Higher RMSSD, SDNN, HFnu indicates better parasympathetic tone and lowers LFnu indicates decreased sympathetic activity in athletes. Few studies didn't find this positive effect on the autonomic modulation.[27-30] Our study demonstrates that, athletes had better autonomic tone marked by parasympathetic dominance which enabled them to undergo physical challenges in a better way when compared to non-athletes. In athletes, the sympathovagal balance was altered in response to different intensities and duration of aerobic training. Overall, our study demonstrates that athletes had better anthropometric and autonomic tone, which can be attributed to the physical training they undergo. Hence our study recommends that the PA is beneficial for our overall health.

CONCLUSION

Our study demonstrates that structured physical activity leads to better body composition and better sympathovagal balance, enabling athletes to meet physiological challanges in a better way than non-athletes.

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REFERENCES

1. Blair SN, Cooper KH, Gibbons LW, et al. Changes in coronary heart disease risk factors associated with increased treadmill time in 753 men. Am J Epidemiol, 1983; 118: 352–9.
2. Felton GM, Dowda M, Ward DS, et al. Differences in physical activity between black and white girls living in rural and urban areas. J Sch Health, 2002; 72: 250–5.
3. Gutin B, Yin Z, Humphries MC, et al. Relations of body fatness and cardiovascular fitness to lipid profile in black and white adolescents. Pediatr Res, 2005; 58: 78–82.
4. Blair SN, Goodyear NN, Gibbons LW, et al. Physical fitness and incidence of hypertension in

healthy normotensive men and women. JAMA, 1984; 252: 487–90.
5. Sawada SS, Lee IM, Muto T, et al. Cardiorespiratory fitness and the incidence of type 2 diabetes: prospective study of Japanese men. Diabetes Care, 2003; 26: 2918–22.
6. Tulppo MP, Hautala AJ, Makikallio TH, Laukkanen RT, Nissila S, Hughson RL, Huikuri HV: Effects of aerobic training on heart rate dynamics in sedentary subjects**.** J Appl Physiol, 2003: 95(Suppl 1): 364–72.
7. Sinning, Wayne E. "Body composition and athletic performance." Limits of human performance. The academy papers, 1985; 18: 45-56.
8. Huxley R, James WP, Barzi F, Patel JV, Lear SA, Suriyawongpaisal P, et al. Ethnic comparisons of the cross-sectional relationships between measures of body size with diabetes and hypertension. Obes rev, 2008(Mar9); Suppl(1): 53-61.
9. Misra A, Khurana L. Obesity-related non-communicable diseases: South Asians vs White Caucasians. Int J Obes, 2011; 35(2): 167-87.
10. Berntson GG, Bigger JT, Jr, Eckberg DL, et al. Heart rate variability: origins, methods, and interpretive caveats. Psychophysiology, 1997; 34(6): 623–48.
11. Yeragani VK, Rao KA, Pohl R, Jampala VC, Balon R. Heart rate and QT variability in children with anxiety disorders: a preliminary report. Depression anxiety, 2001; 13(2): 72–7.
12. Longin E, Dimitriadis C, Shazi S, Gerstner T, Lenz T, Konig S. Autonomic nervous system function in infants and adolescents: impact of autonomic tests on heart rate variability. Pediatr Cardiol, 2009; 30(3): 311–24.
13. Fallen EL, Kamath MV, Ghista DN. Power spectrum of heart rate variability: a non-invasive test of integrated neurocardiac function. Clin Invest Med, 1988; 11(5): 331–340.
14. Carter JEL. Part 1: The Heath-Carter Anthropometric Somatotype-Instruction Manual, 2002.
15. Jackson, A. S., & Pollock, M. L. Generalized equations for predicting body density of men. British Journal of Nutrition, 1978; 40: 497-504.
16. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology,Heart rate variability: standards of measurement, physiological interpretation and clinical use. Circulation, 1996; 93(5): 1043–65.
17. Sharma VK, Subramanian SK, Arunachalam V, Rajendran R. Heart Rate Variability in Adolescents – Normative Data Stratified by Sex and Physical Activity. J Clinical Diag Res: JCDR, 2015; 9(10): CC08-CC13.
18. Lazaar N, Aucouturier J, Ratel S, Rance M, Meyer M, Duché P**.** Effect of physical activity intervention on body composition in young children: influence of body mass index status and gender. Acta Paediatr, 2007 Sep; 96(9): 1315-20.
19. Willis LH, Slentz CA, Bateman LA, Shields AT, Piner LW, Bales CW, Houmard JA. Kraus WE of aerobic and/or resistance training on body mass and fat mass in overweight or obese adults. J Appl Physiol, 2012 Dec15; 113(12): 1831-7.
20. Sharma VK, Trakroo M, Subramaniam V, Rajajeyakumar M, Bhavanani AB, Sahai A. Effect of fast and slow pranayama on perceived stress and cardiovascular parameters in young health-care students. Int J Yoga, 2013; 6: 104-10.
21. Hermida RC, Fernández JR, Ayala DE, Mojón A, Alonso I, Smolensky M. Circadian rhythm of double (rate-pressure) product in healthy normotensive young subjects. Chronobiol Int, 2001; 18: 475-89.
22. Kitamura K, Jorgensen CR, Gobel FL, Taylor HL, Wang Y. Hemodynamic correlates of myocardial oxygen consumption during upright exercise. J Appl Physiol, 1972; 32: 516-22.
23. Holmberg S, Serzysko W, Varnauskas E. Coronary circulation during heavy exercise in control subjects and patients with coronary heart disease. Acta Med Scand, 1971; 190: 465-80.
24. Madanmohan, UdupaK, BhavananiAB, ShatapathyCC, SahaiA. Modulation of cardiovascular response to exercise by yoga training. Indian J Physiol Pharmacol, 2004; 48: 461-5.
25. Mourot L, Bouhaddi M, Tordi N, Rouillon JD, Regnard J. Short- and long-term effects of a single bout of exercise on heart rate variability: Comparison between constant and interval training exercises. Eur J Appl Physiol, 2004; 92: 508–17.
26. Vanderlei LC, Silva RA, Pastre CM, Azevedo FM, Godoy MF. Comparison of the Polar S810i monitor and the ECG for the analysis of heart rate variability in the time and frequency domains. Braz J Med Biol Res, 2008; 41: 854–9.
27. Migliaro ER, Contreras P, Bech S, et al. Relative influence of age, resting heart rate and sedentary life style in short-term analysis of heart rate variability. Braz J Med Biol Res, 2001; 34(4): 493-500.
28. Uusitalo AL, Tahvanainen KU, Uusitalo AJ, et al. Non-invasive evaluation of sympathovagal balance in athletes by time and frequency domain analyses of heart rate and blood pressure variability. Clin Physiol, 1996; 16(6): 575-88.
29. Stein R, Medeiros CM, Rosito GA, et al. Intrinsic sinus and atrioventricular node electrophysiologic adaptations in endurance athletes. J Am Coll Cardiol, 2002; 39(6): 1033-8.
30. Catai AM, Chacon-Mikahil MP, Martinelli FS, et al. Effects of aerobic exercise training on heart rate variability during wake-fulness and sleep and cardiorespiratory responses of young and middle-aged healthy men. Braz J Med Biol Res, 2002; 35(6): 741-52.