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Abnormal sympathetic functioning is linked to familial hypertension in nonathletic young males

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Abstract:

BACKGROUND: Sympathetic overactivity mediates abnormal cardiovascular outcome that is affected by stress, lack of physical activity (PA), and familial hypertension (HTN). It can be assessed by blood pressure-based sympathetic function tests.

OBJECTIVE: We studied sympathetic function tests in young nonathletic males in relation to measures of obesity, PA, and familial HTN.

METHODOLOGY: We recruited 100 males (mean age: 19 years) and measured body mass index (BMI) and body composition parameters by tetrapolar bioelectrical impedance such as total body fat, visceral fat, subcutaneous fat, and skeletal muscle mass. Using instrument cardiac autonomic neuropathy system of Recorders and Medicare System Company, India, blood pressures (supine, standing, and post hand grip) were recorded and studied quantitatively and qualitatively.

RESULTS: Physically active and inactive individuals (n = 50 each) had comparable age, BMI, measures of obesity, and sympathetic function tests. However, individuals with familial HTN (n = 37) showed significantly higher obesity measures and blood pressures (supine: systolic blood pressure [SBP] – 133 vs. 115 and diastolic blood pressure [DBP] – 79 vs. 76; standing: SBP – 136 vs. 122 and DBP – 80 vs. 76; post hand grip: SBP – 136 vs. 125 and DBP – 86 vs. 81). Qualitatively, postural hypotension was seen in only two individuals, while worst grading was in post hand grip test significantly and more so in physically inactive group (30%, 28%, and 42% vs. 16%, 20%, and 64%) and individuals with positive familial HTN (32%, 38%, and 30% vs. 17%, 13%, and 70%).

CONCLUSION: Familial HTN, but not physical inactivity, affects sympathetic functioning in nonathletic young male medical personnel. It asks for other lifestyle modifications for better cardiovascular health as primary prevention.

Keywords:

Blood pressure, family history, hypertension, physical activity, sympathetic

Introduction

With decline in communicable diseases, global focus is now shifted to noncommunicable diseases which are aftermaths of civilized culture.[1] Our cardiovascular system is governed by autonomic nervous system, and sympathetic overdrive is known to be a cardiac risk factor.[2] Stress,[3] physical inactivity,[4] and family history of hypertension (HTN)[5] can increase sympathetic tone, which can be judged by simple sympathetic function tests.[6] Measurement of heart rate and blood pressures is a simple parameter wherein former is the index of parasympathetic tone[7] and latter is the index of sympathetic tone.[8] These simple measures can easily reveal the picture that can give proof linking beneficial effect of physical activity (PA) on cardiovascular health as indicated by autonomic balance. Hence, we compared blood pressure-based sympathetic function tests between physically active and sedentary 18–35 years aged individuals.

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Methodology

Study type and subjects

We conducted a cross-sectional study in clinical research laboratory of the physiology department of our medical college. Prior approval was taken from the institutional review board of our college and permission was taken from the physiology department of our college. Written informed consent was taken from participants undergoing study, and they were informed about benefit, objectivity, and aim of this study. Case group had 50 young athletic males, enrolled from our institute, doing minimum 5 h of moderate exercise in a week. Control group had 50 young sedentary males, enrolled from our institution, not involved in active exercise and living sedentary lifestyle.

Inclusion and exclusion criteria

We included male participants with known status of familial HTN, ready for written informed consent, aged between 18 and 35 years, without any medical or drug history. All cases were doing at least 5 h of regular moderate exercise in a week and controls were not. We excluded participants who were trained athletic individuals, not giving written informed consent, not knowing familial HTN status, known to have cardiovascular disease (CVD), addict to substance abuse or taking any medications affecting autonomic nervous system, and using any other lifestyle interventions such as yoga and meditation.

Assessment of body composition

A digital, portable noninvasive instrument Omron Karada Scan (Body Composition Monitor, Model HBF-510, Omron Healthcare Singapore Pvt. Limited, China) working on the principle of tetrapolar bioelectrical impedance analysis (BIA) was used. After entering age, gender, and height taken by standiometer, instrument was calibrated and a participant was allowed to stand on the instrument. It passes electric current of 500 μA at frequency 5 kHz to scan the whole body to derive regional body composition. BIA displays body weight (kg), body mass index (BMI), total body fat (TBF) %, visceral fat (VF) %, subcutaneous fat (SF), and skeletal muscle mass (SkMM).

Sympathetic function tests

We used cardiac autonomic neuropathy (CAN) system instrument of Recorders and Medicare Systems Pvt. Ltd., India. It is a computer-based CAN analysis system with interpretation. It measures:

1. Resting systolic blood pressure (SBP) and diastolic blood pressure (DBP): A participant is given 5-min rest and then SBP and DBP measurement is done in the right brachial artery by instrument only
2. SBP and DBP fall in response to standing: After recording resting BP, a participant stands unaided and immediately next BP measurement is done
3. Rise in DBP in response to isometric exercise handgrip test
4. A participant generates a maximum handgrip with handgrip dynamometer. Thereafter, 30% of maximum value is sustained for a period of time or until exhaustion, 1 min. Moreover, at the end of exercise, post test BP measurement is done
5. Grading of postural hypotension – Grades 0, 1, and 2 based on supine to standing blood pressure changes
6. Grading of post hand grip test blood pressure changed – Grades 0, 1, and 2 based on blood pressure changes after as compared to before sustained hand grip isometric exercise.

Statistical analysis

The data were expressed as mean ± standard deviation for quantitative variables and as number (percentage) for categorical variables. All calculations were accomplished by GraphPad InStat 3 software (demo version free software of GraphPad Software, Inc., California, USA). Observed difference in mean distribution of quantitative variables was compared by Student's *t*-test or Mann–Whitney U-test. Categorical data were tested for significant difference in distribution between groups by Chi-square test. Any observed difference was considered statistically significant with $P < 0.05$.

Results

There were equal numbered physically active and inactive males and former group chose cricket, body building, cycling, walking, and other sports [Figure 1]. None of the participants was involved in competitive sports or taking training as athlete. These groups had comparable age (mean: 19 years), height, weight, BMI (mean: 21 kg/m^2), and heart rate (mean: 79 vs. 81). Physically active individuals had slightly better body composition profile

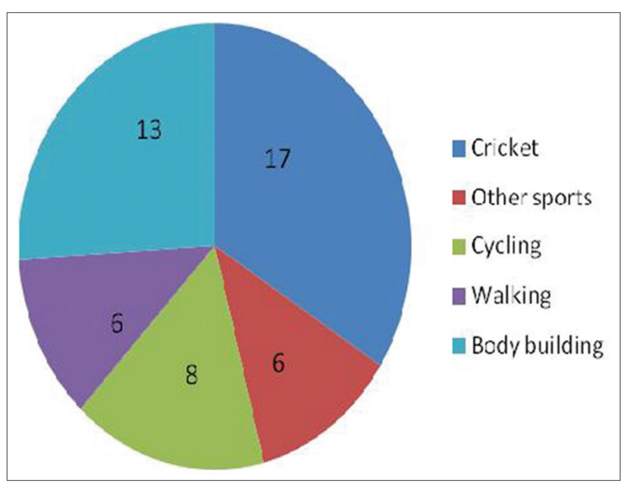

Figure 1: Distribution of physical activity in physically active group

and blood pressure results of sympathetic function testing, but except TBF (17% vs. 20%), all were statistically insignificant. Subgroup with positive family history of HTN (FH+, n = 37) was comparable to subgroup with negative family history of HTN (FH−, n = 63) in age and heart rate. FH − group had significantly better obesity measures than FH + group (weight – 59 vs. 68 kg, BMI – 20 vs. 24 kg/m^2, TBF – 17 vs. 21%, VF – 7 vs. 5%, SF – 12 vs. 15%, and SkMM – 36 vs. 34%). As compared to FH − group, FH + group had more adverse blood pressures (supine: SBP – 133 vs. 115 and DBP – 79 vs. 76; standing: SBP – 136 vs. 122 and DBP – 80 vs. 76; post hand grip: SBP – 136 vs. 125 and DBP – 86 vs. 81) and rate pressure product (105 vs. 93) [Table 1].

Qualitative analysis of grading for sympathetic function test was done during change in posture from supine to standing and following isometric hand grip (IHG) test. All but two participants were free from postural hypotension (Grade 0), and these two participants were physically inactive having positive family history of HTN. Post hand grip test revealed sympathetic dysfunction to be more in physically inactive than active individuals (Grade 0 – 30% vs. 16%, Grade 1 – 28% vs. 20%, and Grade 2 – 42% vs. 64%) and in FH + group than FH − group (Grade 0 – 17% vs. 32%, Grade 1 – 13% vs. 38%, and Grade 2 – 70% vs. 30%), and these were statistically significant differences [Table 2].

Discussion

Self-reported moderate PA proved insignificant for sympathetic functioning, as assessed by blood pressure-based tests, among medical professionals. Other studies, done mostly in general population, contradict to this and mostly, highlight lesser sympathetic tone in individuals with active than sedentary lifestyle.[9-11] This contrast can be due to few facts. First, we included only male participants.[12] Middle-aged males tend to have more sympathetic control of cardiovascular system than females who have more of a parasympathetic control. This gender bias is absent after 50 years. Second, mean age was 19 years which may deny assessment of effect of aging.[13] Autonomic tone is better in young individuals, and hence, postural sympathetic response was normal in all but 2 out of 100 participants. Third, physically active participants were not trained athletes. It is only strenuous anaerobic variety of exercise which can turn vagal tone to sympathetic tone at rest[14] and moderate exercise is not harmful in this regard. Even participants doing moderate exercise had near-normal sympathetic tone, and this is in line with recommended intensity for healthy heart.[15] Severe high-intensity anaerobic exercises rather impose a risk responsible for sudden cardiac death as previously documented.[16] Fourth, all participants were exposed to mental stress of medical profession[17] which may overshadow the impact of PA or inactivity. Parameters of body composition were not significantly better with PA. It can be due to lack of lifestyle modification apart from irregular PA and stressful way of living. Diet, sleep, salt intake, and other variables can blunt the benefits of moderate PA in young individuals.

Positive family history of HTN imposed higher blood pressures (supine, standing, and post handgrip) and higher rate pressure products despite comparable heart rate. This sympathetic dysfunction is known and supported by other studies.[18-20] Such difference at age <35 years also underscores onset of early cardiovascular aging in individuals with familial HTN.

Table 1: Baseline and clinical parameters (mean±standard deviation) of whole study group and subgroups stratified by physical activity or family history of hypertension

Parameter	Whole group (n=100)	PA+ (n=50)	PA− (n=50)	P	FH+ (n=37)	FH− (n=63)	P
Age	19.29±2.41	19.40±2.37	19.28±2.3	0.80	19.43±1.88	19.43±2.53	0.46
Height	169.78±7.84	169.74±7.8	169.51±7.77	0.88	166.82±9.94	170.35±6.32	0.35
Weight	62.45±13.31	61.73±12.81	62.79±13.67	0.69	68.35±12.39	58.98±12.69	0.0005*
BMI	21.48±4.35	21.27±4.3	21.67±4.5	0.65	23.58±4.19	20.25±3.98	<0.0001*
TBF	18.07±7.07	16.88±6.31	19.61±7.33	0.049*	20.99±7.07	16.59±6.76	0.002*
VF	5.13±4.10	5.83±3.46	5.4±4.6	0.60	6.68±4.35	4.33±3.77	0.001*
SF	12.85±4.98	12.2±3.93	13.66±5.68	0.14	14.78±4.73	11.96±5.18	0.001*
SkMM	35.37±3.62	35.68±2.83	34.97±4.20	0.32	34.31±4.57	35.89±2.90	0.001*
HR	80.08±10.12	78.74±9.78	81.42±10.39	0.19	79.46±10.57	80.44±9.92	0.64
Supine-SBP	121.60±11.4	121.9±11.4	121.3±11.52	0.79	132.76±8.51	115.05±6.91	<0.0001*
Supine-DBP	76.9±8.31	76.08±8.27	77.64±8.36	0.35	79.43±6.86	75.35±8.76	0.006*
Standing-SBP	126.91±12.03	126.52±12.6	127.3±11.53	0.75	135.59±9.55	121.81±10.33	<0.0001*
Standing-DBP	77.8±8.35	77.92±8.9	77.68±7.85	0.89	80.43±7.16	76.26±8.66	0.015
PHG-SBP	129.02±11.65	128.5±11.6	129.54±11.8	0.66	136.11±8.70	124.86±11.19	<0.0001*
PHG-DBP	89.35±63.60	82.06±7.20	83.24±8.94	0.69	85.95±8.55	81.19±7.24	0.69
RPP	97.26±14.64	95.91±14.59	98.61±14.71	0.35	105.32±14.39	92.53±12.66	<0.0001*

*Statistical significance. PA+=Physical activity present, PA−=Physical activity absent, FH+=Family history present, FH−=Family history absent, BMI=Body mass index, TBF=Total body fat, VF=Visceral fat, SF=Subcutaneous fat, SkMM=Skeletal muscle mass, HR=Heart rate, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, PHG=Posthandgrip, RPP=Rate pressure product

Table 2: Qualitative comparison of sympathetic functioning-postural hypotension grading and posthandgrip test grading between subgroups

Grade	PA+ (*n*=50), *n* (%)	PA− (*n*=50), *n* (%)	χ^2	*P*	FH+ (*n*=37), *n* (%)	FH− (*n*=63), *n* (%)	χ^2	*P*
Postural hypotension test-qualitative analysis based on grades								
0	48 (96)	50 (100)	1.021	0.60	35 (96)	63 (100)	1.264	0.26
1	2 (4)	0			2 (4)	0		
2	0	0			0	0		
Handgrip test-qualitative analysis based on grades								
0	15 (30)	8 (16)	11.506	0.003*	12 (32)	11 (17)	84.17	0.0001*
1	14 (28)	10 (20)			14 (38)	8 (13)		
2	21 (42)	32 (64)			11 (30)	42 (70)		

*Statistical significance. PA+=Physical activity present, PA−=Physical activity absent, FH+=Family history present, FH−=Family history absent

Aging induces changes of reduced compliance and loss of elasticity of the aorta that increases impedance, and with early wave reflection, there is an increased workload on the heart[21] which, in our case, was evident as significantly higher RPP. Such functional and structural changes define vascular phenotype of HTN,[21] and we highlighted the same. Individual with a known history of HTN in family should better adapt to healthy lifestyle as primary prevention for them. Cases with familial HTN had significantly worst measures of obesity with increased overall obesity as weight, BMI, visceral obesity as VF, and reduced SkMM. This also supports the linkage of obesity to sympathetic over activity in individuals with inheritance of HTN.[2] It also highlights that simple measures of weight control by healthy life measures can be used more so when stress level is continuous like medical profession. Comparable heart rate (mean: 80) in all groups indicates that parasympathetic tone is not much affected at this age. High rate pressure product despite comparable heart rate in cases with familial HTN highlights the importance of blood pressure and sympathetic over activity at this young age that needs corrective attention.

We observed a significantly better profile of sympathetic responsiveness to IHG test with PA and in the absence of familial HTN. IHG exercise training might be a simple, effective, inexpensive, and nonpharmacological method in lowering blood pressure.[22] Static exercises are not useful in assessing the cardiovascular status of an individual or in predicting cardiovascular events.[23] Our physically active participants were doing mainly dynamic exercise that leads to better IHG profile suggesting comparatively reduced CVD risk in them. Regular exercise is known to inculcate better sympathetic adjustment to isometric conditions.[24]

In a recent study based on pulse wave analysis by Mobil-O-Graph, we found that young first-degree relatives of diabetics had significantly higher arterial stiffness parameters indicating vascular progeria.[25] Using the same instrument in our population, we found higher central hemodynamics in young aged first-degree relatives of hypertensives.[26] In both these studies,[25,26] alike this study, positive family history of diabetes or HTN rather than PA was a significant factor. These results support our observation but with respect to other parameters of cardiovascular health.

Good habits are being consolidated during school and college life, but sedentary modern lifestyle denies inclusion of structured and measurable athletic activities which are beneficial for health. Picture becomes even worse among science stream people more so in medical students.[27] Although sympathetic tone was not proved to be affected by the presence of moderate PA, we have other tools to study it further and there are other health benefits of exercise, which were not present only in one facet that we questioned. In medical professionals, level of perceived stress and predominance of type A personality are suggested as culprits and their contribution cannot be neglected among study participants who were exposed to it.

Limitations

Our study was limited by small sample size, exclusion of females, narrow range of age, presence of confounding factors, exclusion of parasympathetic function tests, absence of vertical follow-up, and lack of quantification of PA.

Conclusion

Positive family history of HTN, but not physical inactivity, affects sympathetic functioning in non-athletic young male medical personnel. It clues to other lifestyle modifications for better cardiovascular health as primary prevention of its aftermath, HTN.

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Conflicts of interest

There are no conflicts of interest.

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