Original Research Paper Physiology

PREVALENCE OF HYPERTENSION IN UNDERGRADUATE MEDICAL STUDENTS WITH EVALUATION OF DETERMINANTS AND ASSOCIATION WITH CARDIAC AUTONOMIC FUNCTION.

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ABSTRACT

Introduction: Hypertension or increased blood pressure is a major public health problem in India. Medical students are very prone to hypertension. Autonomic assessment has played an important role in elucidating the role of autonomic nervous system in diverse clinical and research settings. Autonomic nervous system abnormality can clinically manifest as hypertension. Increased release of norepinephrine from the brain has also been described in hypertension, and increased sympathetic activity can be demonstrated by analysis of heart rate variability. The present study aims to estimate the prevalence and determinants of hypertension and also to identify its association with cardiac autonomic function. **Methods:** An observational cross-sectional study was conducted among medical students in the Department of Physiology, R.G. Kar Medical College and Hospital from January 2023 to August 2023. Subjects aged between 17-21 years were included in the study. Subjects with known co-morbidities like diabetes, thyroid diseases, etc. were excluded from the study. A total of 50 subjects aged between 17 to 21 years were included in the study. All the study subjects were subdivided into groups based on their body weight. Group 1 were subjects with normal weight, group 2 were pre-obese and group 3 were obese individuals. The autonomic function test assessment was done for deep breathing, postural autonomic function with tilt-table, sustained handgrip and Valsalva manoeuvre using CANS 504 machine and short-term heart rate variability for SDNN and LF/HF ratio was conducted using Polyrite-D machine. Statistical analysis was done with Statistical Package for Social Sciences (SPSS) version-20. **Results:** Prevalence of hypertension among medical students was 16% (n=8). A significant association was noted between postural cardiac autonomic function and body weight with standing standard deviation of 45.541(±12.707) in group 1 (n=27), 38.93(±13.74) in group 2 (n=18) and 25.028(±9.575) in group 3 (n=5). This association was further established with standing co-efficient of 0.496(±0.221) was found in subjects of group 1, 0.375(±0.182) in group 2 and 0.208(±0.074) in group 3. Also, systolic blood pressure after grip was 131.85(±10.509) in group 1, 129.83(±12.538) in group 2 and 147.40(±16.319) in group 3. The diastolic blood pressure was 91.26(±6.948) in normal weight, 97.06(±6.102) in pre-obese and 90.60(±13.795) in obese subjects. A significant association between Valsalva manoeuvre parameter and body weight was found. Valsalva ratio was 2.177(±0.486) in group 1 subjects, 2.269(±0.495) in group 2 and 2.918(±0.874) in group 3. There was a significant difference of LF/HF ratio between the three groups. It was 0.878(±0.226) in group 1, 0.828(±0.324) in group 2 and 1.340(±0.367) in group 3. But there was no significant changes in SDNN between the three groups. **Conclusion:** A high prevalence of hypertension was found among medical students in the present study. It also showed high LF/HF ratio that indicates sympathetic overdrive in obese subjects. A noteworthy association between obesity and impaired cardiac autonomic function was found. Moreover, no association was found between deranged cardiac autonomic function and gender.

KEYWORDS : Blood pressure, Sympathetic nervous system, Parasympathetic nervous system, Obesity, Short term heart rate variability, LF/HF ratio, Cardiovascular health.

INTRODUCTION

Hypertension or increased blood pressure is a major public health problem in India. According to WHO, hypertension is diagnosed if, when it is measured on two different days, the systolic blood pressure readings on both days is ≥140 mmHg and/or the diastolic blood pressure readings on both days is ≥90 mmHg. The prevalence of hypertension among adults aged above 25 years, in the world, was approximately 40% in the year 2008. The total population with uncontrolled blood pressure increased from 600 million in 1980 to nearly 1 billion in 2008 [1]. Increased blood pressure is a major contributor of coronary heart disease, ischemic and haemorrhagic stroke. The chances of cardiovascular disease double for each increment of 20/10 mmHg of blood pressure. Cardiac failure, peripheral vascular disease, renal morbidity, ophthalmic conditions like retinal haemorrhage are also consequences of hypertension. WHO revealed that in 2008, prevalence of hypertension in the Indian population was 32.5% (33.2% in males and 31.7% in females).[1] Medical students are inclined to stress and unhealthy lifestyles, making them a vulnerable group. Prevalence of hypertension among medical students is 18.5% [2].

The autonomic nervous system plays a crucial role in blood pressure (BP) and heart rate (HR) control and may thus be an important pathophysiological factor in the development of hypertension [3]. Autonomic nervous system control of the heart is a dynamic process in both health and disease. A brief description of the advancements in our understanding of the physiology of cardiac autonomic control is in order to place autonomic testing in context. Autonomic control of the heart is achieved by afferent neural impulses that are transmitted from the heart to the intrinsic neurons of the heart, to extracardiac intrathoracic ganglia (e.g., stellate ganglion), to the spinal cord, and to the brain stem. These afferent neural signals are processed by various parts of the nervous system to regulate the cardio-motor neural output to the heart via the sympathetic and parasympathetic nerves. It is important to emphasize that the anatomical nerve trunks that reach the heart, which are traditionally described as the sympathetic and parasympathetic trunks, have both afferent and efferent nerve fibres [4]. The sympathetic neurons that regulate cardiac function are located in the stellate ganglion. Efferent post-ganglionic fibres travel alongside the coronary vasculature to penetrate the epicardial regions and travel toward the endocardium. Stimulation of the stellate ganglion results in an increase in dromotropic, chronotropic, lusitropic, and inotropic activity [5]. Cardiac afferent neurons transduce a variety of chemicals, including various neuropeptides, such as substance P, bradykinin, and calcitonin gene–related peptide (CGRP) [6]. These cardiac afferents are also involved in initiating local inflammatory and vascular reactions that may play an important role in cardiac remodelling [7]. The parasympathetic nervous system also has important afferent and efferent component. The cardio motor function of this system helps slow the heart rate, reduce blood pressure, and balances the system to ensure there is a counterbalance to sympathetic excitation. The parasympathetic effects are coordinated via the cervical vagus nerve [8]. In the resting state, the cardiac ANS is an intricate balance between sympathetic and parasympathetic inputs. Finally, the regulation of the cardiac ANS is also under central nervous system control. The balance of activation and inhibition of neurons is finely tuned and is designed to provide dynamic control of the heart under a range of physiological conditions ranging from rest to severe exertion. This exquisite multilevel neural network is hugely altered in the presence of cardiac dysfunction [9]. HRV represents a measure of the oscillation in the intervals between consecutive heart beats. In the present study we took into consideration the time-domain parameter of SD of normal RR intervals (SDNN) and the frequency domain (spectral) measure of LF/HF ratio. Low-frequency (0.04-0.15 Hz) /high-frequency (0.15-0.4 Hz) ratio is often considered an index of sympatho-vagal balance [10]. Sympathetic as well as parasympathetic outflow may influence the power of low-frequency heart-rate modulation. The heart-rate modulation in the HF range is mainly due to parasympathetic efferent influences and represents respiratory variability [11]. During increased sympathetic activity, the LF–HF ratio will show higher values. During predominance of the parasympathetic system, the ratio will show smaller values [12].

Autonomic assessment has played an important role in explaining the role of autonomic nervous system in diverse clinical and research settings. Increased release of norepinephrine from the brain has also been described in hypertension, and increased sympathetic activity can be demonstrated by analysis of heart rate variability. An array of test probes various aspects of cardiac autonomic control in either resting conditions or with physiological disruption from resting conditions. Various manoeuvres are established to activate the sympathetic or parasympathetic nervous system [13]. For routine evaluation of cardiovascular autonomic function, we consider the Valsalva manoeuvre, active standing and deep (or metronomic) breathing [14].

Objectives:

The present study aims to

1. Estimate the prevalence and determinants of hypertension; and also
2. To identify its association with cardiac autonomic function.

MATERIALS AND METHODS

An observational cross-sectional study was carried out for 8 months among medical students in the Department of Physiology, R.G. Kar Medical College and Hospital from January 2023 to August 2023. Study was commenced after taking Ethical committee approval. Prior to inclusion in the study, informed consent of the subjects was obtained and confidentiality was adequately maintained. Subjects aged between 18-21 years were included in the study. Subjects with known co-morbidities like diabetes, thyroid diseases etc. were excluded from the study. A total of 50 subjects aged between 18 to 21 years were included in the study

Data Collection: Data was recorded on a pre-designed and pre-tested questionnaire and data was collected regarding the following variables age, gender, history of any pre-existing illness or surgical intervention, history of smoking or alcohol consumption, family history, Height, weight, BMI, waist circumference, waist-hip ratio were recorded.

- The WHO category based on body-weight status was determined based on BMI (in Kg/m^2) according to which Underweight (BMI <18.5), Normal range (18.5-24.9), Overweight (25.0-29.9), Obese (≥30).
- The subjects were asked to refrain from taking tea and coffee within 12 hours prior to the test and sedatives or drugs affecting the nervous system or smoking in the preceding 24 hours.
- The subjects were asked to wear loose clothes and wearing of tight under clothing or metallic objects were not allowed.
- The subjects were advised to have a sound sleep the night before.
- The test procedures were performed in the first half of the day and the room temperature of the laboratory was maintained between 18° to 25°C.
- The study subjects were classified as using the diagnostic criteria of the American Heart Association (AHA) 2017:

BLOOD PRESSURE CATEGORY	SYSTOLIC BP (mmHg)		DIASTOLIC BP (mmHg)
NORMAL	<120	and	<80
ELEVATED	120-129	and	<80
HYPERTENSION STAGE 1	130-139	or	80-89
HYPERTENSION STAGE 2	≥140	or	≥90

A total of 50 subjects aged between 17 to 21 years were included in the study. All the study subjects were subdivided into groups based on their body weight. Group 1 were subjects with normal weight, group 2 were pre-obese and group 3 were obese individuals. Short-term heart rate variability for SDNN and LF/HF ratio was conducted using Polyrite-D machine. The autonomic function test assessment was done for deep breathing, postural autonomic function with tilt-table, sustained handgrip and Valsalva manoeuvre using CANS 504 machine. Statistical analysis was done with Statistical Package for Social Sciences (SPSS) version-20.

Valsalva Manoeuvre: The Valsalva manoeuvre is known to affect heart rate, but actually evaluates the baroreflex arc and its sympathetic and parasympathetic responses. During the manoeuvre, the person breathes into a special mouthpiece that is connected to a manometer and maintains an expiratory pressure of 40 mmHg for 15–20 s.[15] The manoeuvre consists of four phases. Phase 1 occurs during the first 2–3 s of the forced expiration and shows a brief decrease in heart rate and increase in blood pressure due to mechanical compression of the aorta. During phase 2, blood pressure first decreases and then increases in the late portion of this phase. The initial decrease in blood pressure activates the baroreflex and results in an increase of sympathetic activity and a consequent increase of peripheral resistance and blood pressure during the late stage of phase 2. Venous return is lowered because of the continuous expiratory strain and reduces cardiac stroke volume, which again results in a baroreflex-mediated tachycardia and peripheral vasoconstriction. Phase 3 describes the first 1–2 s after release of the expiratory strain. There is a passive decline in blood pressure and increase in heart rate. Finally, phase 4 shows a blood pressure overshoot that is due to the persistent increase in peripheral resistance and a normalization of venous return and stroke volume. Mean blood pressure can increase by more than 10 mmHg, but an increase is absent in patients with sympathetic dysfunction. The blood pressure increase mediates a baroreflex-induced bradycardia. This bradycardia is a measure of baroreflex buffer capacity and vagal cardiac innervation. Blood pressure changes during phases 2 and 4 reflect sympathetic responses. The Valsalva ratio is used as an index of the baroreflex-mediated bradycardia and is calculated as the ratio of the highest heart rate during expiration and the lowest heart rate during the first 20 s after the expiratory strain. A Valsalva ratio below 1.10 is abnormal [14].

Orthostatic challenge by head-up tilting or active standing (Ewing manoeuvre): Orthostatic challenge causes an early cardiovascular response that occurs within the first 30s. During assumption of the upright position, 300–900 ml of blood is redistributed from central blood vessels to the lower extremity. Active standing (the so-called Ewing manoeuvre) is more suited to assess responses during the initial phase of orthostatic challenge. The early circulatory stabilization occurs after 1–2 min of orthostasis. Finally, there is a response to prolonged orthostasis lasting for more than 5 min. The initial decline and secondary overshoot of systolic and diastolic blood pressure within the first seconds of orthostatic challenge can be recorded by continuous non-invasive blood pressure measurements. An initial drop in systolic blood pressure by more than 40 mmHg or in diastolic blood pressure by more than 25 mmHg is abnormal. Ewing suggested that the ratio is calculated between the highest heart rate, i.e., the shortest RR interval, after approximately 15 heart beats from standing up, and the slowest heart rate, i.e., the longest RR interval, after approximately 30 heart beats from beginning the challenge, as a parameter of orthostatic cardiac response. This 30/15 ratio should be above 1.04, yet values are age-dependent [15].

Cardiovascular adaptation to prolonged orthostatic challenge can be tested by means of passive head-up tilting. The cardiovascular changes during head-up tilt are more gradual than during active standing. There is no biphasic response of heart rate and blood pressure, but instead a gradual increase in diastolic pressure and heart rate and no major change in systolic pressure. The different effects seem to result from the abdominal and lower-limb muscle contractions during active standing and the absence of such contractions during passive tilting [16]. However, muscle activation can only be avoided if the patient is not brought to the fully upright position. The gravitational stress or hydrostatic effect during orthostasis corresponds to the tilt angle. If the patient is tilted to a 70° angle, the orthostatic challenge is almost identical with the challenge in the upright position. To assure that there is no muscle contraction, we only tilt to a 60° angle.

Deep (metronomic) breathing: Deep metronomic breathing at a rate of six cycles per minute is probably the most common and reliable test to assess acceleration of heart rate during inspiration and deceleration during expiration (respiratory sinus arrhythmia) under optimized conditions. The expiratory–inspiratory difference (E-I difference) or the expiratory–inspiratory ratio (E/I ratio) can be determined from the maximum and minimum heart rate during respiration at six cycles per minute [17]. E-I differences exceeding 15 heart beats per minute are considered to be normal. E-I differences below 10 beats per minute are abnormal in persons below the age of 40 years. The E/I ratio should exceed values of 1.23 in persons younger than 20 years [18].

Sustained handgrip: First, the subject is asked to press a handgrip dynamometer with full strength. Then, the handgrip should be maintained for 3–5 min at one-third of the maximum contraction strength. The consequent increase of sympathetic activity and vasoconstriction induces a blood pressure rise that is considered to reflect sympathetic autonomic activity. The early acceleration of heart rate during the manoeuvre is due to a withdrawal of vagal activity, whereas the late heart-rate acceleration results from sympathetic activation. Normally, diastolic blood pressure at the end of the effort is at least 16 mmHg higher than before the manoeuvre. An increase in diastolic blood pressure by only 10 mmHg or less is abnormal [14].

Heart rate variability: Healthy biological systems exhibit complex patterns of variability that can be described by mathematical chaos.

SDNN is a measure of variation in the value of NN intervals. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values [19]. SDNN represents a global measure of HRV and provides information about all HRV components [20]. SDNN values predict both morbidity and mortality. Based on 24-hour monitoring patients with values below 50 milliseconds (ms) are categorised as unhealthy. 50-100 ms have compromised health and above 100 ms are considered to be healthy. [21]

The LF/HF ratio where LF stands for low frequency and HF stands for high frequency, expresses the balance between sympathetic and parasympathetic nervous system. The very low frequency (VLF) component was not evaluated in the present study, because it requires long-term ECG monitoring [20]. Power is the signal energy found with a particular band of frequency. The assumption underlying the LF/HF ratio is that LF may be generated by the sympathetic nervous system while HF is produced by the parasympathetic nervous system. Therefore, a low LF/HF ratio indicates dominance of parasympathetic system. This is seen when we conserve energy and engage in tend and befriend kind of behaviour. In contrast, a high LF/HF ratio indicates dominance of sympathetic nervous system, which is seen when we engage in fight or flight kind of behaviour or parasympathetic withdrawal [22].

RESULT:

The present study found that (Table 1) 56% of the study subjects were males and 44% were females. 12% of the study subjects were smokers while 8% of the subjects had history of alcohol intake. It was also observed that 50% of the subjects had normal body mass index (BMI) while 40% were pre-obese and 10% were obese.

Table 1: Baseline Characteristics Of The Study Subjects

parameter		n (%)
gender	Male	28 (56%)
	Female	22 (44%)
habits	smoking	6 (12%)
	Alcohol intake	4 (8%)
Dietary habits	Vegetarian	7 (14%)
	Mixed diet	43 (86%)
Height (in cms)	150-160	21 (41%)
	160-170	10 (20%)
	170-180	19 (38%)
BMI	Normal	25 (50%)
	Pre-obese	20 (40%)
	Obese	5 (10%)
Baseline BP	SBP>140 and/or DBP>90	8(16%)
	SBP/DBP<140/90	42(84%)

A high prevalence of hypertension among medical students was 16%, according to WHO criteria. WhileTable-2 shows that based on the American heart association (AHA) criteria for hypertension, 26% of the subjects had normal blood pressure, 36% had elevated blood pressure while 22% were in stage 1 category and 16% were in stage 2 category, so with AHA criteria for hypertension the prevalence of hypertension in our study was 38% (n=19).

Table 2: distribution of study subjects based on AHA criteria for hypertension

Category	n (%)	Male	Female
Normal	13 (26%)	9(18%)	4
Elevated	18(36%)	9(18%)	9(18%)
Stage 1 hypertension	11(22%)	5(10%)	6(12%)
Stage 2 hypertension	8(16%)	3(6%)	5(10%)

It was observed that 54% of the study subjects had normal diastolic blood pressure (DBP) change after sustained hand grip while 24% had an abnormal rise in DBP (Table-3). Also, systolic blood pressure (Table-4) after grip was increased in obese (147.40±16.319) than that in the normal weight (131.85±10.509) and in pre-obese (129.83±12.538) groups though the changes was not significant. The diastolic blood pressure was (91.26±6.948) in normal weight, (97.06±6.102) in pre-obese and (90.60±13.795) in obese subjects and these changes were not significant.

Table 3: Frequency distribution of autonomic function test parameters

PARAMETER		n (%)
HRV	SDNN <50 ms	45 (90%)
	SDNN 50-100 ms	5 (10%)
	SDNN >100 ms	nil
	Low (<1) LF/HF Ratio	35 (70%)
	High (>1) LF/HF Ratio	15 (30%)
Valsalva manoeuvre	Normal (Valsalva ratio >1)	50 (100%)
	Abnormal (Valsalva ratio<1)	0
Deep breathing	Normal (E-I diff >15bpm)	50 (100%)
	Abnormal (E-I diff<15bpm)	0
DBP change after Sustained hand grip	>16 (normal)	27(54%)
	10-16	11(22%)
	<10 (abnormal)	12 (24%)
Tilt-table test 30:15 ratio	Normal (>1.04)	31(62%)
	Abnormal (<1.04)	19(38%)

A significant association between Valsalva manoeuvre parameter and body weight was found. Valsalva ratio was (2.177±0.486) in normal weight subjects, (2.269±0.495) in pre-obese and (2.918±0.874) in obese groups. All the study subjects had normal Valsalva ratio (Table-3). The present study also showed that 62% of the study subjects had normal tilt-table test 30:15 ratio while 38% had an abnormal 30:15 ratio (Table-3). Also, all the study subjects had normal expiratory-inspiratory difference (Table-3). In HRV parameters (Table 3) 90% of study subjects had SDNN of <50 ms while none of the study subjects had SDNN of >100 ms. 70% of the study subjects had low LF/HF ratio while 30% of the study subjects had high LF/HF ratio.

Table 4 shows that, there was no significant dependence on body weight and deep breathing cardiac autonomic function test parameters. The expiration-inspiration difference was lowest in obese group (34.80±5.167) and highest in the normal category (42.44±13.518)). The R-R interval during both inhalation and exhalation was lowest in the obese category (98.80±11.077) and highest in the normal group (106.33±16.190) but these changes were not significant (p>0.05)

A significant association was noted between postural cardiac autonomic function and body weight and it was found (Table-4) that with standing standard deviation of (45.541±12.707) in normal weight subjects (n=27), (38.93±13.74) in pre-obese (n=18) and (25.028±9.575) in obese (n=5). There was a significant difference of standing co-efficient between the three groups and standing co-efficient of (0.496±0.221) was found in subjects of normal body weight, (0.375±0.182) in pre-obese and (0.208±0.074) in obese.

Table 4: comparison of deep breathing measurements, postural and Valsalva test with BMI

Parameters		Normal weight (mean±SD) (N=27)	Pre-obese (mean±SD) (N=18)	Obese (mean±SD) (N=5)	p-value
Deep breathing can measurements	Standard Deviation	44.850(±13.458)	42.494(±14.848)	31.038(±18.951)	0.189
	Co-Efficient	0.662(±0.229)	0.630(±0.265)	0.372(±0.242)	0.076
	E-I Difference	42.44(±13.518)	37.44(±9.411)	34.80(±5.167)	0.220
	Exhale R-R Interval	72.50(±10.257)	69.70(±12.044)	62.40(±13.390)	0.231
	Inhale R-R Interval	106.33(±16.190)	102.96(±13.472)	98.80(±11.077)	0.537
Postural can measurements	Standing SD	38.928(±13.736)	45.541(±12.707)	25.028(±9.575)	0.011*
	Standing Co-Efficient	0.375(±0.182)	0.496(±0.221)	0.208(±0.074)	0.011*
	30:15 Stand Ratio	1.053(±0.087)	1.089(±0.092)	1.042(±0.135)	0.394
	Standing R-R at 30th beat (msec)	635.200(±112.26)	621.657(±131.03)	575.216(±135.984)	0.597
	standing r-r @ 15th beat (msec)	605.103(±124.64)	599.653(±125.93)	564.69(±139.15)	0.806
	supine SBP	122.96(±8.985)	123.61(±13.470)	137.00(±22.650)	0.072
	supine DBP	74.96(±7.187)	79.00(±9.610)	83.80(±13.103)	0.079
	SBP after 120s	129.63(±10.419)	126.39(±12.958)	139.20(±23.424)	0.157

There was a significant difference of LF/HF ratio between the three groups (Table-4). It was (0.828±0.324) in normal weight subjects, (0.878±0.226) in pre-obese and (1.340±0.367) in obese. But there were no significant changes in SDNN between the three groups. It was also observed that the systolic and diastolic blood pressure change after grip were statistically significant in accordance to body weight. Also, the LF/HF ratio was the highest in the obese category (1.340±0.367) and this finding was statistically significant. (Table 4)

Table 4 also shows that there was significant dependence between Valsalva ratio and body weight. The Valsalva ratio was the highest in the obese category (2.918±0.874) and lowest in the normal weight (2.177±0.486) subjects. Though not statistically significant the standard deviation obtained during Valsalva manoeuvre was the least in the obese group (30.150±11.777).

Table 5: association between gender and deep breathing, postural and HRV measurements

	Deep breathing test measurements	Male (mean±SD) (n=28)	Female (mean±SD) (n=22)	p-value
Deep breathing test measurements	Standard deviation	43.575 (±15.671)	40.441 (±14.222)	0.469
	Co-efficient	0.586 (±0.252)	0.654 (±0.268)	0.360
	E-I difference	38.93 (±12.181)	39.05 (±9.454)	0.971
	Exhale R-R interval	68.11 (±11.344)	72.36 (±11.919)	0.204
	Inhale R-R interval	103.86(±13.410)	103.64(±15.537)	0.957

Postural test measurements	Standing sd	40.766(±14.872)	38.840(±13.281)	0.636
	Standing co-efficient	0.417 (±0.220)	0.382(±0.190)	0.550
	30:15 stand ratio	1.059 (±0.096)	1.072 (±0.091)	0.630
	Standing R-R at 30th beat (msec)	646.803 (±125.039)	595.719 (±110.120)	0.138
	Standing R-R at 15th beat (msec)	615.579 (±125.350)	578.126 (±122.268)	0.294
	Supine SBP	123.82(±12.976)	125.59(±12.927)	0.634
	Supine DBP	76.00 (±8.546)	78.95 (±9.589)	0.256
	SBP after 120s	129.75 (±13.743)	129.00 (±12.743)	0.844
	DBP after 120s	81.82 (±7.940)	82.18 (±8.628)	0.880
	SBP after grip	134.25 (±12.607)	130.68 (±12.741)	0.328
	DBP after grip	92.36 (±8.120)	94.45 (±7.614)	0.356
	SDNN (in ms)	42.840(±11.844)	39.794(±8.298)	0.311
	LF/HF Ratio	0.903(±0.302)	0.910(±0.328)	0.942
Valsalva test	Standard deviation	43.463(±15.253)	36.960(±11.766)	0.095
	Co-efficient	0.495(±0.202)	0.515(±0.195)	0.714
	Valsalva Ratio	2.315(±0.540)	2.246(±0.607)	0.675

Table 5 shows that there was no significant dependence on deep breathing parameters and gender. The E-I difference was high in females (39.05 ±9.454) than in males (38.93 ±12.181). The exhale R-R interval was higher in females (72.36 ±11.919) than males (68.11 ±11.344) while the inhale R-R interval was higher in males. The standard deviation obtained during deep breathing test was lower in females than males, but this finding was not statistically significant. Also, there was no significant dependence on postural autonomic function test parameters and blood pressure changes after sustained hand-grip test with gender. It was observed that the standing co-efficient was lower in females than males. The standing R-R interval at 30th beat and 15th beat was also lower in females than in males. Though not statistically significant it was seen that the blood pressure changes after sustained hand-grip test were slightly more in males than females. (Table 5). It was also observed that there was no significant dependence on heart-rate variability parameters and gender. However, it was observed that the SDNN was higher in males compared to females while the LF/HF ratio slightly higher in females than in males. (Table 5)

DISCUSSION:

In our study, the overall prevalence of hypertension was 38% according to AHA criteria. Studies by Gupta et al (33.4%) [23], Shanthirani et al (21.1%) [24], Anand (34.0%) [25] in the early 2000s, and Reddy et al (27.7%) [26] and Midha et al (32.8%) [27] in the later years have shown that hypertension prevalence in the Indian population was ranging from 20% to 40%. The present study also showed that prevalence of hypertension was 16% in males and 22% in females. In our study we have found that the mean of resting heart rate, SBP, DBP and MAP was higher in the obese group compared to the normal group but this finding was not statistically significant. These findings were in congruence with the study conducted by Sharma R. et al [28].

In the study conducted by Grewal s. et al, the expiration/ inspiration ratio, that is, the expiration-inspiration difference was low in the obese group than in the normal weight group but it was non- significant statistically. This finding is in agreement with our study which also showed a low expiration-inspiration difference (34.80±5.167) in the obese group, in the pre-obese group (37.44±9.411) it was relatively more than the obese group but less than the normal group (42.44±13.518). But no statistical significance was found [29].

In our study, the standing standard deviation (25.028) and the standing co-efficient (0.208) was the least in the obese group and was statistically significant (p-value <0.05). The 30:15 ratio indicating heart rate response to immediate standing was found to be less in obese group in comparison with the normal and the pre-obese group but was not significant statistically. This finding is similar to that of the study conducted by Grewal S. et al [29], where the 30:15 ratio was found to be less than the normal group and was statistically not significant. Sharma R. et al [28] found that the mean of Valsalva ratio in obese group of their study was 0.9922 ($p<0.001$) which was similar to our study where the mean was found to be 1.118 ($p<0.05$) in the obese group. Grewal S. et al in their study found that the Valsalva ratio in the obese group was low (1.41±0.38) as compared to normal individuals but was not significant statistically ($p=0.892$) [29]. In the present study, the Valsalva ratio was low in obese group compared to normal and pre-obese group and it was significant statistically. In our study it was noted that the beat-to-beat variation was more in males (43.575±15.671) as compared to females (40.441±14.222) while the expiration-inspiration difference was more in females (39.05±9.454) compared to males (38.93±12.181), however it was not significant statistically (p-value>0.05). The Valsalva test is known to affect heart rate but actually evaluates the baroreflex arc and the sympathetic and parasympathetic responses [29].

Isometric handgrip exercise (IHG) triggers acute increases in cardiac output to meet the metabolic demands of the active skeletal muscle. In the present study no significant dependence on gender was noted with isometric hand-grip test, although blood pressure responses to handgrip tended to be slightly greater in men than women [30]. This is in agreement with the study conducted by Cauwenberghs, N. et al where it was noted that women presented a weaker cardiovascular response to IHG than men [30]. Likewise, beat-to-beat variation expressed as the standard deviation of the mean R-R interval did not correlate with the coefficient of variation and the expiration/inspiration ratio of beat-to-beat variation, in the study by Gautschy B. et al [31]. However, in the study conducted by Jayachandra S. et al the 30:15 ratio in non-obese (1.39±0.86) was more than obese group (1.05±1.93) but not significant statistically, which is not in agreement with our study [32]. Also, blood pressure responses to handgrip tended to be slightly greater in men than in women in the study conducted by Kapoor M.et al which is also in agreement with our study. The consequent increase in sympathetic activity and vasoconstriction induces a blood pressure rise that is considered to reflect sympathetic autonomic activity [33].

In our study there was a significant difference between SBP and DBP after sustained hand grip and body weight. The mean of SBP after grip in obese group was 147.40 ($p<0.05$) while the mean DBP after grip was found to be 90.60 ($p<0.05$). Sharma R. et al in their study had found the mean of DBP after grip to be 90.960 ($p<0.001$) which is in congruence with our study. In our study, 30:15 ratio in males was 1.059 and was relatively more in females 1.072 but is not significant statistically [28]. In the study conducted by Yograj S.et al, the ratio in males was 1.06 but was relatively more than females 1.01 and was statistically significant (p-value<0.001) [34].

Heart-rate variability shows that the body can adapt well to internal and external physical and psychological stressors. SDNN is a measure of variation in the value of normal R-R interval or NN interval [34]. In our study we found that SDNN, which describes parasympathetic or vagal activity, was higher in females compared to men but was not significant statistically. While the LF/HF ratio, which signifies the sympatho-vagal balance, was lower in females compared to males but was not significant statistically. Likewise, in the study conducted by Sharma VK et al, the SDNN ratio was more in females and the LF/HF ratio was less in females. No significant dependence on gender was noted, although blood pressure responses to handgrip tended to be slightly greater in men than women [35]. A low standard deviation indicates that the data points tend to be very close to the mean whereas a high standard deviation indicates that the data were spread out over a large range of values. The LF/HF ratio expresses the balance between sympathetic and parasympathetic nervous system activity [35]. Hypertension is as major health problem in India and other developing countries. The persistence of high blood pressure in childhood and adolescent population and its progression into adult hypertension has been shown in various studies in the past. High prevalence has been demonstrated in earlier studies in young adults [36]. In the study conducted by Tonhajzerova.et al the deep-breathing E-I difference was significantly lower in females than males which is not agreement with the present study [37].

The medical students undergo tremendous amount of stress during various phases of their course and are inclined to unhealthy lifestyles making them prone to obesity. A high prevalence of hypertension was found medical students with significant dependence on body weight. Moreover, no association was found between deranged cardiac autonomic function and gender. Most of the subjects were previously undiagnosed which poses a considerable threat. The pre-hypertensives need regular health check-up and follow-up. The early identification helps with early and active management of hypertension and thereby reducing the probability of cardiovascular changes and end-organ damage, later in life. Autonomic nervous system control of heart is a dynamic process in both health and disease. Further studies need to be conducted as there is lack of data on hypertension among medical students, in order to formulate preventive strategies at all levels. With autonomic function test analysis and individual therapy adjustments to achieve the most favourable sympathetic and para-sympathetic balance might be possible in the future.

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