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RESEARCH ARTICLE

Gender difference in heart rate variability in medical students and association with the level of stress

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ABSTRACT

Background: Academic stress is the predominant stress in medical students, and there are studies conducted before on the assessment of stress during exams. However, medical students also face other kinds of stressors apart from academics which are present in their day to day activities. Heart rate variability (HRV) is a proved reliable non-invasive marker of cardiovascular health and has been used in the cardiovascular risk stratification. **Aims and Objectives:** This study was designed to compare the HRV in medical students and assess the association between the stress level and HRV in both genders. **Materials and Methods:** This was a cross-sectional analytical study, conducted in the Department of Physiology, Meenakshi Medical College, Kanchipuram, Tamil Nadu, India. 150 first year MBBS medical student volunteers were included in the study. 78 female and 72 male students were recruited for the study. The level of stress was assessed using the medical students' stress questionnaire. Basal heart rate (BHR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were recorded by the oscillometric method using automated BP monitor Omron MX3 (Omron Healthcare Co. Ltd, Kyoto, Japan). Short-term HRV recording was done using lead II ECG. The data acquisition was done using 16 bit, 16 channel data acquisition system BIOPAC MP100 (BIOPAC Inc., Goleta, CA, USA) with AcqKnowledge 3.8.2 software (BIOPAC Inc., Goleta, CA, USA). **Results:** More female students have fallen in the category of high and severe stress in comparison to males. All the frequency domain indices (total power, low-frequency power, high-frequency power, and normalized high-frequency power [HFnu]) were reduced with increase in the intensity of stress except for LFnu, which significantly increased. With increase in the intensity of stress, BHR, SBP, DBP, pulse pressure (PP), and rate pressure product (RPP) were significantly increased. Females have significantly higher BP, BHR, PP, and RPP than males. All the HRV parameters and coefficient of variation parameters had a significant correlation with the cumulative stress score. **Conclusion:** We found that medical students are exposed to significant stressors during their medical training, and especially female students are more affected. With increase in the intensity of stress, the cardiovascular health of the student can get hampered with decreased HRV and increased BP and RPP.

KEY WORDS: Stress; Heart Rate Variability; Medical Students; Male; Female

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INTRODUCTION

Medical education has been known to be stressful to students; especially in the beginning years while they get accustomed to the new environment and curriculum.[1] Although certain amount of stress (favorable stress) motivates them in learning, persistent/excessive unfavorable stress can have significant deleterious effects. An excessive stress level is known to affect the psychological and the behavioral aspect of students leading to a low self-esteem,[2,3] anxiety and depression,[4,5] difficult social relationships,[6] sleeping disorders,[7,8] increased substance abuse.[9-11] Finally, the overall students' academic achievement and personal growth get weighed down.[2]

Although stress has a psychological impact, it also affects the various physiological processes.[12] Exposure to stress triggers the autonomic nervous system and is associated with an increase in sympathetic cardiac control, a decrease in parasympathetic control, or both.[13] The oscillations in the intervals between consecutive heart beats have been described as the heart rate variability (HRV). HRV assessed using the RR tachogram, depicts the ability of the heart to respond to various perturbations, and reflects the status of ANS. Through its influence on the ANS, stress can affect the HRV of an individual. Hence, the HRV measures represent the dynamic sympathovagal balance that gets influenced by the level of stress experienced.

Academic stress is the predominant stress in medical students, and there are studies conducted before on the assessment of stress during exams. However, medical students also face other kinds of stressors apart from academics which are present in their day to day activities. The medical students' stress questionnaire (MSSQ), developed by Mohammed et al*.*, has addressed all the stressors that can be experienced by the medical students during their routine life.[14] It is categorized under six domains: Academic related stressors (ARS), intrapersonal and interpersonal related stressors (IRS), teaching and learning related stressors (TLRS), social related stressors (SRS), drive and desire related stressors (DRS), and group activities related stressors (GARS). The questionnaire has been reported to be reliable and valid in assessing the stress level among medical students.

There are studies that have assessed the acute stress in medical students such as during exams and its association with HRV. However, there are only a few studies, which have specifically assessed the effect of stress, caused by the stressors present during their daily routine and associating it with the HRV. HRV is a proved reliable non-invasive marker of cardiovascular health and has been used in the cardiovascular risk stratification. As stress is known to affect the cardiovascular autonomic modulation, it warrants the quantification of the stress perceived by the medical students and its effect on their HRV. Furthermore, both stress experienced[15] and HRV exhibit gender difference.[16,17]

Hence, the objective of our study was to assess the cumulative stress using MSSQ, which would depict the overall stress student experiences during everyday life and associate it with the cardiovascular health. Further, we have tried to compare and associate the stress level and HRV specifically in male and female students.

MATERIALS AND METHODS

This was a cross-sectional analytical study, conducted in the Department of Physiology, Meenakshi Medical College, Kanchipuram, Tamil Nadu, India. The approval of the Institute Research Council and Institute Ethics Committee for human studies was obtained before the commencement of the study.

About 150 first year MBBS medical student volunteers were included in the study. 78 female and 72 male students were recruited for the study. The participants included students in the age group of 18-24 years. Students on medication, known history of diabetes mellitus, hypertension, and hormonal disorders were excluded. Written informed consent was obtained from all the students before the commencement of the study.

Stress Assessment

The level of stress was assessed using the MSSQ. It is a self-reported, self-scoring questionnaire combining 40 items, which encompass the stressors categorized into the six domains: ARS, IRS, TLRS, SRS, DRS, and GARS. The raw score for each domain was assessed. Each domain has been graded from mild to severe based on their raw scores. Students may not have a similar score in all the domains. Determining their stress level based on one domain may not be the correct method to assess the overall stress level in an individual. Hence, we considered the highest grade of stress level in any one of the domain to be the stress level of the individual and categorized them as mild, moderate, high, and severe.

We calculated the cumulative score by summing up the raw scores encompassing the six domains for each student.

Baseline Cardiovascular Parameters

After 5 min of sitting rest, basal heart rate (BHR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were recorded by the oscillometric method using automated BP monitor Omron MX3 (Omron Healthcare Co. Ltd, Kyoto, Japan). Further pulse pressure (PP) is calculated as a difference between systolic and diastolic BP. A higher PP is considered as an important predictor of cardiovascular heart disease.[18] Rate pressure product (RPP), a determinant of myocardial oxygen consumption and workload, was calculated using the formula: $RPP = (BHR \times SBP) \times 10^{-2}$.[19]

Recording of HRV

The female students were asked to report during the follicular phase of the menstrual cycle as ovarian hormones are known to influence HRV.[20] The subjects were asked to report after overnight fasting and were advised to refrain from nicotine/

alcohol for 48 h and caffeine for 24 h before the test. The subjects were explained about the tests. The tests were done with subjects in loose clothing and after voiding urine. The room temperature at 23°C and the humidity between 25% and 35% were maintained.[21]

Short-term HRV recording was done using lead II ECG, following the standard procedure as per the recommendation of Task Force.[21] The data acquisition was done using 16 bit, 16 channel data acquisition system BIOPAC MP100 (BIOPAC Inc., Goleta, CA, USA) with AcqKnowledge 3.8.2 software (BIOPAC Inc., Goleta, CA, USA). Sampling rate was kept at 500 samples per second per channel. Raw ECG was filtered using band pass filter (2 to 40 Hz). HRV analysis of the RR tachogram was done for frequency domain (by power spectral analysis using fast Fourier transformation) and time domain measures using the software from Biomedical signal analysis group, version 1.1 (Kuopio, Finland). The frequency domain indices included low frequency (LF; 0.04 – 0.15 Hz), high frequency (HF; 0.15-0.4 Hz), total power (TP), LF in normalized units (LFnu), HF in normalized units (HFnu), and the ratio of LF to HF (LF-HF ratio). The time domain measures included mean of RR interval (mean-RR), standard deviation of RR interval (SDNN), the square root of the mean of the sum of the squares of the differences between adjacent NN intervals (RMSSD), the number of pairs of adjacent NN intervals differing by more than 50 ms in the entire recording (NN50), and the percentage of NN50 counts, given by NN50 count divided by total number of all NN intervals (pNN50). The HF, HFnu, TP, SDNN, RMSSD, NN50, and PNN50 of HRV indices represent the cardiac parasympathetic drive (vagal tone). The LF and LFnu represent sympathetic tone. The LF-HF ratio depicts the sympathovagal balance.[21]

Statistical Tests

Comparison between various levels of stress for HRV parameters was done using Kruskal–Wallis test followed by Mann–Whitney *U*-test to compare any two levels of stress. Comparison between various levels of stress for cardiovascular parameters was done using one-way ANOVA followed by post hoc Tukey test to compare any two levels of stress. Gender comparison of HRV parameters was done using Mann–Whitney *U*-test and of cardiovascular parameters were done using unpaired Student's *t*-test. Correlation between cumulative stress score and HRV parameters were done using Spearman's Correlation and between cumulative stress score and cardiovascular parameters were done using Pearson's correlation.

RESULTS

Table 1 shows the percentage distribution of stress levels in medical students among 150 students and when gender stratified. We observed that only one male student had mild stress out of 150 students. Furthermore, we observed that more female students have fallen in the category of high and severe stress in comparison to males whose perception of stress is more of moderate and high grades.

Table 1: Categorical distribution of stress levels

Gender	Stress level	Frequency (%)
Female+male	Mild	1 (0.7)
	Moderate	33 (22.0)
	High	94 (62.7)
	Severe	22 (14.7)
	Total	150 (100.0)
Female	Mild	0 (0)
	Moderate	3 (3.8)
	High	57 (73.1)
	Severe	18 (23.1)
	Total	78 (100.0)
Male	Mild	1 (1.4)
	Moderate	30 (41.7)
	High	37 (51.4)
	Severe	4 (5.6)
	Total	72 (100.0)

Table 2 shows the comparison of HRV parameters between different intensities of stress (moderate, high, and severe) among the 150 students, irrespective of gender. Since only one student had mild stress, we did not include it as a separate group for comparison. We found a significant difference between the groups. The time domain indices were found to be significantly reduced with an increase in the intensity of stress. All the frequency domain indices (TP, LF power, HF power, and HFnu) were reduced with increase in the intensity of stress except for LFnu, which significantly increased.

Table 3 shows the comparison of cardiovascular parameters, between different intensities of stress (moderate, high, and severe) among the 150 students, irrespective of gender. With the increase in the intensity of stress, BHR, SBP, DBP, PP, and RPP were significantly increased.

Table 4 shows a significant gender difference in HRV parameters (all stress level included). We observed that females had significantly reduced time domain indices. Furthermore, the females had reduced HFnu and total power and increased LFnu in comparison to males. Table 5 shows that females have significantly higher BP, BHR, PP, and RPP than males.

HRV and cardiovascular parameters were compared between females and males for the same level of stress (Tables 6 and 7, respectively). Although not significant, there was a difference between males and female students in HRV. The HR, BP, PP, and RPP were also high among females, though not significant.

Table 2: Comparison of HRV parameters between various levels of stress (both male and female)

Parameters	Highest score based						Kruskal–Wallis test *P* value	Moderate versus high	Moderate versus severe	High versus severe
	Moderate (*n*=33)		High (*n*=94)		Severe (*n*=22)					
	Median	IQR	Median	IQR	Median	IQR				
SDNN (ms)	50.90	29.20	30.90	20.23	21.70	13.70	<0.001	<0.001	<0.001	0.001
RMSSD (ms)	59.50	50.60	33.55	32.70	24.60	21.40	<0.001	<0.001	<0.001	0.006
NN50 (ms)	137.00	85.50	53.50	107.50	16.00	44.25	<0.001	<0.001	<0.001	0.004
pNN50	36.80	29.70	13.20	27.13	3.60	10.90	<0.001	<0.001	<0.001	0.003
LF power (ms^2)	815.00	830.00	364.00	496.50	118.00	118.75	<0.001	<0.001	<0.001	0.000
HF power (ms^2)	1146.00	1974.00	363.00	735.50	153.00	245.50	<0.001	<0.001	<0.001	0.007
Total power (ms^2)	2207.00	2474.50	794.00	1284.75	322.00	294.50	<0.001	<0.001	<0.001	0.000
LF/HF ratio	0.60	0.72	0.84	1.28	0.81	0.75	0.061	0.021	0.151	0.540
LFnu	37.40	24.35	45.60	30.30	44.55	21.65	0.060	0.021	0.149	0.540
HFnu	62.60	24.35	54.40	30.30	55.45	21.65	0.060	0.021	0.149	0.540

Comparison between various levels of stress is done using Kruskal–Wallis test followed by Mann–Whitney *U*-test to compare two levels of stress.
SDNN: Standard deviation of all NN intervals, RMSSD: Square root of mean of the sum of the squares of differences between adjacent NN intervals, NN50 count: Number of pairs of adjacent NN intervals differing by more than 50 ms in entire recording, Total power: The variance of NN intervals over the temporal segment, LF: Power in low frequency range (0.04-0.15 Hz), HF: Power in high frequency range (0.15-0.4 Hz), LF norm: LF power in normalized units (LF/[TP−VLF]*100), HF norm: HF power in normalized units (HF/[TP−VLF]*100), LF/HF ratio: Ratio LF (ms^2)/HF (ms^2), pNN50: The percentage of NN50 counts, HRV: Heart rate variability, IQR: Interquartile range

Table 3: Comparison of cardiovascular parameters between various levels of stress (both male and female)

Parameters	Highest score based			ANOVA *P* value	Moderate versus high	Moderate versus severe	High versus severe
	Mean±SD						
	Moderate (*n*=33)	High (*n*=94)	Severe (*n*=22)				
Systolic blood pressure (mm Hg)	108.49±7.82	115.60±8.24	126.46±9.10	<0.001	<0.001	<0.001	<0.001
Diastolic blood pressure (mm Hg)	73.18±4.56	76.36±4.36	82.14±5.51	<0.001	0.002	<0.001	<0.001
Heart rate (beats per minute)	72.94±9.64	81.38±9.98	90.55±10.69	<0.001	<0.001	<0.001	0.001
Pulse pressure (mm Hg)	35.30±6.03	39.23±6.24	44.32±4.48	<0.001	0.004	<0.001	0.001
Rate pressure product	7921.74±1239.67	9415.13±1372.58	11449.57±1492.63	<0.001	<0.001	<0.001	<0.001

Comparison between various levels of stress is done using one-way ANOVA test followed by *post-hoc* Tukey test to compare two levels of stress. SD: Standard deviation

The association between the stress intensity and the cardiovascular health was analyzed using Spearman correlation analysis (cumulative score and the HRV parameters) and Pearson correlation analysis (cumulative score and the coefficient of variation [CV] parameters). We observed that all the HRV parameters and CV parameters had a significant correlation with the cumulative stress score (Tables 8 and 9, respectively).

Tables 8 and 9 also show the simple linear regression analysis, with HRV parameters and CV parameters as the dependent variable and cumulative score as an independent variable, respectively. Cumulative stress was able to predict vagal tone dependent parameters (SDNN, RMSSD, and TP) than LF-HF ratio.

DISCUSSION

In this study, we have observed the effect of the routine stressors on the cardiovascular health of the medical students. The stress level of first year medical students using MSSQ under six domains: ARS, IRS, TLRS, SRS, DRS, and GARS were assessed. The highest grade of stress level in any one of the domains was considered to be the stress level of the individual and was categorized as mild, moderate, high, or severe.

The main finding of our study is that more than 75% of students are under the high/severe level of stress.

HRV is a non-invasive marker of cardiac autonomic activity and cardiovascular health. Decreased HRV occurs due to autonomic dysfunction and is known to be a significant cardiovascular risk factor.[22] A reduction in HRV is known to be associated with early onset of prehypertension and other cardiovascular diseases. Our findings indicate that with increased stress there is a reduction in HRV. Furthermore, increased sympathetic and decreased parasympathetic modulations are markers of poor cardiovascular health as evidenced from studies on patients with myocardial

Table 4: Gender difference in HRV parameters

Parameters	Female (*n*=78)		Male (*n*=72)		*P* value
	Median	IQR	Median	IQR	
SDNN (ms)	26.750	20.000	42.900	27.5	<0.001
RMSSD (ms)	28.400	27.250	46.800	32.8	<0.001
NN50 (ms)	29.00	90.500	103.00	116.0	<0.001
pNN50	7.000	22.525	27.400	32.3	<0.001
LF power (ms^2)	261.00	376.750	499.00	738.0	<0.001
HF power (ms^2)	277.50	572.500	757.00	1318.0	<0.001
Total power (ms^2)	553.00	1028.250	1528.00	1846.0	<0.001
LFHF ratio	0.95550	1.151	0.69100	0.9	0.026
LFnu	48.850	26.175	40.900	26.6	0.026
HFnu	51.150	26.175	59.100	26.6	0.026

Gender comparison was done using Mann–Whitney *U*-test. SDNN: Standard deviation of all NN intervals, RMSSD: Square root of mean of the sum of the squares of differences between adjacent NN intervals, NN50 count: Number of pairs of adjacent NN intervals differing by more than 50 ms in entire recording, Total power: The variance of NN intervals over the temporal segment, LF: Power in low frequency range (0.04-0.15 Hz), HF: Power in high frequency range (0.15-0.4 Hz), LF norm: LF power in normalized units (LF/[TP−VLF]*100), HF norm: HF power in normalized units (HF/[TP−VLF]*100), LF/HF ratio: Ratio LF (ms^2)/HF (ms^2). Comparison between girls and boys is done using Mann–Whitney *U*-test, pNN50: The percentage of NN50 counts, HRV: Heart rate variability, IQR: Interquartile range

Table 5: Gender difference in cardiovascular parameters

Parameters	Mean±SD		*P* value
	Female (*n*=78)	Male (*n*=71)	
Systolic blood pressure (mm Hg)	118.86±9.38	112.38±9.39	<0.001
Diastolic blood pressure (mm Hg)	77.91±5.12	75.07±5.10	0.001
Heart rate (beats per minute)	83.62±11.01	77.99±10.84	0.002
Pulse pressure (mm Hg)	40.95±6.25	37.31±6.43	0.001
Rate pressure product	9956.77±1612.49	8798.86±1640.82	<0.001

Gender comparison was done using unpaired Students *t*-test. SD: Standard deviation

infarction.[23,24] Hence, chronic stress has the potency to become a significant CV risk factor in the long run. Since we did not have a mild stress group, we were unable to have a control group in this study.

We also observed that with increased level of stress there was an increase in BHR, SBP, and DBP, indicative of the increased sympathetic and decreased vagal tone in them. Furthermore, the students with severe stress were prehypertensives. Prehypertensive individuals have a threefold higher risk of developing hypertension and CVD in the future as compared to normal BP individuals.[25] Previous studies have shown that CVD is associated with BP starting from 115/75 mmHg itself, further risk of CVD doubled with each 20 mmHg rise in SBP and 10 mmHg in DBP.[26] The RPP, an index of increased myocardial oxygen demand was also elevated with increased stress level. Myocardial ischemia is due to the imbalance between the demand and supply of blood supply to the heart. As the oxygen demand increased with stress, there is a higher risk of developing myocardial ischemia with an increase in the level of stress.

Table 6: Gender difference in HRV parameters in high-level stress students

Parameters	Female (*n*=57)		Male (*n*=37)		*P* value
	Median	IQR	Median	IQR	
SDNN (ms)	28.30	18.05	38.90	24.00	0.025
RMSSD (ms)	29.40	27.60	44.00	34.15	0.048
NN50 (ms)	32.00	91.50	76.00	118.50	0.060
pNN50	7.80	24.60	22.30	29.70	0.069
LF power (ms^2)	307.00	396.00	399.00	657.50	0.044
HF power (ms^2)	287.00	694.50	564.00	1052.00	0.031
Total power (ms^2)	623.00	996.50	1129.00	1880.50	0.019
LFHF ratio	1.14	1.30	0.72	1.05	0.223
LFnu	53.20	28.45	41.70	28.10	0.223
HFnu	46.80	28.45	58.30	28.10	0.223

Gender comparison was done using Mann–Whitney *U*-test. SDNN: Standard deviation of all NN intervals, RMSSD: Square root of mean of the sum of the squares of differences between adjacent NN intervals, NN50 count: Number of pairs of adjacent NN intervals differing by more than 50 ms in entire recording, Total power: The variance of NN intervals over the temporal segment; LF: Power in low frequency range (0.04-0.15 Hz); HF: Power in high frequency range (0.15-0.4 Hz); LF norm: LF power in normalized units (LF/[TP−VLF]*100); HF norm: HF power in normalized units (HF/[TP−VLF]*100); LF/HF ratio: Ratio LF (ms^2)/HF (ms^2). Comparison between girls and boys is done using Mann–Whitney *U*-test, pNN50: The percentage of NN50 counts, HRV: Heart rate variability, IQR: Interquartile range

Table 7: Gender difference in cardiovascular parameters in high-level stress students

Parameters	Mean±SD		*P* value
	Female (*n*=57)	Male (*n*=37)	
Systolic blood pressure (mm Hg)	117.05±8.25	113.35±7.80	0.033
Diastolic blood pressure (mm Hg)	76.81±4.38	75.68±4.31	0.221
Heart rate (beats per minute)	81.81±9.98	80.73±10.08	0.612
Pulse pressure (mm Hg)	40.25±6.48	37.68±5.57	0.050
Rate pressure product	9578.57±1359.31	9163.34±1373.03	0.153

Gender comparison was done using unpaired Students *t*-test. SD: Standard deviation

The other main finding in our study was that females had lower HRV and higher BHR, BP, PP, and RPP than males. Since we observed that HRV decreased and BHR, BP, PP, and RPP increases with stress levels, the observed gender difference might be due to a higher level of stress observed in females. Moreover, this was further substantiated and clarified by the comparison of HRV and cardiovascular parameters between females and males for the same level of stress. Although not significant, there was a difference between males and female students in HRV. The HR, BP, PP, and RPP were also high among females, though not significant. Hence, we could infer that females had more derangement in CV health compared to males. Even with the same level of stress, the HRV was reduced in females compared to males and the females had increased sympathetic tone and reduced vagal tone.

Individuals may react to the same stress differently, and their perceived stress may be different. The observed gender difference may be because those female students perceive the stress higher than the males.[27,28]

Table 8: Correlation and simple linear regression analysis between cumulative score and HRV parameters (both female and male)

Parameters	*R*	*P* value	R^2	*F* value
SDNN (ms)	−0.715	<0.001	0.417	<0.001
RMSSD (ms)	−0.662	<0.001	0.333	<0.001
NN50 (ms)	−0.636	<0.001	0.344	<0.001
pNN50	−0.652	<0.001	0.338	<0.001
LFpower (ms^2)	−0.683	<0.001	0.278	<0.001
HFpower (ms^2)	−0.681	<0.001	0.222	<0.001
Total power (ms^2)	−0.733	<0.001	0.287	<0.001
LFnu	0.253	0.002	0.051	0.005
HFnu	−0.253	0.002	0.051	0.005
LFHF ratio	0.253	0.002	0.020	0.084

Spearman correlation was done between cumulative score and HRV parameters. Simple linear regression was done to with cumulative score as independent factor. SDNN: Standard deviation of all NN intervals, RMSSD: Square root of mean of the sum of the squares of differences between adjacent NN intervals, NN50 count: Number of pairs of adjacent NN intervals differing by more than 50 ms in entire recording, Total power: The variance of NN intervals over the temporal segment; LF: Power in low frequency range (0.04-0.15 Hz); HF: Power in high frequency range (0.15-0.4 Hz); LF norm: LF power in normalized units (LF/[TP−VLF]*100); HF norm: HF power in normalized units (HF/[TP−VLF]*100); LF/HF ratio: Ratio LF (ms^2)/HF (ms^2). Comparison between girls and boys is done using Mann–Whitney *U*-test, pNN50: The percentage of NN50 counts, HRV: Heart rate variability

Table 9: Correlation and simple linear regression analysis between cumulative score and cardiovascular parameters (both female and male)

Parameters	*r*	*P* value	R^2	*F* value
Systolic blood pressure	0.494	<0.001	0.239	<0.001
Diastolic blood pressure	0.468	<0.001	0.219	<0.001
Heart rate	0.367	<0.001	0.129	<0.001
Pulse pressure	0.368	<0.001	0.129	<0.001
Rate pressure product	0.515	<0.001	0.260	<0.001

Pearson's correlation was done between cumulative score and the cardiovascular parameters. Simple linear regression was done to with cumulative score as independent factor

Our observation is contradictory to the common observation where females have better HRV than males with increased parasympathetic tone, attributed inherently to the hormonal difference between the two genders.[29,30] Estrogen causes increased parasympathetic tone and testosterone increases the sympathetic tone. Hence, the reverse scenario observed in our study could be attributed to the increased level of stress among the female students. That is, the effect of stress is more pronounced in female students.

The drawback in selecting the domain with the highest score and categorizing the student based on that score is that we would lose information about stress level in other domains and the combined effect of all the domains. We, therefore, calculated the cumulative score combining the raw scores from all the six domains for females and males and compared it. Figure 1 shows the cumulative stress score for males and females, and as expected, it was statistically more in females. Our above observations were confirmed by the significant negative correlation of HRV parameters and cardiovascular parameters with cumulative stress scores.

Limitations

Since it is a convenient sampling, we have not got many numbers of students for mild stress. Students with mild stress would have served as a control for other higher stress level groups. BMI has been known to influence HRV. We have not categorized the subjects based on BMI. However, we found no significant difference in the BMI between various stress levels (Moderate: 23.20 ± 3.79; High: 22.83 ± 4.24; Severe: 23.10 ± 4.15) and between genders (Male: 22.79 ± 3.69; Female: 23.05 ± 4.48).

CONCLUSION

We observed that more than 75% of medical students are exposed to high level of stress, and females have higher levels

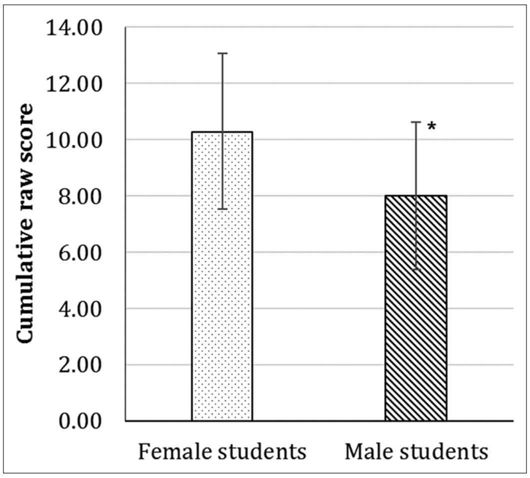

Figure 1: Gender difference in cumulative raw score. Comparison was done using unpaired Student's *t*-test.*$P < 0.05$, *$P < 0.01$, *$P < 0.001$

of stress than males. With the increase in the intensity of stress, the cardiovascular health of the student gets hampered in terms of decreased HRV and increased BP and RPP.

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