Original Article

Evaluation of the Cardiovascular Status of Medical Students During and After the Examination

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ABSTRACT:
Background: Stress is an extremely adaptive phenomenon in human beings. The current study was conducted to evaluate the cardiovascular status of medical students by measuring their heart rate and blood pressure before, during and after the examination. **Methods**: A total of 124 first year MBBS students were selected comprising of 62 males and 62 females. Student's height, weight, pulse rate, systolic blood pressure and diastolic blood pressure were recorded. All the subjects were examined two months prior to the internal assessment examination and again 2 days prior to and one month after the internal assessment examination. Mean and standard deviation (SD) was calculated and reported for quantitative variables. A p-value of <0.05 was considered as statistically significance. **Results**: Mean pulse rate (beats/minute) was high in students during examination as compared to before and after examination. More students had SBP in the range of 120-129 mmHg during examination as compared to 100-109 mmHg before examination. There was not much change in DBP among students before, during or after examination. **Conclusions**: The conclusion showed that mean pulse rate and systolic blood pressure statistically significant increase during examination as compared to before and after examination.
Key words: Cardiovascular status, Blood pressure, Stress, Examination.

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INTRODUCTION

Examination is a specific stressor. Several studies have reported changes in markers of stress in students during the time of examinations.[1-3] Examination stress is one of the most widely suffered problems in medical students throughout the world. There are several changes that one go through in the time period that is followed by exams. These changes may be: *physiological, hormonal, immunological, psychological* and *behavioural*. The extent to which these changes take place in different individuals can depend upon gender, hormonal status, physical activity and spiritual strength, etc.[4]

According to Varvogli and Darviri (2011)[5], stress is a state of threatened homeostasis and it is re-established by complex behavioral and physiologic adaptive responses. Singh *et al.* (2012) defined stress as 'a physical or psychological stimulus that can produce mental or physiological reactions that may lead to illness'.[6]

Autonomic imbalance is also associated with stress. The stress response consists of activation of sympathetic nervous system (SNS) and hypothalamo-pituitary-adrenal (HPA) axis. Human body responds to stress by alterations in different biological functions especially autonomic functions like heart rate and blood pressure.[7] Increase in pulse rate and blood pressure is important sympatho-adrenal responses to physiological stressful experience when outcome is unpredictable or in condition of fear, there is an increase in adrenaline secretion. Increased level of plasma epinephrine and nor-epinephrine during stress increases heart rate and systolic blood pressure by their action on beta receptors of heart.[8-10]

As stress acts directly or indirectly upon brain stem, a great sympathetic discharge is induced at the level of spinal cord and terminal endings of the sympathetic nervous system. The release of norepinephrine is the cause of arteriolar vasoconstriction raising peripheral resistance and that increases diastolic blood pressure.[11]

Activation of sympathetic nervous system is known to increase core body temperature by increasing thermogenesis, including non-shivering thermogenesis in brown adipose tissue and by decreasing heat loss with peripheral vasoconstriction and increasing body temperature.[12-14] During emotional excitement the body temperature slightly increases due to involuntary increased tension in muscles.

Shah and Patel (2014) found highly significant increase in pulse rate, body temperature, systolic and diastolic blood pressure and highly significant decrease in galvanic skin resistance during pre-examination period among 30 first year medical students.[15]

Sharma *et al.* (2011) found highly significant difference in pulse rate, systolic blood pressure and diastolic blood pressure during examination.[16] It was also observed that the stress level was more in females as compared to males. The study concluded that academic examinations for medical students were stressful and produced changes in vital parameters which affected their academic performance. To evaluate the cardiovascular status of medical students by measuring their heart rate and blood pressure before, during and after the examination.

METHODOLOGY
The study was done in the Postgraduate Department of Physiology in collaboration with the Department of Biochemistry, Government Medical College, Jammu. Healthy first year medical students of either sex appearing for their final internal assessment examination were recruited. A written consent was obtained from all the participants.

Exclusion criteria:
- Subjects with a medical disease.
- Suffering from any infections, allergies or inflammatory responses.
- Those taking major psychotropic medications, smokers or alcoholics.
- Subjects having abnormal baseline blood tests (lipid profile and blood cell parameters).
- Obesity.

The subjects were explained the purpose and importance of the study. They were motivated to participate in the present work. Two months prior to the internal assessment examination height, weight, pulse rate, systolic blood pressure and diastolic blood pressure were recorded and again 2 days prior to and one month after the internal assessment examination the same were repeated.

Physical measurements
Record of body weight, height, waist circumference and hip circumference was made as per WHO standards. The body mass index and waist hip ratio were calculated.

Body mass index (BMI): Body mass index was calculated by dividing weight (kg) by height squared (m^2).
Regarding the classification of the subjects in overweight and obese categories, the BMI interpretation used is:-
- BMI < 25   Normal
- BMI 25-30   Indicates overweight
- BMI > 30   Obese[17]

The blood pressure was recorded by ausculatory method using mercury sphygomomanometer in sitting position.[18]

Data analysis
The data was analyzed using computer software Microsoft Excel and IBM SPSS version 22.0 for Windows. Mean and standard deviation (SD) was calculated and reported for quantitative variables. The statistical difference in mean value was tested using paired t test and independent t test. ANOVA (analysis of variance) was also performed to evaluate statistical significance in more than two groups. A p-value of <0.05 was considered as statistically significance. All p-values reported are two-tailed.

RESULTS
The present study was conducted on 124 first year MBBS students comprising of 62 males and 62 females appearing in their final internal assessment examination.

The mean ± standard deviation (SD) age of the total students was 20.21 ± 1.11 years with a range of 18 to 23 years. The mean age ± SD of male and female subjects was 19.98 ± 1.18 years and 20.45 ± 1.00 years respectively.

Table 1 shows description regarding distribution of total subjects before, during and after examination in relation to pulse rate. When pulse rate was recorded before examination, maximum students (38.70%) had pulse rate in the range of 70-79 beats/minute. During examination, maximum students (45.16%) had pulse rate in the range of 90-99 beats/minute, where as when the pulse rate was recorded after examination, it reverted back to 70-79 beats/minute in 27.41% subjects.

Table 2 shows the mean ± SD pulse rate (beats/minute) of subjects before, during and after examination. Mean ± standard deviation pulse rate (beats/minute) was high in males, females and in total subjects during examination. Overall mean pulse rate decreased after examination as compared to the mean before examination and the same scenario was seen for the female subjects, where as in case of male subjects, the mean pulse rate after examination was high as compared to that before examination.

Table 3 compares mean difference in pulse rate of males, females and total subjects in three different pairs *i.e.* before vs during examination, before vs after examination and during vs after examination. The mean difference for all comparisons for males, females and total subjects was statistically significant.

Table 4 shows description regarding distribution of total subjects before, during and after examination in relation to systolic blood pressure (SBP). When SBP was recorded before examination, maximum students (51.61%) had SBP

in the range of 100-109 mmHg. During examination, maximum students (58.87%) had SBP in the range of 120-129 mmHg, where as when SBP was recorded after examination, it was observed to be 130-139 mmHg in 30.64% students.

Table 5 shows the mean ± SD SBP (mmHg) of subjects before, during and after examination. Mean ± standard deviation SBP (mmHg) was high in males, females and in total subjects after examination. The mean SBP during examination was high in males as compared to females or total subjects.

Table 6 compares mean difference in SBP of males, females and total subjects in three different pairs *i.e.* before vs during examination, before vs after examination and during vs after examination. Barring during vs after examination in males, the mean difference for other comparisons for males, females and total subjects was statistically significant.

Table 7 shows description regarding distribution of total subjects before, during and after examination in relation to diastolic blood pressure (DBP). When DBP was recorded before examination, during examination and after examination, maximum students on all three occasions had DBP in the range of 80-89 mmHg.

Table 8 shows the mean ± SD DBP (mmHg) of subjects before, during and after examination. Mean ± standard deviation DBP (mmHg) was high in males, females and in total subjects after examination. The mean DBP during examination was high in females as compared to males or total subjects.

Table 9 compares mean difference in DBP of males, females and total subjects in three different pairs *i.e.* before vs during examination, before vs after examination and during vs after examination. Barring before vs during examination in males, as well as during vs after examination in females, the mean difference for other comparisons for males, females and total subjects was statistically significant.

Table 1: Description regarding distribution of total subjects before, during and after examination in relation to pulse rate (beats/minute)

Pulse rate (beats/min)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
<60	3 (2.41)	0	25 (20.16)
60 – 69	20 (16.12)	2 (1.61)	28 (22.58)
70 – 79	48 (38.70)	10 (8.06)	34 (27.41)
80 – 89	40 (32.25)	33 (26.61)	16 (12.90)
90 – 99	13 (10.48)	56 (45.16)	18 (14.51)
>100	0	23 (18.54)	3 (2.41)
Total	124 (100.00)	124 (100.00)	124 (100.00)

Table 2: Mean ± standard deviation of pulse rate (beats/minute) of subjects on three different occasions

Pulse rate	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (beats/min)	73.32 ± 8.67 (56 – 97)	83.93 ± 8.33 (61 – 99)	78.62 ± 10.00 (56 – 99)
During examination (beats/min)	90.35 ± 9.50 (68 – 100)	94.16 ± 7.13 (70 – 100)	92.25 ± 8.58 (68 – 100)
After examination (beats/min)	79.03 ± 12.46 (54 – 98)	70.67 ± 14.99 (47 – 100)	74.85 ± 14.35 (47 – 100)

Table 3: Comparison of mean difference of pulse rate (beats/minute) of subjects recorded before, during and after examination (paired 't' test)

Pulse rate	Before vs During examination	Before vs After examination	During vs After examination
Males			
Mean ± SD	-17.03 ± 8.63	-5.70 ± 13.90	11.32 ± 14.85
't' value	-15.52	-3.23	6.00
'p' value	.000[**]	.002[**]	.000[**]
Females			
Mean ± SD	-10.22 ± 8.53	13.25 ± 14.65	23.48 ± 15.30
't' value	-9.4	7.1	12.08
'p' value	.000[**]	.000[**]	.000[**]
Total			
Mean ± SD	-13.62 ± 9.20	3.77 ± 17.12	17.40 ± 16.21
't' value	-16.4	2.45	11.95
'p' value	.000[**]	.016[**]	.000[**]

Table 4: Description regarding distribution of total subjects before, during and after examination in relation to SBP (mmHg)

SBP (mmHg)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
90 – 99	0	0	2 (1.61)
100 – 109	64 (51.61)	2 (1.61)	20 (16.12)
110 – 119	35 (28.22)	12 (9.67)	32 (25.80)
120 – 129	23 (18.54)	73 (58.87)	0
130 – 139	2 (1.61)	37 (29.80)	38 (30.64)
140 – 149	0	0	24 (19.35)
150 – 159	0	0	5 (4.03)
≥160	0	0	3 (2.41)
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 5: Mean ± standard deviation of SBP (mmHg) of subjects on three different occasions

SBP	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mmHg)	108.29 ± 9.35 (100 – 130)	105.82 ± 6.91 (100 – 120)	107.05 ± 8.28 (100 – 130)
During examination (mmHg)	123.70 ± 6.06 (110 – 130)	119.82 ± 6.84 (100 – 139)	121.76 ± 6.73 (100 – 139)
After examination (mmHg)	126.91 ± 14.93 (90 – 156)	128.64 ± 15.65 (100 – 167)	127.78 ± 15.26 (90 – 167)

Table 6: Comparison of mean difference of SBP (mmHg) of subjects recorded before, during and after examination (paired 't' test)

SBP	Before vs During examination	Before vs After examination	During vs After examination
Males			
Mean ± SD	-15.41 ± 9.40	-18.62 ± 17.86	-3.20 ± 16.47
't' value	-12.91	-8.21	-1.53
'p' value	.000**	.000**	.130*
Females			
Mean ± SD	-14.00 ± 7.38	-22.82 ± 16.91	-8.82 ± 17.66
't' value	-14.92	-10.62	-3.93
'p' value	.000**	.000**	.000**
Total			
Mean ± SD	-14.70 ± 8.45	-31.33 ± 16.88	-16.62 ± 16.50
't' value	-19.37	-20.66	-11.21
'p' value	.000**	.000**	.000**

Table 7: Description regarding distribution of subjects before, during and after examination in relation to DBP (mmHg)

DBP (mmHg)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
50 – 59	5 (4.03)	4 (3.22)	2 (1.61)
60 – 69	26 (20.96)	15 (12.09)	9 (7.25)
70 – 79	39 (31.45)	38 (30.64)	26 (20.96)
80 – 89	52 (41.93)	60 (48.38)	56 (45.16)
90 – 99	7 (5.64)	16 (12.90)	31 (25.00)
≥100	1 (0.80)	1 (0.80)	0
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 8: Mean ± standard deviation of DBP (mmHg) of subjects on three different occasions

DBP	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mmHg)	76.46 ± 9.44 (54 – 100)	76.77 ± 9.14 (56 – 98)	76.62 ± 9.25 (54 – 100)
During examination (mmHg)	78.29 ± 10.08 (56 – 100)	83.33 ± 9.47 (50 – 98)	80.81 ± 10.07 (50 – 100)
After examination (mmHg)	83.93 ± 8.23 (67 – 98)	84.59 ± 10.53 (50 – 98)	84.26 ± 9.41 (50 – 98)

Table 9: Comparison of mean difference of DBP (mmHg) of subjects recorded before, during and after examination (paired 't' test)

DBP	Before vs During examination	Before vs After examination	During vs After examination
Males			
Mean ± SD	-1.82 ± 11.11	-7.46 ± 12.98	-5.64 ± 14.28
't' value	-1.29	-4.53	-3.11
'p' value	.202*	.000**	.003**
Females			
Mean ± SD	-6.56 ± 13.71	-7.8 ± 13.54	-1.25 ± 13.82
't' value	-3.76	-4.5	-.716
'p' value	.000**	.000**	.476*
Total			
Mean ± SD	-4.19 ± 12.65	-7.6 ± 13.21	-3.45 ± 14.17
't' value	-3.68	-6.44	-2.71
'p' value	.000**	.000**	.008**

DICSUSSION

Stress is defined as an imbalance between environmental conditions necessary for survival and the ability of individuals to adapt to those conditions. Stress in medical students has been recognized for a long time. Many studies have explored the causes, consequences and solutions.[19]

There are three issues considered the most important for the development of stress in medical students. First is the fact that they have to learn a lot of new information in a short time. Second is when they have exams (evaluation period), and last one is that they have little or no time to review what they have learnt.

The present study showed a significant increase in pulse rate and blood pressure prior to the examination. Among female students, mean pulse rate was more as compared to male students before (83.93 vs 73.32 beats/minute) and during (94.16 vs 90.35 beats/minute) examination, but after examination mean pulse rate was more in male students as compared to female students (79.03 ± 70.67 beats/minute).

These findings are in accordance with the observations of Freychuss et al. (1988),[7] who attributed this to increased epinephrine secretion. According to them, the rise in mean pulse rate and mean blood pressure are important sympatho-adrenal response to physiological stressful experience. Jern et al. (1989) also found significant increase in heart rate and systolic and diastolic blood pressure in response to mental stress.[20]

Malathi and Parulkar (1992) observed in their study that significant increase in pulse rate and blood pressure prior to

examination resulted in increased arousal and it was related to sympatho adrenal responses.[21]

The result of the present study is analogous with the study of Sharma et al. (2011),[16] who found highly significant difference in pulse rate, systolic blood pressure and diastolic blood pressure during examination. It was also observed that the stress level was more in females as compared to males. The study concluded that academic examinations for medical students were stressful and produced changes in vital parameters which affected their academic performance.

Al-Zamely (2012) observed that heart rate, systolic blood pressure and neutrophils count increased significantly during academic examination in all student groups while other hematological parameters did not reveal any significant changes.[22]

Anandarajan et al. (2013) found increase in pulse rate and systolic blood pressure in students one hour before the examination compared to pulse rate and systolic blood pressure ten days before and ten days after the examination. Diastolic blood pressure also increased one hour before the examination as compared to ten days before examination.[23]

On the other hand, Pincomb et al. (1987) observed increased heart rate and systolic blood pressure in medical students during examination, especially in situation of increased caffeine intake by the students due to cumulative stress response.[24]

CONCLUSION

The conclusions drawn from study showed that mean pulse rate statistically significant increase during examination as compared to before and after examination. Systolic blood pressure also showed statistically significant increase during examination as compared to before examination and a significant rise in diastolic blood pressure is also seen during examination.

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