e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2022; 14(10); 396-404

Original Research Article

Examination Stress and its Correlation with Cardiovascular Parameters and Lipid Profile

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Received: 23-08-2022 / Revised: 22-09-2022 / Accepted: 10-10-2022

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Conflict of interest: Nil

Abstract

Introduction and Aim: Examination stress can be among the numerous factors that may bring about cardiovascular and lipoprotein changes in Indian subjects. The study was planned to examine the cardiovascular and lipid profile changes among first-year medical students undergoing their academic examinations.

Materials and Methods: Blood pressure, pulse and lipid profile were assessed among 60 students, two months prior to final examinations and on the day of examination.

Results: The systolic blood pressure, diastolic blood pressure & pulse rate, during exam period versus non-exam period showed statistically significant increase and positive correlation; except diastolic blood pressure where though the correlation was positive but it was not statistically significant. Total Cholesterol and LDL values during exam period versus non-exam period were raised significantly, whereas HDL values showed a significant decrease; triglycerides values increased during examination, but it was not statistically significant. There was significant positive correlation among (total Cholesterol, HDL, and LDL) during non-exam and exam period; except Triglycerides values, where though the correlation was positive, it was not significant.

Conclusion: These findings suggest that during the examination period, the stress the students undergo leads to significant changes in cardiovascular and lipid parameters. In the long run these effects can accumulate with subsequent examinations and it can predispose the students to cardiovascular and metabolic diseases.

Keywords: Medical Students, Academic, Blood Pressure

Introduction

Stress is a psychophysiological homeostatic imbalance which arises whenever there is a real or perceived demand capacity mismatch between the individual and his or her environment [1].

Stress involves a stressor and a stress response. A stressor may be physical or psychological. Physical stressors include environmental factors such as noise, overcrowding and excessive heat or cold. Stressors also include primary psychological experiences and daily hassles in the family & workplace [2]. Physiological consequence of these stressors includes specific biological &

cellular tissue alterations [3]. During stress there is an increase in levels of cortisol, nor-epinephrine, and growth hormone [4]. This can result in lipolysis, glycogenolysis, and increased contractility of heart, increased heart rate, cardiac output & blood pressure [5].

Several studies from western countries and Asia have reported that medical training is highly stressful, particularly for those who are beginning their medical education (First year M.B.B.S students). It is likely that the sources of stress are common across cultures [6].

Academic stress is a good model of psychological stress in humans and is therefore useful for studying psychoneurohormonal changes [7]. During chronic psychological stress, changes in catecholamines and lipoproteins levels may contribute to increased mortality in coronary heart diseases. [8].

Repeated stress during academic life can have a profound impact on the overall health of the student. Therefore, the study was aimed to examine changes in pulse, blood pressure and lipid level and their correlation during examination stress, if any. As, such a type of stress is easy to administer and is easily reproducible.

Material and Methods

The study was conducted in the Department of Physiology, Pad. Dr. D.Y. Patil Medical College, Pune, Maharashtra, India, with the approval of Institutional Ethical Committee. This was a cross-sectional study.

The study included 60 medical students. The sample size was chosen after a detailed discussion with the Statistician of Pad. Dr. D. Y. Patil Medical College. Informed consent was taken from all the students.

Inclusion Criteria

Healthy medical students, aged 18-21years, with body mass index less than twenty-five (B.M.I <25)

Exclusion Criteria

Students with a history of smoking, hypertension, diabetes mellitus, renal disease or any other disease that could affect serum lipids and lipoprotein metabolism were excluded.

The following estimations were carried out in the study subject.

For body weight, a balance weighing scale {LIBRA} was used to measure body weight. Subjects were weighed without their shoes and with light summer clothing.

Standing body height was measured without shoes to the nearest 0.5 cm by using height measuring scale stand with shoulders in a relaxed position and arms hanging freely.

B.M.I. was calculated as body weight in kilograms divided by square of body weight in meters. B.M.I. cut off for the subjects were taken as 25 as per the revised WHO standards [9]. Those having B.M.I. greater than 25 were categorised into obese and those with B.M.I. less than 25 as nonobese.

For Pulse, subjects were seated comfortably with their forearms in semi pronated position and wrist semi flexed. Pulse rate was measured using the three-finger method. Pulse rate was counted for full one minute.

The blood pressures of the subjects were measured using a manual mercury sphygmomanometer. B.P was recorded at a fixed time between 8:30 – 9:30 am to maintain constancy of conditions. The B.P was measured in a lying down position. The measurement was taken after 5 minutes of rest by the subject. The appropriate size sphygmomanometer cuff was applied to the right arm of the subject to ensure a correct reading. The first and fifth Korotkoff sounds were recorded for systolic and diastolic readings respectively [10]. Two readings separated by two minutes were averaged, however, if they differed by more than 5mm of Hg, an

additional reading was taken and the average of all three were taken. The same person carried out the measurements in all the subjects to avoid an individual error.

The first recording of pulse and blood pressure was done in the non-exam period (non-stress period) during the middle of the second semester, approximately 2 months prior to the final examinations.

The second recording of pulse and blood pressure from the same 60 students was collected on the day of examination itself and this constituted the stress period.

To estimate the lipid profile 10ml of venous blood sample was withdrawn from each individual between 8:30am-9:30 am, after an overnight fast to maintain constancy. The blood was kept in a sterile container, allowed to clot and the serum was separated. The serum sample collected from the students before and during the examination period was analysed on the same day.

For HDL, Total Cholesterol, Triglyceride analysis, standard commercially available kits were used and analysed on semiautomatic analyser. (Erba Chem Pro). LDL was calculated using the formula: LDL (mg%) =TC-HDL-TG/5.Total Cholesterol was estimated by the Cholesterol esterase and oxidase enzymatic method. HDL Cholesterol was estimated by cholesterol esterase and oxidase method by first removing all non - HDL lipoproteins using polyanionic detergent. LDL was estimated by Friedwald Equation (LDL Cholesterol = Total Cholesterol- [HDL Cholesterol]-[Triglyceride/5].Triglyceride was measured by splitting them with lipoprotein lipase) [11].

Results

Results are expressed as mean ±SEM for normally distributed variables or as median and interquartile range when data was not normally distributed. Statistical difference between groups was assessed by paired t-test.

Mean pulse rate during the non-examination period was 77.06±0.79/min and that during the examination period was 81.35±0.67/min. The difference between non examination and examination was ($p<0.0001$) (Table 1).

The mean systolic blood pressure in the non-examination period was 107.16±1.91 mm Hg and that during examination period was 114.76±0.98 mm Hg. The difference between non examination and examination period was ($p<0.0001$) (Table 1).

The mean diastolic blood pressure in the non-examination period was 68.23±1.09 mmHg and that during examination period was 75.73± 0.86 mmHg. The difference between non examination and examination period was ($p<0.0001$) (Table 1)

Table 1: Mean values of test parameters in Subjects during examination and non-examination period

Parameters	Non Examination Period n = 60	Examination Period n = 60	P Values
Pulse	77.06±0.79	81.35±0.67	< 0.001
Diastolic BP (mm of Hg)	68.23±1.09	75.73± 0.86	<0.001
Systolic BP (mm of Hg)	107.16±1.91	114.76±0.98	<0.001
Inference: - The systolic & diastolic blood pressure, pulse rate were significantly raised during the examination period.			

The data for non-exam period and that for the exam period was analysed for normal distribution and after that correlation was assessed using Pearson's correlation. All the parameters showed positive correlation i.e. (r>0). Pulse (0.7), Systolic BP (0.2), Diastolic BP (0.2). The paired t test was applied to the correlation coefficients to test the statistical significance. All values except diastolic blood pressure showed significant correlation. (Table 2)

Table 2: Correlation coefficients between cardiovascular parameters

Parameters	Pearson's Correlation (r)	P Value
Pulse	0.7	(p<0.001)
Systolic Blood Pressure	0.2	(p<0.001)
Diastolic Blood Pressure	0.2	(p>0.001)
Inference: There was positive correlation among all the parameters (pulse, systolic and diastolic blood pressure). Pulse and systolic blood pressure showed statistically significant positive correlation. The diastolic blood pressure also showed positive correlation but was statistically non-significant.		

Mean total Cholesterol in the non-examination period was 148.31±3.50 mg/dl, and that during the examination period was 171.28±3.14 mg/dl. The difference between non-examination and examination period values was (p<0.0001) (Table 3).

A mean triglyceride level, in the non-examination period, was 87.43±3.37 mg/dl and that during the examination period was slightly raised 95.38±3.48 mg/dl. However, the difference between non-examination and examination period values was (p=0.0693). Mean high-density lipoprotein levels, in the non-examination period, were 49.66±0.85 mg/dl and that during the examination period were 46.06±0.72 mg/dl. The difference between the non-examination and examination period was (p<0.0001)(Table 3).

Mean low density lipoprotein levels, in the non-examination period, were 81.15±2.89 mg/dl and that during examination period was 106.23±3.04 mg/dl. The difference between non-examination and examination was (p<0.0001) (Table 3).

Table 3: Mean Values of test parameters in Subjects during the examination and non-examination period.

Parameters	Non Examination Period n = 60	Examination Period n = 60	P Values
Total Cholesterol (mg/dl)	148.31±3.50	171.28±3.14	< 0.0001
Triglyceride (mg/dl)	87.43±3.37	95.38±3.48	=0.0693
HDL (mg/dl)	49.66±0.85	46.06±0.72	<0.0001
LDL (mg/dl)	81.15±2.89	106.23±3.04	< 0.0001
Inference: The Total Cholesterol, LDL were significantly raised during the examination period. The Triglycerides values showed increase during examination period, but it was not statistically significant. The HDL values showed a significant decrease during the examination period			

The data during non-exam period and that during exam period was analysed for correlation. (Table 4]). All the parameters showed positive correlation i.e. (r>0). Total Cholesterol (0.6), Triglyceride (0.2), HDL(0.4), LDL(0.6).The paired t-test was applied to the correlation coefficients .'p' value was assessed to ascertain whether the correlation of the above parameters were significant or not. The result was Total cholesterol (p<0.001), triglyceride (p>0.001), HDL(p<0.001), LDL(p<0.001) (Table 4). Therefore, Triglycerides values showed a non-significant correlation.

Table 4: Correlation coefficients between lipid parameters

Parameters	Pearson's Correlation (r)	p value
Total Cholesterol	0.6	(p<0.001)
Triglyceride	0.2	(p>0.001)
HDL	0.4	(p<0.001)
LDL	0.6	(p<0.001)
Inference: There was positive correlation among all the parameters (total Cholesterol, triglyceride, HDL, LDL). Pulse, Total Cholesterol, HDL, LDL and systolic blood pressure, showed significant correlation. The Triglycerides values showed non- significant correlation.		

Discussion

In our study the systolic & diastolic blood pressure, pulse rates were significantly raised during the examination period in comparison to the non-examination period. These results are similar to the ones obtained in other studies.

In 2005 Pramanik Tapan *et al.,* found out in the period of preparations for final examinations a significant rise in diastolic and mean blood pressure took place in both sexes. They concluded that this may be due to vestibule sympathetic reflex elicited by head down and neck flexed posture (the conventional position of study) for a prolonged time [12].In 2017 K. Bhaskara Raju *et al.*,noted significant rise in systolic blood pressure & diastolic blood pressure and pulse rate before examination [13].In 2018 Alves De Oliveira T *et al.* , verified that the systolic arterial pressure and cardiac frequency values checked on exam days were statistically higher than when measured on class days or during vacations [14].Same year Dulloo P *et al.*, observed significant difference for the level of pulse rate, systolic blood pressure & diastolic blood pressure before the exam and relaxed state as well as post exam state. Heart rate and diastolic blood pressure were not statistically significant in comparison to relaxed state versus post-exam [15]. In year 2020 Richa Singh *et al.,* noted a statistically significant increase in systolic blood pressure and diastolic blood pressure during and after examinations [16]. Same year N. O. Ajayi *et al.*, study concluded that examination stress increases towards the start of examination and reduces after it, males and females differ in their experience of stress imposed by academic examination, and blood pressure increases with stress [17].

In our subjects , stress induced stimulation of the sympathetic nervous system released nor epinephrine, exciting the heart, veins and arterioles. In addition, the sympathetic nerves to the adrenal medulla caused these glands to secrete both norepinephrine and epinephrine into the blood . This leads to lipolysis and glycogenolysis , increased contractility of heart , rise in heart rate , cardiac output , and blood pressure . There was a positive correlation among all the parameters (pulse rate, systolic and

diastolic blood pressure). This shows that parameters during the non-examination period and the ones during the examination period were correlated. All parameters had significant positive correlation except diastolic B.P. which had insignificant positive correlation.

In 2002 Bachen EA *et al.,* findings suggested that stress associated elevation in total Cholesterol and its HDL and LDL sub fractions were attributed to concomitant haemoconcentration and not to sympathetically mediated alteration in lipid metabolism. However, increased fatty acids and T.G.L. resulted from direct metabolic effect of sympathetic activation, as evidenced by their amelioration under adrenoceptor blockade [18]. In 2014 A.I Uba *et al.*, study revealed raised serum Triglycerides, low-density cholesterol and total Cholesterol but decreased high density lipoprotein levels during the commencement of examination. Their study showed that the higher the examination stress, the higher the serum total cholesterol, Triglycerides, Low density lipoprotein levels and lower the serum High density lipoprotein levels, suggesting an increased risk of hypercholesterolemia in stress condition [19]. In 2015 Ignatius C Maduka *et al.*, study observed a significant rise in adrenaline, serum cortisol, Total Cholesterol, HDL and LDL levels during examination in comparison to non-exam period [20].

In 2018 Mohammad Ahmad Hamza *et al.*, observed that M.D.A., Total Cholesterol, Triglyceride, LDL, VLDL increased significantly and HDL, HDL / total cholesterol ratio decreased significantly in stress condition when compared with "non-stress" conditions [21].Same year Jawad Hussain *et al.*, noted that total Cholesterol, triglycerides and LDL were raised during the stress state while the level of HDL during the stressed was decreased as compared to the relaxed phase [22]. In 2020 Tangeda Padmaja Rao study observed an increase in cortisol, T.C., HDL and LDL which was significant during examination stress but between cortisol and the other parameters no significant correlation was observed [23]. In 2019 Maradi R *et al.*, stated that hormone sensitive lipase are activated due to decrease in insulin level prior to examination, which leads to lipolysis and increased Triglyceride production [24]. However, some workers like Niarura et al have observed, that commonly occurring stressful situations induced significant psychological distress but no changes in plasma lipid and lipoprotein levels [25].

Therefore, from the previous studies it is concluded that stress associated elevation in total Cholesterol and its HDL and LDL sub fractions are attributed to haemoconcentration secondary to decreased plasma volume, perhaps due to vascular fluid shift (however in our studies we have not studied these fluid shift mechanisms), whereas increased fatty acids and T.G.L. result from direct metabolic effect of sympathetic activation.

In the present study the Total Cholesterol, Triglycerides and LDL values were raised during the examination period. These results agree with those obtained by other workers [19-23].

The HDL values showed a significant decrease during the examination period, similar to other studies [19,21,22]. However other workers have shown an increase in the level of HDL during examination period [18,20,23]. The effects thus observed in our study could be a consequence of haemoconcentration and or the effect of sympathetic activation. There was positive correlation among all the parameters (total Cholesterol, triglyceride, HDL, LDL). This shows that parameters during the non-examination period and the ones during the examination period were correlated. Also, except triglyceride rest all parameters correlation was significant.

Our study shows that the medical students have an adverse lipoprotein profile characterised by reduction in level of high-

density lipoprotein and increase in the level of Total Cholesterol and Low-density lipoprotein along with a small increase in Triglycerides. These changes may be the consequences of increase in mental stress during their examinations. It is important to follow these students throughout their medical education, to evaluate their lipid profile for any long-term adverse effects. It would also require undertaking studies for effect of haemoconcentration in the future.

These findings will help guide academic curriculum planners on optimal strategies to reduce mental stress among students during examinations & throughout the period of medical training.

These results will add to our knowledge of the numerous factors that may bring about lipid and lipoprotein changes in Indian subjects.

Cardiovascular diseases are related to stress induced mechanism which causes adrenergic stimulation, elevation in lipid levels, changes in blood coagulability, atherogenesis and haemodynamic changes leading to hypertension and ischemic heart diseases [26]. As per latest research on animal models, acute stress stimulates arrhythmogenesis, platelet activity and increase blood viscosity through haemoconcentration [27].

Conclusion

In our study we found a significant increase in pulse rate, systolic & diastolic blood pressure. Also, there was positive correlation among all parameters. Total Cholesterol & LDL was found to be increased significantly while HDL level show significant decrease; there was positive correlation among all the parameters. These findings suggest that during the examination period the stress through which the students undergo lead to adverse changes in cardiovascular parameters and lipids. If the study could be extended to the whole duration of M.B.B.S course, it will provide a greater overview of the prevailing health status of the students. Effect of stress on fibrinogen level, plasma viscosity, hematocrit and hemoglobin concentration could also be done to assess the degree of haemoconcentration (if any).

Though our study subjects are young but by further assessing them with Anxiety scale, the students predisposed to stress can be identified and guided accordingly. These findings will help guide academic curriculum planners on optimal strategies like (relaxation techniques, time management, yoga/pranayama, counselling, diet alteration) etc. to reduce mental stress among students during examinations & throughout the period of medical training. This will prove to be of great help in the general wellbeing of our students and our future doctors.

Acknowledgment

I shall be ever grateful to Dr. Mahesh Karandikar, Professor, Department of Physiology, who encouraged me to perform this study. His constant guidance & inspiration helped me, to successfully complete the study.

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