International Journal of Research in Health and Allied Sciences

Journal home page: www.ijrhas.com

Official Publication of "*Society for Scientific Research and Studies*" [Regd.]

ISSN 2455-7803 Index Copernicus value 2016 = 68.10

Original Article

Effect of Examination Stress on Serum Cholesterol, Triglycerides, Lipoprotein and Blood Sugar

Kaniz Fatima[1], Vanita Sharma[2]

[1]Senior Resident, Department of Physiology, Government Medical College, Jammu, India, [2]Associate Professor, Department of Physiology, Government Medical College, Jammu, India

ABSTRACT:

Background: Examination has been described as a naturalistic stressor capable of affecting human health. The study was planned to evaluate the effect of examination stress on serum cholesterol, triglycerides, low density lipoprotein, high density lipoprotein and blood sugar. **Methods**: The present study was conducted on 124 first year MBBS students comprising of 62 males and 62 females. In this study examination of serum cholesterol, serum triglycerides, serum HDL, serum LDL and blood sugar were recorded of students. The examination was done two months prior to the internal assessment examination and again 2 days prior to and one month after the internal assessment examination. The statistical difference in mean value was tested using paired t test and independent t test. ANOVA was also performed to evaluate statistical significance in more than two groups. A p-value of <0.05 was considered as statistically significance. **Results**: The levels of serum cholesterol, serum triglycerides and serum LDL cholesterol are at higher during examination period. Blood sugar also showed increase in levels during examination. No significant alteration was observed in the levels of serum HDL cholesterol in our study. **Conclusions**: The study concluded that the levels of serum cholesterol, serum triglycerides, serum LDL cholesterol and serum blood sugar rise significantly due to examination stress, whereas serum HDL cholesterol remain almost constant.

Key words: Stress, Serum Cholesterol, Triglycerides, Lipoprotein, Blood sugar

Corresponding Author: Dr. Kaniz Fatima, Department of Physiology, Government Medical College, Jammu, India

This article may be cited as: Fatima K, Sharma V. Effect of Examination Stress on Serum Cholesterol, Triglycerides, Lipoprotein and Blood Sugar. Int J Res Health Allied Sci 2018; 4(2):15-22.

INTRODUCTION

The modern age has been called the age of stress. All things, events, conditions or situations that demand a change or adjustment in the physical and emotional functions are termed as stressors. Medical students are usually under stress due to a variety of reasons like vast curriculum, academic competition, examinations, etc. During these stressful situations there might be increase in anxiety level and sympathetic discharge **(Shah and Patel, 2014)**.

Mental stress acutely enhances insulin induced glucose utilization through stimulation of SNS **(Seematter *et al.*, 2000)**. Stress directly stimulates HPA axis resulting in excess production of cortisol. This cortisol alters many physiological actions resulting in physical illness **(Miller and O'Callaghan, 2002)**.

Physiological studies have shown that stress from any source can influence on the endocrine, haemopoietic and immune systems **(Dorshkind *et al.*, 2001)**. Psychological stress increases the activity of HPA axis leading to increase circulating levels of glucocorticoids **(Tsigos and Chrousos, 2002; Raison and Miller, 2003)**. HPA axis includes sympathetic activation leading to changes in heart rate, blood pressure, rate and depth of respiration, body temperature, reaction time and galvanic skin resistance **(Shah and Patel, 2014)**.

Activation of sympathetic nervous system during stress increases the production of serum lipids and lipoproteins by altering serum lipid metabolic processes **(Brindley *et al.*, 1993)**. Catecholamines induce lipolysis and release free fatty acids into the circulation; free fatty acids in turn serve as substrate for the re-synthesis of triglycerides and subsequently very low density lipoprotein production by the liver **(Brindley and Rolland, 1989)**.

Since serum cortisol has similar primary structure (cyclopentanoperhydro-phenanthrene ring system) as steroids and lipids, and lipids are usually metabolized to release energy, there may be a possibility of examination stress affecting the lipid profile in the body. Any alteration in the plasma lipid which leads to increase in cardiac risk factor may ultimately predispose the student to risk **(Maduka *et al.*, 2015)**.

Increase in serum lipids during stress cause acute intravascular hemoconcentration through a decrease in plasma volume, which leads to an increase in the concentration of blood cell, plasma proteins and circulating lipoproteins **(Patterson *et al.*, 1993)**. Studies have suggested that hemoconcentration accounts for rise

in total and high density lipoprotein cholesterol during experimental stressor **(McCann *et al.*, 1995)**.

Various studies have been conducted to examine lipids and lipoproteins under different stressors. Some of those have shown to increase **(Francis, 1979; McCann *et al.*, 1995)** and others detected decrease **(Ahaneku *et al.*, 2001)** in blood lipids and lipoproteins.

Serum cholesterol level is an important parameter related with stress. During stress cortisol level is elevated along with other stress hormones and due to lipolytic effects of cortisol, serum triglycerides and cholesterol levels are found to be increased in stress. A number of investigators have found that cholesterol levels are appreciably higher during periods of stress than at other times but there are a few studies establishing relationship between mental stress and serum lipid profile **(Hildesheimer *et al.*, 1985)**. Students are exposed to high levels of stress at an early age. Male students are affected more due to the testosterone which increases the circulating levels of low density lipoprotein cholesterol (LDL-C) and decreases plasma high density lipoprotein cholesterol (HDL-C). Estrogens have a significant plasma cholesterol lowering action and they rapidly produce vasodilatation by increasing the local production of nitric oxide. Estrogen is known to be a vagotonic and sympatholytic hormone **(Matousek *et al.*, 2010)**. Hormonal factors do cause of variance in heart rate variability among males and females. These actions inhibit atherogenesis and contribute to the low incidence of acute myocardial infarction and other complications of atherosclerotic vascular disease in premenopausal females **(Shahnam *et al.*, 2010)**.

The present study was conducted to evaluate the effect of examination stress on serum cholesterol, triglycerides, low density lipoprotein, high density lipoprotein and blood sugar.

MATERIAL AND METHODS

The study was conducted in the Postgraduate Department of Physiology in collaboration with the Department of Biochemistry, Government Medical College, Jammu.

After approval from the Institutional Ethics Committee, healthy first year medical students of either sex appearing for their final internal assessment examination were recruited. A written informed consent was obtained from all the participants.

Selection criteria

Those subjects having medical complications and suffering from any type of infections. Also subjects having abnormal baseline blood tests (lipid profile and blood cell parameters) were excluded.

Two months prior to the internal assessment examination height, weight, serum cholesterol, serum triglycerides, serum HDL, serum LDL and blood sugar were recorded and again 2 days prior to and one month after the internal assessment examination the same were repeated.

Subjects were asked about their dietary intake, smoking habits, alcohol intake and physical activity.

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 **(WTRS, 1995)**

For biochemical parameters, subjects were asked to fast for 14 hours before the day of test. This was to avoid the influence of diet on serum lipid profile and blood sugar. 5 ml of venous blood was drawn from anticubital vein under all aseptic precautions for the estimation of biochemical parameters. The sample from disposable syringe was transferred immediately to plain vacutainers which were marked already and were kept in the rack and allowed to clot at room temperature for more than 30 minutes. These samples were centrifuged in Remilab centrifuge at 3000 rpm for 15 minutes. Serums were separated and transferred to other dry test tubes which were then capped with cotton plugs and taken to the Department of Biochemistry for analysis of the following biochemical parameters. Lipid profile was performed on Architect c System and Aeroset system by using special kits supplied by Abbot Laboretterie. The instrument is a triangular shaped electronic device that calculates and prints out the concentration of biochemical tests.

1. **Serum total cholesterol** estimation was done by fully enzymatic cholesterol oxidase-peroxidase method (CHOD-POD) **(Varley *et al.*, 1984a)**.
2. **Serum triglycerides** estimation was done by fully enzymatic glycerol phosphate oxidase-peroxidase method (GPO-POD) **(Fossati and Prencipe, 1982)**.
3. **Serum high density lipoprotein (HDL) cholesterol** estimation was done by autozyme precipitation reagent method in conjunction with autozyme cholesterol reagent **(Varley *et al.*, 1984b)**.
4. **Serum low density lipoprotein (LDL) cholesterol** was calculated by the method of Friedwald formula **(NCEP, 1994)**. None of the subjects had serum triglyceride levels above 400 mg/dL and, therefore, Friedwald formula was used in all the subjects to calculate serum LDL cholesterol. LDL Cholesterol mg% = Total Cholesterol – HDL Cholesterol – (Triglyceride ÷ 5).
5. **Fasting blood glucose** estimation was done by fully enzymatic glucose oxidase-peroxidase method (GOD-POD) **(Varley *et al.*, 1984c)**.

Lipid profile values were assessed according to the National Cholesterol Education Programme of USA **(NCEP, 1994)** which classifies total cholesterol as desirable (<200 mg/dL), borderline high risk (200 – 239 mg/dL) and high risk (≥240 mg/dL); triglycerides as desirable (<200 mg/dL), borderline (200 – 400 mg/dL),

high (400 to 1000 mg/dL) and extremely high (>1000 mg/dL) and HDL cholesterol as low (< 35 mg/dL), normal (35 – 59 mg/dL) and high (> 60 mg/dL).
The blood glucose values were assessed according to Harrison's Principles of Internal Medicine, which classifies blood glucose values as normal (75 – 110 mg/dL), impaired glucose tolerance (111 – 125 mg/dL) and diabetes mellitus (>125 mg/dL) **(Fauci *et al.*, 2008)**.

Statistical analysis
The statistical difference in mean value was tested using paired t test and independent t test. ANOVA was also performed to evaluate statistical significance in more than two groups. A p-value of <0.05 was considered as statistically significance.

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.
Table 1 shows description regarding distribution of total subjects before, during and after examination in relation to serum cholesterol. Before examination, maximum students (29.83%) had serum cholesterol in the range of 140-159 mg/dL. During examination, maximum students (41.12%) had serum cholesterol in the range of 180-199 mg/dL, while after examination maximum students (25.80%) had serum cholesterol either in the range of 140-159 or 160-179 mg/dL.
Table 2 shows the mean ± SD serum cholesterol (mg/dL) of subjects before, during and after examination. Mean ± standard deviation serum cholesterol (mg/dL) was high in males, females and in total subjects during examination as compared to before or after examination.
Table 3 shows description regarding distribution of total subjects before, during and after examination in relation to serum triglycerides. Before examination, maximum students (43.54%) had serum triglycerides in the range of 60-79 mg/dL. During examination, maximum students (34.67%) had serum triglycerides in the range of 120-139 mg/dL, while after examination maximum students (48.38%) again had serum triglycerides in the range of 60-79 mg/dL.
Table 4 shows the mean ± SD serum triglycerides (mg/dL) of subjects before, during and after examination. Mean ± standard deviation serum triglycerides (mg/dL) was high in males, females and in total subjects during examination as compared to before or after examination.
Table 5 shows description regarding distribution of total subjects before, during and after examination in relation to serum high density lipoprotein (HDL). Before examination, maximum students (57.25%) had serum HDL in the range of 40-49 mg/dL. During examination, maximum students (49.19%) also had serum HDL in the range of 40-49 mg/dL, while after examination maximum students (40.32%) had serum HDL in the range of 50-59 mg/dL. Table 6 shows the mean ± SD serum HDL (mg/dL) of subjects before, during and after examination. Mean ± standard deviation serum HDL (mg/dL) was high in males, females and in total subjects after examination as compared to before or during examination. Serum HDL was slightly high in males during examination as compared to females or total subjects.
Table 7 shows description regarding distribution of total subjects before, during and after examination in relation to serum low density lipoprotein (LDL). Before examination, maximum students (58.87%) had serum LDL <100 mg/dL. During examination, maximum students (53.23%) also had serum LDL in the range of 100-129 mg/dL, while after examination maximum students (59.67%) had serum LDL in the range of <100 mg/dL. Table 8 shows the mean ± SD serum LDL (mg/dL) of subjects before, during and after examination. Mean ± standard deviation serum LDL (mg/dL) was high in males, females and in total subjects during examination as compared to before or after examination. Serum LDL was high in females during examination as compared to males or total subjects. Table 9 shows description regarding distribution of total subjects before, during and after examination in relation to serum blood sugar. Before examination, maximum students (35.48%) had serum blood sugar in the range of 80-89 mg/dL. During examination, maximum students (50.80%) had serum blood sugar in the range of 100-109 mg/dL, while after examination maximum students (31.45%) had serum blood sugar in the range of 70-79 mg/dL. Table 10 shows the mean ± SD serum blood sugar (mg/dL) of subjects before, during and after examination. Mean ± standard deviation serum blood sugar (mg/dL) was high in males, females and in total subjects during examination as compared to before or after examination.

Table 1: Description regarding distribution of total subjects before, during and after examination in relation to serum cholesterol (mg/dL)

Serum cholesterol (mg/dL)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
≤99	0	0	2 (1.61)
100 – 119	15 (12.09)	1 (0.80)	14 (1.29)
120 – 139	22 (17.74)	3 (2.41)	27 (21.77)
140 – 159	37 (29.83)	24 (19.35)	32 (25.80)
160 – 179	36 (29.03)	29 (23.38)	32 (25.80)
180 – 199	13 (10.48)	51 (41.12)	17 (13.70)
≥200	1 (0.80)	16 (12.90)	0
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 2: Mean ± standard deviation of serum cholesterol (mg/dL) of subjects on three different occasions

Serum cholesterol	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mg/dL)	139.79 ± 24.11 (100 – 200)	161.87 ± 22.36 (102 – 198)	150.83 ± 25.67 (100 – 200)
During examination (mg/dL)	171.74 ± 22.18 (100 – 205)	184.62 ± 16.54 (130 – 200)	178.18 ± 20.53 (100 – 205)
After examination (mg/dL)	136.24 ± 25.87 (76 – 189)	163.06 ± 21.95 (100 – 199)	149.65 ± 27.42 (76 – 199)

Table 3: Description regarding distribution of total subjects before, during and after examination in relation to serum triglycerides (mg/dL)

Serum triglycerides (mg/dL)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
40 – 59	14 (11.29)	2 (1.61)	17 (13.70)
60 – 79	54 (43.54)	7 (5.64)	60 (48.38)
80 – 99	35 (28.22)	23 (18.54)	28 (22.58)
100 – 119	8 (6.45)	19 (15.32)	8 (6.45)
120 – 139	13 (10.48)	43 (34.67)	6 (4.83)
140 – 159	0	23 (18.54)	4 (3.22)
160 – 179	0	3 (2.41)	1 (0.80)
180 – 199	0	4 (3.22)	0
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 4: Mean ± standard deviation of serum triglycerides (mg/dL) of subjects on three different occasions

Serum triglycerides	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mg/dL)	79.69 ± 24.69 (48 – 135)	87.11 ± 17.84 (51 – 154)	83.40 ± 21.77 (48 – 154)
During examination (mg/dL)	117.62 ± 25.61 (57 – 187)	122.38 ± 28.48 (56 – 198)	120.00 ± 27.08 (56 – 198)
After examination (mg/dL)	81.90 ± 27.71 (46 – 169)	80.37 ± 17.63 (43 – 137)	80.62 ± 22.52 (43 – 169)

Table 5: Description regarding distribution of total subjects before, during and after examination in relation to serum HDL (mg/dL)

Serum HDL (mg/dL)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
<40	4 (3.22)	0	0
40 – 49	71 (57.25)	61 (49.19)	47 (37.90)
50 – 59	43 (34.67)	51 (41.12)	50 (40.32)
60 – 69	6 (4.83)	11 (8.87)	25 (20.17)
≥70	0	1 (0.80)	2 (1.61)
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 6: Mean ± standard deviation of serum HDL (mg/dL) of subjects on three different occasions

Serum HDL	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mg/dL)	47.79 ± 8.00 (19 – 67)	49.53 ± 5.35 (41 – 60)	48.66 ± 6.83 (19 – 67)
During examination (mg/dL)	51.32 ± 8.01 (40 – 70)	50.16 ± 5.60 (40 – 64)	50.74 ± 6.91 (40 – 70)
After examination (mg/dL)	51.79 ± 7.57 (43 – 76)	55.24 ± 8.22 (41 – 75)	53.51 ± 8.06 (41 – 76)

Table 7: Description regarding distribution of total subjects before, during and after examination in relation to serum LDL (mg/dL)

Serum LDL (mg/dL)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
<100	73 (58.87)	42 (33.87)	74 (59.67)
100 – 129	49 (39.52)	66 (53.23)	49 (39.52)
≥130	2 (1.61)	16 (12.90)	1 (0.81)
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 8: Mean ± standard deviation of serum LDL (mg/dL) of subjects on three different occasions

Serum LDL	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mg/dL)	76.66 ± 22.72	103.74 ± 17.13	90.20 ± 24.21 (39 – 134)
During examination (mg/dL)	96.64 ± 23.46	111.37 ± 20.79	104.00 ± 23.28 (13 – 144)
After examination (mg/dL)	78.56 ± 24.79	97.64 ± 20.09	88.10 ± 24.43 (34 – 139)

Table 9: Description regarding distribution of subjects before, during and after examination in relation to serum blood sugar (mg/dL)

Serum blood sugar (mg/dL)	Before examination No. (%)	During examination No. (%)	After examination No. (%)
<70	3 (2.41)	0	37 (29.83)
70 – 79	35 (28.22)	2 (1.61)	39 (31.45)
80 – 89	44 (35.48)	11 (8.87)	28 (22.58)
90 – 99	36 (29.03)	35 (28.22)	20 (16.12)
100 – 109	6 (4.83)	63 (50.80)	0
≥110	0	13 (10.48)	0
Total	**124 (100.00)**	**124 (100.00)**	**124 (100.00)**

Table 10: Mean ± standard deviation of serum blood sugar (mg/dL) of subjects on three different occasions

Serum blood sugar	Males Mean ± SD (Range)	Females Mean ± SD (Range)	Total Mean ± SD (Range)
Before examination (mg/dL)	83.24 ± 8.95 (55 – 100)	88.64 ± 8.69 (70 – 100)	85.94 ± 9.19 (55 – 100)
During examination (mg/dL)	98.95 ± 7.80 (78 – 117)	99.79 ± 6.62 (80 – 120)	99.47 ± 7.13 (78 – 120)
After examination (mg/dL)	75.29 ± 11.95 (45 – 98)	81.62 ± 11.28 (55 – 99)	83.14 ± 13.49 (45 – 99)

DISCUSSION

Medical students are overloaded with a tremendous amount of information. The overload of information creates a feeling of disappointment because the students do not handle all information and therefore are not successful during the examination period.

Stress and Biochemical Parameters

The present study showed a significant rise in serum cholesterol with examination stress. In our study, more students had serum cholesterol within the range of 140 to 179 mg/dL two months prior to the first professional internal assessment examination, 160 to 199 mg/dL 2 days prior to first professional internal assessment examination and again 140 to 179 mg/dL one month after the examination. Mean serum cholesterol was high in all subjects during examination as compared to before or after examination.

Similarly, there was a clear and significant rise in levels of serum triglycerides before, during and after the examination. More students had mean triglycerides within the range of 60 to 79 two months prior to the first professional internal assessment examination, 120 to 139 mg/dL 2 days prior to first professional internal assessment examination and again 60 to 79 mg/dL one month after the examination.

However, values of mean serum high density lipoprotein cholesterol were within the range of 47 to 50 mg/dL two

months prior to first professional internal assessment examination, within the range of 50 to 52 two days prior to the first professional internal assessment examination, while it ranged from 51 to 56 mg/dL one month after the examination. There was a statistically significant difference when males, females and total subjects were analyzed before, during and after examination for mean serum high density lipoprotein cholesterol (p=0.00 for all).

The results of present study are similar to the study of **Van-Dooren and Van-Blokland (1987)**, who observed rise in serum cholesterol from 4.45 mmol/L on control days to 4.69 mmol/L on stress day in both males and females. These changes were mediated by stress hormones having lipid mobilizing properties.

Kurian *et al.* (2015) in a cross-sectional study found low high-density lipoprotein-cholesterol (HDL-C) was significantly more among females. Male preponderance was observed in high triglycerides (TG), total cholesterol (TC) and high density lipoprotein-cholesterol/total cholesterol ratio levels, though it was statistically not significant. This study is partially in agreement with the result of the present study. The effect of stress on serum cholesterol seems to be variable. In a study of 55 volunteers, **Kuhl *et al.* (1954)** found an increase in serum cholesterol levels following brief immersion in cold water. **Thomas and Murphy (1958)** observed that cholesterol values were elevated during the initial weeks of medical school and thus proposed a period midway through the academic career as an appropriate time for baseline observations. The prevalence of coronary heart disease appears to increase with increasing levels of serum low density lipoprotein cholesterol and decrease with increasing level of serum high density lipoprotein cholesterol. They postulated that ratio of high density lipoprotein/total cholesterol is one of the most powerful predictor of risk for developing coronary heart diseases.

Observations similar to the present study were also observed by **Bogdonoff *et al.* (1960)**, who found that stress situation in medical students, especially during examination period, had significant increase in free fatty acids along with elevation of cholesterol ranging from 10 to 25% due to increased activity of autonomic nervous system causing release of adrenaline from adrenal medulla and noradrenaline from sympathetic nerve endings.

Our findings are also in agreement with **Bridley *et al.* (1993)**, who reported that activation of sympathetic nervous system during stress increased the production of lipoproteins by altering serum lipid metabolic processes.

Agarwal *et al.* (1997) exhibited rise in serum cholesterol and triglycerides levels proportional to degree of examination stress whereas total lipids exhibited initial rise followed by a fall which returned to normal when stress was over. According to them, these changes in biochemical parameters were due to stress-induced changes in hormonal levels and peripheral lipolysis.

The present study is in agreement with **Dahlin *et al.* (2005)**, who carried out a study on 342 registered students of years 1st, 3rd and 6th. They assessed the exposure to different stressors and the prevalence of depression among medical students at different levels of education, taking gender differences into account. The response rate was 90.4%. Year 1 students indicated experiencing the highest degree of pressure from studies. A gender difference regarding stress levels was also seen, where women reported higher levels of stress than men. Medical students had higher depression rates than the general population, and women students had higher rates than men.

Joshi *et al.* (2012) reported that examination stress disturbed homeostasis of the body such as change in hypothalamus-pituitary-adrenal axis activity, resulting into increased levels of plasma cortisol. **Subramanian *et al.* (2012)** observed that examination stress elevated total cholesterol and triglycerides levels. **Maduka *et al.* (2015)** found statistically significant increase in serum cortisol, adrenaline, total cholesterol, high density lipoprotein-cholesterol and low density lipoprotein-cholesterol levels in students under examination stress compared to the non-examination period.

The present study is not in agreement with **Dimsdale and Herd (1982)**, who found that cholesterol levels increased above baseline under stressful conditions which was attributed to increased catecholamines or corticosteroids. However, no consistent pattern of triglycerides response was observed in response to emotional arousal.

Flynn *et al.* (1984) reported no significant change in HDL-cholesterol during examination stress. **Friedman *et al.* (1988)** in their study of 40 male subjects observed that severe occupational stress or other forms of emotional tension were association with a sudden and often profound rise in serum cholesterol.

Stress and Blood Sugar

During stressful situations, epinephrine (adrenaline), glucagon, growth hormone and cortisol play a role in blood sugar levels. When stressed, the body prepares itself by ensuring that enough sugar or energy is readily available. Though insulin levels fall, glucagon and epinephrine adrenaline levels are raised and more glucose is released from liver. At the same time, growth hormone and cortisol levels are raised which causes body tissues to be less sensitive to insulin. As a result, more glucose is available in the blood stream.

In the present study it was observed that two months prior to the first professional internal assessment examination, the value of serum blood sugar was within the range of 83 to 89 mg/dL, 98 to 100 mg/dL 2 days prior to first professional internal assessment examination and 75 to 84 mg/dL one month after the examination. Mean serum blood sugar was high in males (98.95 mg/dL), females (99.79 mg/dL) and in total subjects (99.47 mg/dL) during examination as compared to before or after the examination.

The results of the present study are analogous with those of **Bogdonoff *et al.* (1960)**, who found that mental stress led to increased plasma levels of free fatty acids with rise in plasma glucose concentration and there was an approximate correlation between rise in plasma free fatty

acids and the rise in plasma glucose possibly because of increased activity of autonomic nervous system which mediates these responses.

Our study is also in agreement with the study of **Armarto *et al.* (1996)**, who found hyper glycemia in response to the examination which prevailed anxiety in female medical students with significant correlation between stress and glucose levels.

Our study is not in agreement with the study of **Kemmer *et al.* (1986)**, who reported no significant change in concentration of blood sugar, plasma ketone bodies and free fatty acids during mental stress or stress during public speaking because neither glucagon nor growth hormone levels increased during stress period and plasma catechalomines and cortisol levels also did not rise above threshold necessary to evaluate metabolite effects. **Moan *et al.* (1995)** reported increased glucose uptake during hyperinsulinaemia accompanied with acute mental stress. **Seemalter *et al.* (2000)** reported that in obese non-diabetic patients effect of mental stress on serum glucose increased and insulin stimulated glucose utilization was abolished but in lean subjects mental stress elicited an increase in glucose uptake. Same was also observed by **Moan *et al.* (1995)** and **Touma *et al.* (1996)**. **2. Agarwal *et al.* (1996)** found hyperglycaemia in response to the examination which provoked stress in female medical students with significant correlation between anxiety and glucose levels.

CONCLUSION

The study concluded that the levels of serum cholesterol, serum triglycerides and serum LDL cholesterol are at higher during examination period. Blood sugar also showed increase in levels during examination. No significant alteration was observed in the levels of serum HDL cholesterol in our study. Stress induces changes in the levels of various stress hormones resulting in peripheral lipolysis causing increase in serum cholesterol and serum triglycerides and glycogenolysis leading to rise in blood sugar levels.

REFERENCES

1. Ahaneku JE, Nwosu CM, Ahaneku GI, Farotimi A. lipid and lipoprotein cardiovascular risk factor responses to episodic academic stress. J Health Sci 2001; 47: 323-326.
2. Agarwal V, Gupta B, Choudhary L, Singhal U. Effect of examination stress on some metabolic parameters. Ind J Physiol Pharmacol 2000; 44(4): 506-508.
3. Bogdonoff M, Estes E, Harlan W, Trout D, Kirshner N. Metabolic and cardiovascular changes during a state of acute central nervous system arousal. J Clin Endocrinol Metab 1960; 20: 1333-1340.
4. Brindley DN, McCann BS, Niaura R, Stoney CM, Suarez EC. Stress and lipoprotein metabolism: Modulators and mechanisms. Metabolism 1993; 42: 3-15.
5. Brindley DN, Rolland Y. Possible connections between stress, obesity, hypertension and altered lipoprotein metabolism that may result in atherosclerosis. Clin Sci 1989; 77: 453-61.
6. Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: a cross-sectional study. Med Educ 2005; 39(6): 594-604.
7. Dimsdale JE, Herd JA. Variability of plasma lipids in response to emotional arousal. Psychosom Med 1982; 44: 413-430.
8. Dorshkind K, Horseman NS. Anterior pituitary hormones, stress, and immune system homeostasis. Bioessays 2001; 23: 288-294.
9. Fauci AS, Braunwald E, Kasper DL, Hauser SL, Longo DL, Jameson JL, Loscalzo J. Diabetes mellitus: Diagnosis, classification and management. In: Harrison's Principles of Internal Medicine, 17th edition. New York, The McGraw-Hill Companies, Inc. 2008, Vol. II, p. A-5.
10. Friedman M, Rosenman RH, Carroll V. Changes in the serum cholesterol and blood clotting time in men subjected to cyclic variation of occupational stress. Circulation 1988; 17: 852-861.
11. Hildesheimer M, Muchnik C, Rubinstein M, Molho M. Basic metabolic rate in emotional stress: its potential influence on cochlear function. Laryngocope 1985; 95(1): 63-66.
12. Joshi RM, Sanghavi SJ, Upadhyaya DP, Chauhan A, Halvadia S. Effect of examination stress on the plasma cortisol level. National J Medical Res 2012; 2(4): 435-38.
13. Kurian S, Manjula VD, Annamma, Zakariah J. A study on cardiovascular risk factor profile of medical students in a tertiary care hospital of Central Kerala. Nat J Med Res 2015; 5(1): 11-17.
14. Kuhl WJ, Beck EM, Gershberg H, Street E, Ralli EP. Effect of cold water stress on blood and urine constituents in 55 normal male subjects. Metabolism 1954; 4: 143-152.
15. McCann BS, Magee MS, Broyles FC, Vaughan M, Albers JJ, Knopp RH. Acute psychological stress and epinephrine infusion in normolipidemic and hyperlipidemic men: effects on plasma lipid and apoprotein concentrations. Psychosom Med 1995; 57: 165-76.
16. Miller DB and O'Callaghan JP. Neuroendocrine aspects of the response to stress. Metabolism 2002; 51: 5-10.
17. Maduka IC, Neboh EE, Ufelle SA. The relationship between serum cortisol, adrenaline, blood glucose and lipid profile of undergraduate students under examination stress. Afr Health Sci 2015; 15(1): 131-136.
18. Matousek RH, Dobkin PL, Pruessner J. Cortisol as a marker for improvement in mindfulness-based stress reduction. Complement Ther Clin Pract 2010; 16: 13-19.
19. Patterson SM, Gottdiener JS, Hecht G, Vargot S, Krantz DS. Effects of acute mental stress on serum lipids: mediating effects of plasma volume. Psychosom Med 1993; 55: 525-32.
20. Raison CL, Miller AH. When not enough is too much: The role of insufficient glucocorticoid signaling in the pathophysiology of stress-related disorders. Am J Psychiatry 2003; 160: 1554-1565.
21. Shahnam M, Roohafza H, Sadeghi M, Bahonar A, Sarrafzadegan N. The correlation between lipid profile and stress levels in Central Iran: Isfahan Healthy Heart Program. ARYA Atheroscler 2010; 6: 102-106.
22. Seematter G, Guenat E, Schneiter P, Cayeux C, Jequier E, Tappy L. Effects of mental stress on insulin-mediated glucose metabolism and energy expenditure in lean and obese women. Am J Physiol Endocrinol Metab 2000; 279: 799-805.
23. Shah SJ, Patel HM. Effect of examination stress on parameters of autonomic functions in medical students. Int J Sci Res 2014; 3(7): 273-76.
24. Tsigos C, Chrousos GP. Hypothalamic-pituitary-adrenal axis, neuroendocrine factors and stress. J Psychosom Res 2002; 53: 865-871.

25. Van-Doornen LJP, Van-Blokland RW. Serum cholesterol: Sex specific psychological correlation during rest and stress. J Psychosomat Res 1987; 31: 239-249.
26. Varley H, Gowenlock AH, Bell M. Lipids and lipoproteins (cholesterol). In: Varley H, Gowenlock AH, Bell M (editors), Practical Clinical Biochemistry, 5th edition. William Heinmann Medical Books Ltd., London 1984a; 21(1): 652-653.

Source of support: Nil **Conflict of interest:** None declared