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Effects of Exam Stress on Body Mass Index in medical students of Al-Wataniya Private University

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ABSTRACT

Stress refers to the body's response to overwhelming pressures that exceed one's capacity to manage various demands. Stress leads to several physiological disorders; therefore, this study investigates the effect of exam stress on plasma levels of Cortisol and Body Mass Index (BMI), among 40 medical students at Al-Wataniya Private University. These parameters were assessed 11 weeks prior to the final exams (Pre-exams) and on the day of exams (during exams). Cortisol was increased significantly during-exams compared to pre-exams period, which could potentially increase the risk of metabolic diseases. While BMI distribution was close in both periods, suggesting stress-BMI relationship may depend on individual stress coping mechanisms, and lifestyle of student.

KEYWORDS: Exam stress, Cortisol, body mass index, Students.

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Introduction

Stress refers to the body's response to overwhelming pressures that exceed one's capacity to manage various demands. It arises when life's challenges interfere with an individual's ability to handle situations effectively. The experience of stress varies from person to person, as situations that may be stressful for one individual might not be perceived the same way by another [1]. When the body encounters physical or psychological challenges that disturb its balance, it triggers a stress reaction. These challenges, known as stressors, lead to various physiological and behavioral adjustments as the body attempts to adapt. The stress reaction involves an intricate interaction among the nervous, endocrine, and immune systems, engaging pathways such as the sympathetic-adreno-medullary (SAM) axis, the hypothalamic-pituitary-adrenal (HPA) axis, and the immune system [2]. Stress response is driven by the activation of HPA axis. This process begins with the release of corticotropin-releasing hormone (CRH) from the hypothalamus. When CRH is released, it prompts the anterior pituitary gland to produce ACTH. ACTH then signals the adrenal cortex to release glucocorticoid hormones, including cortisol. The total cortisol level in the body is reflected in serum cortisol measurements, with approximately 80% bound to cortisol-binding globulin and 10% attached to albumin. Only the unbound cortisol is biologically active. The conversion of cortisone, the inactive form, into active cortisol is facilitated by the enzyme 11-β-hydroxysteroid dehydrogenase [3]. Between the two forms, only free cortisol acts as a biologically active hormone capable of entering cells and binding to glucocorticoid receptors. This interaction enables feedback inhibition in the hypothalamus and pituitary gland, which play essential roles in regulating processes like inflammation and maintaining stable blood sugar levels [4]. The HPA axis produces a fluctuating glucocorticoid signal that must be interpreted at the cellular level. Disrupting this rhythmic pattern by stressors can interfere with normal physiological regulation. Even minor changes in the system's rhythm, whether due to chronic stress or certain illnesses, can influence the functioning of various cells and tissues. This may result in shifts in metabolism, behavior, mood, and cognitive abilities, particularly in vulnerable individuals [5]. Stress significantly impacts the digestive system. It can cause esophageal spasms, increased stomach acid production leading to indigestion, nausea, diarrhea, or constipation [6]. Stress plays a significant role in the development of metabolic diseases such as obesity, insulin resistance and disturbances in glucose and lipid metabolism [7]. Prolonged exposure to stress at home, work, or the environment is linked to accelerated aging and metabolic changes, either directly or indirectly through unhealthy behaviors such as physical inactivity, sleep disorders, and alcohol consumption [7].

1. Related Work

Exams act as an unavoidable natural stressor and lead to increased stress in students. Students experience high stress due to various reasons such as lack of preparation, difficulty in understanding the subjects, lack of needed information, fear of not being able to finish the test on time and fear of academic failure [8]. When stress becomes excessive, it leads to anxiety before and during examinations, and it impacts their results [8]. Elevated levels of depression, anxiety, stress, and burnout have been observed among medical students (MS), potentially harming their mental well-being,

reducing motivation, impairing academic performance and cognitive function, and in severe cases, increasing the risk of suicidal behavior [9]. Individuals with higher perceived stress levels at the start exhibited a greater average change in BMI compared to those with lower stress. Likewise, those who encountered stressful life events experienced a more significant increase in BMI than individuals who did not. These associations varied based on factors such as age, smoking status, and initial BMI. Furthermore, individuals exposed to multiple sources of stress faced the highest risk of weight gain [10]. College and university students often face significant stress from multiple sources, leading some to adopt unhealthy coping mechanisms, such as consuming convenience foods. This includes eating fast-food frequently or ordering meals online, which are typically high in calories, processed ingredients, and saturated fats. Such dietary habits can contribute to weight gain and other negative health effects [11]. Shah et al. reported 34.05% and 30.7% of students were found to be overweight respectively. Simultaneously, prolonged sleep deprivation and sedentary lifestyle increase both food intake and energy consumption enhanced by hormonal imbalance. They are, thus, among the leading causes of weight gain [12]. However, the relationship between stress and BMI in medical students is still controversial. Recent studies report a significant negative correlation between stress and BMI [13, 14]. Others find that BMI increase during exams; therefore, academic stress symptoms, with these relationships mediate unhealthy coping mechanisms, such as consuming unhealthy foods, lack of exercise, and internet addiction [13,15, 16,17].

This research contributes to the growing body of evidence on stress physiology and its effect on students during exams. Medical students face high levels of academic stress, especially during exams, which may lead to metabolic disturbances, including obesity. The directionality of the stress-BMI relationship is still conflicting and needs further studies and investigation.

2. Materials and Methods

The study was conducted in the department of biochemistry laboratories of the faculty of pharmacy in Al-Wataniya Private University. The study included 40 healthy medical undergraduate students (pharmacy and dentistry), (20 males and 20 females), aged from 21_25 years old. Exclusion criteria were: family history of chronic diseases, neurological disease, psychiatric disorder, PCOS and menstrual period for female participants, smoking, alcohol and using any kind of medicines.

The study extended from the beginning of the first semester of the academic year 2024-2025 until the final exam, to assess the effect of the exam stress on cortisol level and BMI. Blood sample was collected by 9.00 am, 11 weeks before the exams (pre-exam), and on the day of final exam (during exam). BMI was measured for all students twice: in pre-exam period and during exam period. Height was determined by using a centimeter measuring tape, and it was recorded to the nearest 0.5 cm. Weight was measured by using an electronic kilogram weight scale and it was recorded to the nearest 0.1 kg. The formula used for calculating BMI was weight in kg, divided by square height in meters. BMI was classified into four categories according to the National Institute of Health (NIH) guidelines, 1998: Underweight (BMI < 18.5), Normal weight (BMI =18.5-24.9), Overweight (BMI =25-29.9), Obesity (BMI ≥ 30).

The means values of cortisol obtained in both periods: pre -exams and during exams were calculated and statistically analyzed using paired t-test and BMI records in both periods were statistically analyzed using Chi square test. P-value<0.05 was considered significant.

3. Results and Discussion

Plasma levels of Cortisol were within the normal range in medical students. The mean value of Cortisol during exams (15.71± 4.65µg/dL) was significantly higher than pre-exams (11.97± 4.05 µg/dL), (P=0.000003) (fig 1).

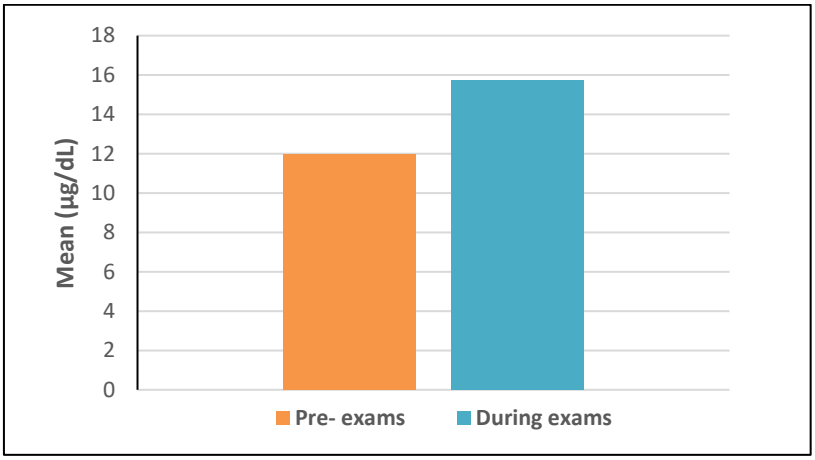

FIGURE (1): COMPARISON OF MEAN VALUES OF CORTISOL IN PRE-EXAMS AND DURING EXAMS

Table1, shows the distribution of the enrolled students for their BMI value, the distribution was close during the two periods. In Pre-exams 67.5% of students had normal BMI; while 20% were found overweight, 12. 5% were found obese. During exams the percentage of Overweight increased slightly 22.5%.

Table (1): Body Mass Index (BMI) distribution between pre-exams and during exams groups

BMI (kg/m2) category	Pre- exams		During exams		chi square value	P value
	N	%	N	%		
Normal (BMI 18.5- 24.9)	27	67.5	26	65	8.087	0.57
Overweight (BMI 25- 29.9)	8	20	9	22.5		
Obesity (BMI ≥ 30)	5	12.5	5	12.5		

These findings indicate that medical students experience a significant increase in plasma cortisol during exam periods compared to pre-exam periods. Multiple studies confirm that medical students reflecting physiological stress during exams, showing normal cortisol levels before exams, but significant increases during exam period [4, 15, 18, 19]. Exams serve as natural stressors, raising cortisol due to activated hypothalamic-pituitary-adrenal axis (HPA axis). Exam stress leads to releasing Corticotropin-Releasing Hormone (CRH) from the Hypothalamus, which prompts the anterior pituitary gland to produce ACTH. ACTH then signals the adrenal cortex to release cortisol with higher levels [3,20].

The finding of this study indicates that most students have normal BMI, with a minority overweight or obese, and no significant BMI distribution change between pre-exam and exam periods, this may be due to the sample size. However, the relationship between stress and BMI in medical students is complex and conflicted concerning eating behavior and regulating appetite depending on person exposed to stress will undereat or overeat [13,14,21]. Several studies report that BMI increases during exams. Chronic stress elevates cortisol level; which reduces dietary restraint and impairs control over eating behavior and increases the tendency to consume high calories foods by acting directly through the central nervous system. In addition to cortisol results in stimulation of orexigenic neuropeptides NPY in hypothalamus [21]. Other studies found a significant negative correlation between stress and BMI, i.e. acute stress is associated with lower BMI. The studies concluded that exam stress induced appetite suppression by acting of high level of cortisol on hypothalamus, inhibiting the release of CRH, which is a potent anorectic substance and acts to decrease the neuropeptides NPY levels [13,14,21].
By consequence students are vulnerable to the fluctuation of their glucocorticoid hormones and are at higher risk for unhealthy coping mechanisms, such as over consuming unhealthy foods, lack of exercise, etc [13, 15, 16, 17].

4. Conclusions and Recommendations

This study aligns with a growing body of evidence showing that exam periods are associated with stress responses in medical students, manifesting as increased cortisol. That could, contribute to long-term several physiological disorders. While BMI distribution remained stable, the directionality of the stress-BMI relationship may depend on lifestyle and individual's ability to handle situations effectively. This is to say, the experience of stress varies from person to person. Therefore, we recommend educators to improve examination assessment methods and develop preventive strategies, and implement stress management programs in order to mitigate long-term health risks.

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