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EFFECT OF EXAMINATION STRESS ON CORTISOL LEVEL AND ANTHROPOMETRIC VARIABLES: ABDOMEN FAT DISTRIBUTION AND BODY MASS INDEX AMONG UNIVERSITY STUDENTS

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ABSTRUCT
Background: Examination stress has become an important issue in academic circle, particularly among university students. It is considered as crucial factor in increasing the level of circulating cortisol hormone which in turn has an effect on the changes in body form such as abdomen fat distribution and BMI among academic students. **Objective:** To investigate whether the academic examination stress affects the cortisol levels and stress-related changes in body form, particularly abdomen fat distribution and body mass index among university students. **Methods**: Forty-one students (14 males and 27 females) aged 18 to 23years were selected from Zawia University faculty of medical technology to perform this study. Cortisol level was measured at the beginning of the academic semester and 12 weeks later during the examination period using Cabas e411 analyser. Abdomen fat distribution determined by waist to hip ratio (WHR) and BMI were measured pre, during and post the exams period. **Results**: Serum cortisol increased significantly during the exams (P<0.01) in all students. The changes in WHR and BMI showed significant result P<0.01 among most students during and after the exams. However, no significant different observed in WHR among boys. There was significant correlation between cortisol and WHR (P<0.01), and between the cortisol and BMI (P<0.05) among students during the exams period. Change in cortisol secretion during the exams period was positively associated with changes in WHR and BMI among students. **Conclusion:** Academic examination stress was implicated in increasing the hyperactivity of cortisol secretion, which has been shown to increase central fat and weight gain in students during and post the exams period.

KEYWORDS: Stress, University Students, Cortisol Level, Waist-To-Hip Ratio (WHR) and Body Mass Index (BMI).

1.0 INTRODUCTION

Stress is a challenge to the natural homeostasis of an organism, and is a psychological or physical stimulus can produce mental or physiological reactions which may lead to illness (Singh *et al.*, 2012). In daily life, all organisms encounter different types of stresses, some of them can cope well with the stress stimuli, while in others repeated daily stress could lead to derangement of the neuroendocrine coping mechanism and balance between pro- and anti-oxidants, producing a wide range of harmful effects on the physiological and psychological homeostasis (Myint *et al.*, 2017). Animals react to stress by producing a physiological stress response to regain equilibrium lost by the stressor. The stress response is characterized by acute behavioural and physical adaptations, including increased cognition, analgesia, gluconeogenesis, lipolysis, and inhibition of reproduction (Kyrou, Chrousos and Tsigos 2006).

Academic examination is considered as external stressors that can undoubtedly cause stress. Stress is nonspecific response of the body under pressure and is not necessarily harmful, where an acute (short-term) stress response is the reaction to an immediate stressor which can protects the body and it is necessary for homeostasis recovery. However, chronic or prolonged (long term) stress responses can be harmful and it can cause difficulties, including impairing the ability to perform well during exams (Rabasa and Dickson (2016). Academic examination stress among students can vary from mild to severe which may affect learning performance differently. Psychological examination stress increases the activity of both sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenocortical (HPA) axis leading to increase circulating levels of catecholamines and glucocorticoids.2,3 respectively (Shireen, Haider and Haleem 2011).

It is well-known that HPA axis is highly sensitive and easily activated by stressors. Once the body experience something stressful, the brains release a substance known as corticotropin-releasing hormone (CRH) through the HPA axis, CRH also triggers the release of the hormones adrenaline (epinephrine), noradrenaline (norepinephrine) and cortisol, which help mobilize carbohydrate and fat for quick energy (Stöppler 2017). When the immediate stress is over, the adrenaline and noradrenaline levels return to normal while the cortisol levels remain elevated over a longer time period to bring the body back into balance (Myint *et al.,* 2017). Continual stress leads to a constant state of excess cortisol production, which stimulates glucose production. This excess glucose then typically is converted into fat, ending up as stored fat (Spudich 2007). According to Dr. Sapolsky, "The net effect of this will increase fat deposition in a certain part of the body particularly in the central abdomen area (Spudich 2007).

Chronic stress including examination strews may lead to elevated cortisol levels that stimulate the appetite, with the end result being weight gain. Elevated cortisol in the bloodstream enhances the activity of lipoprotein lipase in adipose tissue, leading to an increase in fat storage. This occurs particularly in visceral fat where lipoprotein lipase activity is higher and leading to visceral fat accumulation (Sominsky and Spencer 2014). The chronic release of cortisol is linked to the development of abdominal obesity in both men and women (Epel *et al.*, 2000). Spudich (2007) stated that elevated cortisol tend to cause fat deposition in the abdominal area, because fat cells in the abdomen are richer in stress hormone receptors, are particularly sensitive to cortisol and high insulin, and are very effective at storing energy. This is the most dangerous place to gain weight, as it can lead to metabolic syndrome, diabetes, and heart disease (Spudich 2007).

Abdominal fat deposition has been referred to as "toxic fat," since high waist to hip ratio (WHR) is associated with increased risk of hypertension, diabetes, dyslipidemia, and metabolic syndrome when compared to normal waist to hip ratio (WHR) (Baltrus *et al.*, 2010). High WHR regardless of body mass index (BMI) is strongly correlated with the development of cardiovascular disease, including heart attacks and strokes (Epel *et al.,* 2000). A study confirmed that women who stored their excess fat in the abdominal area had higher cortisol levels and reported more lifestyle stress resulting in poor coping with stress (Baltrus *et al.*, 2010). Although, body fatness such as waist circumference (WHR) is a more recent and accurate method to measure body fat distribution and can be used routinely, body mass index (BMI) is the most commonly used measure of adiposity to describe general obesity and to categorize individuals as underweight, normal weight, overweight, obese I and obese II (Doustjalali *et al.,* 2016). However, BMI does not adequately reflect body shape and fat distribution (Chen *et al.*, 2015).

Body Mass Index (BMI) is adopted by the World Health Organization (WHO) as valuable measure of obesity (Zafrir *et al.,* 2013). Numerous studies have demonstrated that obesity is spreading around the world to become one of the annoying diseases in the life (Dahdouli 2015). Many nations including United States is currently facing a very real obesity epidemic, where the most recent National Health (NH) and Nutrition Examination Survey (NES) indicates that approximately two thirds of US adults are presently classified as overweight (BMI $\geq$ 25) and one third as obese (BMI $\geq$ 30) (Flegal *et al.,* 2012). While the numbers alone are formidable, they leave unaddressed and they may exaggerate to cause many health disorders such as obesity related hypertension (Landsberg *et al.,* 2013). Importantly, A high BMI is a risk factor for heart disease, diabetes, and premature death and high WHR an indicator of abdominal body fat distribution is a predictor or risk factor of diabetes mellitus, cardiovascular diseases and their complications (Melnikov and kim 2017).

2.0 Literature Review

Stress is a state of threatened homeostasis, mobilizes a complex spectrum of adaptive physiologic and behavioural responses that aim to re-establish the challenged body homeostasis (Kyrou and Tsigos 2007). The hypothalamic-pituitary-adrenal axis and the sympathetic nervous system constitute the main effector pathways of the stress system, mediating its adaptive functions (Kyrou and Tsigos 2007). Cortisol levels have been shown to be associated with levels of perceived chronic stress and also with abdominal fat deposition and body mass index (Baltrus *et al.,* 2010). The association between cortisol levels and abdominal obesity is often attributed to dysfunction of the hypothalamic-pituitary-adrenal (HPA) axis, which leads to the dysregulation of cortisol (Tull *et al.,* 2005). This may be a result of direct stimulation by the brain (the fight or flight response), or stress coping behaviours such as academic examination, financial problems and cigarette smoking; which has been shown to be related to both cortisol levels and obesity (Baltrus *et al.,* 2010).

Central adiposity or abdomen fat distribution is modified by biological and behavioural responses to examination stress, such as altered hypothalamic-pituitary-adrenal (HPAA) axis activity, sympathetic neural activity, and consumption of foods high in fat and/or sugar (Donoho *et al.,* 2011) Hyperactivity of the HPAA results in increased exposure to circulating levels of cortisol, a hormone associated with stress, increased appetite, and the mobilization of fat from the periphery to the central region (Dallman, Pecoraro and Fleur 2005). Hypercortisolemia, results in weight gain, increased intra-abdominal fat, decreased lean body mass, and bone loss. In contrast, patients with hypocortisolemia due to adrenal insufficiency they intend to lose weight (Schorr *et al.,* 2015). Evidence is accumulating rapidly that chronic examination stress may results in stimulation of the hypothalamic–pituitary–adrenal axis which could play a potential role in the development of visceral obesity. Additional support is that the HPA axis is involved in the regulation of body weight and body fat distribution in obese subjects with visceral fat accumulation, where it enhanced awakening cortisol response, as well as increased cortisol secretion after physical and psychological stressors (Rutters *et al.*, 2012). Thus, an increasing number of people report concerns about the amount of stress in their life (Adam and Epel 2007).

Prior research has suggested that the effects of stress on weight gain may differ by sex, baseline WHR, BMI and cortisol reactivity. These factors may cause some people to gain more weight under stressful circumstances, whilst others may gain less weight or even lose weight when stressed (Hardin *et al.*, 2014). However, the extent to which the association between stress and weight change differs according to demographic and other factors remains unclear (Hardin *et al.*, 2014). According to Roberts *et al.*, (2007), change in cortisol secretion significantly predicted change in BMI and in animal studies; stress-induced cortisol secretion has been shown to increase body weight and central fat. It has been clarified that visceral fat has abundant receptors which is very sensitive to the effects of cortisol, where excess adiposity and obesity result in increased adrenal cortisol secretion, circulating bioavailability, and local tissue activation particularly in adipose tissue (Baudrand, and Vaidya 2015). Excessive central body fat distribution is a risk factor for hyperlipidaemia, hypertension, coronary heart disease, stroke, and diabetes mellitus (Epel *et al.*, 2000).

The most reliable finding in studies so far is that there is a correlation between cortisol levels and the body mass index in stressors, where a high BMI is correlated with a high cortisol measure (Schorr *et al.*, 2015). Researchers found that individuals who had persistently high levels of the "stress hormone" cortisol over long periods of time weighed more, had a higher body mass index, and a larger waist, compared with those who had low levels of the hormone (Whiteman 2017). Interestingly, in a large cohort study of more than 3000 subjects, those with the highest hair cortisol concentrations had an almost 10-fold increased risk of obesity. On the other hand, obesity can lead to increased chronic stress to varying degrees depending on certain individual characteristics. Persons experiencing, for example, weight stigma are known not only to experience more stress but also to have higher long-term cortisol levels (Jackson, Kirschbaum and Steptoe 2016). Additionally, persons with obesity are more likely to suffer from mental (e.g., depression) and physical disorders which can in turn lead to chronic stress and/or higher cortisol levels. This can even be exaggerated by the use of certain medications indicated for obesity-related comorbidities, such as corticosteroids for arthrosis or asthma (Valk, Savas and Rossum 2018).

Joshi1 *et al.*, (2012) concluded that examination stress is a situational stress resulting in anxiety, reflected as disturbed homeostasis of the body such as change in hypothalamus-pituitary-adrenal axis activity, resulting into increased levels of plasma cortisol. Chronic Examination stress can lead to dietary over-consumption (especially palatable foods), increased visceral adiposity and weight gain. These obesogenic effects of stress are mainly explained by the chronic release of cortisol hormone (Rabasa and Dickson 2016). On one hand, Adam and Epel (2007), stated that although there is a link between stress and changes in eating habits in both men and women, not everyone gains weight under stress and still the effects of stress on body weight and food intake are controversial. Likewise, Rabasa and Dickson (2016) stated that acute intense stress is commonly associated with feeding suppression and reduced body weight gain. The aim of this study is to investigate whether the academic examination stress affects the cortisol levels and anthropometric variables such as body fat distribution, and body mass index among academic university students.

3.0 MATERIAL AND METHODS

Forty-one students (14 males and 27 females) aged 18 to 23 years were selected from Zawia University faculty of medical technology to perform this study. Cortisol level was measured twice during this study: at the beginning of the academic semester and 12 weeks later during the examination period using Cabas e411 analyser. Abdomen fat distribution determined by waist to hip ratio (WHR) and obesity determined by BMI were measured 12 weeks pre the exams, during the exams and 12 weeks post the exams period. The measurements were performed as following.

3.1 Cortisol measurement

The first samples were taken at the beginning of the academic semester (three months before the exams), where the students did not undergo the examination stress yet. The second samples were taken on the examination’s day, where the students were undergoing the examination stress. The cortisol samples were taken from all the subjects by using 5ml disposable syringe then analysed and measured by using Cabas e411 (roch \ hatachi) machine.

3.2 The anthropometric measurements (WHR and BMI)

3.2.1 Measurements of the waist- hip ratio (WHR)

WHR were measured three times, the first WHR measures were taken at the beginning of the academic semester (three months before the examination period) then WHR measured again three times during and after the examination period to see any changes in the abdomen central fat distribution and body weight a result of the examination stress. WHR was calculated as the mean waist circumference divided by the mean hip circumference and is recorded by centimetres (cm) (figure 1). According to the World Health Organization (WHO), the healthy WHR is: 0.85 or less for women and 0.9 or less for men.

3.2.2 Measurements of body mass index (BMI)

Body mass index was also measured three times: the first BMI measures were taken at the beginning of the academic semester (three months before the examination period) then BMI measured again three times during and after the examination period to monitor the changes in the participants' weight as a result of the examination stress effect and cortisol secretion. The body mass index (BMI) of all students was measured by using weight and height scale (FAZZINI) (figure2). BMI was calculated using formula of diving weight in kilograms with height taken in meter squares (weight (kg) height (m2). As per revised WHO criteria, BMI ranging from 18.5 to 22.9 is normal; BMI form 23 to 24.9 is overweight and above 25 is obese.

Exclusion criteria in this research included factors that could influence fat distribution, body weight or cortisol level were taken in consideration by giving a short questionnaire form to all subjects before performing this study. Exclusion factors included current smoking or past history of smoking, current or past history of endocrine disorders, eating disorders, depression, hypertension, medication used, recent weight changes, excessive exercise, and diabetes mellitus.

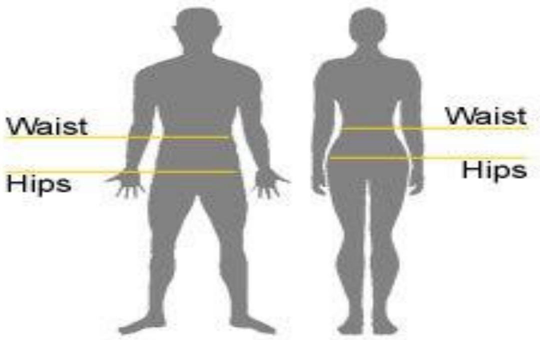

Figure 1: Measurements of the waist- hip ratio (WHR).

Figure 2: Measurements of BMI by weight and height scale FAZZINI scale.

4.0 Statistical analysis

All the calculations and analysis were done using Microsoft Office Excel 2010 and the SPSS 19.0 software (statistical package for statistical analysis). Continuous variables were expressed as Mean ± SEM. Pearson's correlation coefficient (r) analysis was used to ascertain possible associations between the cortisol levels and WHR, also, between the cortisol levels and BMI (pre, during and post examination stress) in university students. A probability value of ANOVA was utilized where a probability value of less than 0.05 (p-value < 0.05) is taken to be significant.

5.0 RESULTS

The aim of this study was to investigate whether the academic examination stress affects the cortisol levels and anthropometric variables such as body fat distribution, and body mass index among university students. A total of 41 subjects (14 male and 27 female) of age ranging between 17 and 23 years were examined and the outcomes of this research study are illustrated and shown.

5.1 The effect of the examination stress on the cortisol levels among males and females students (pre- and during the exams).

Table1 shows the changes in the cortisol levels as a result of examination stress (pre- and during exams) among male and female students; and correlation coefficient(r).

Sex	Sample number	The mean± SD of cortisol level pre - exams	The mean± SD of cortisol level during exams	Correlation coefficient (r) of cortisol levels differences	P-Value
Male	14	471.78 ±184.78	637.4 ±202.67	0.774	<0.01
Female	27	362.16 ± 108.61	455.37 ±154.79	0.625	<0.01

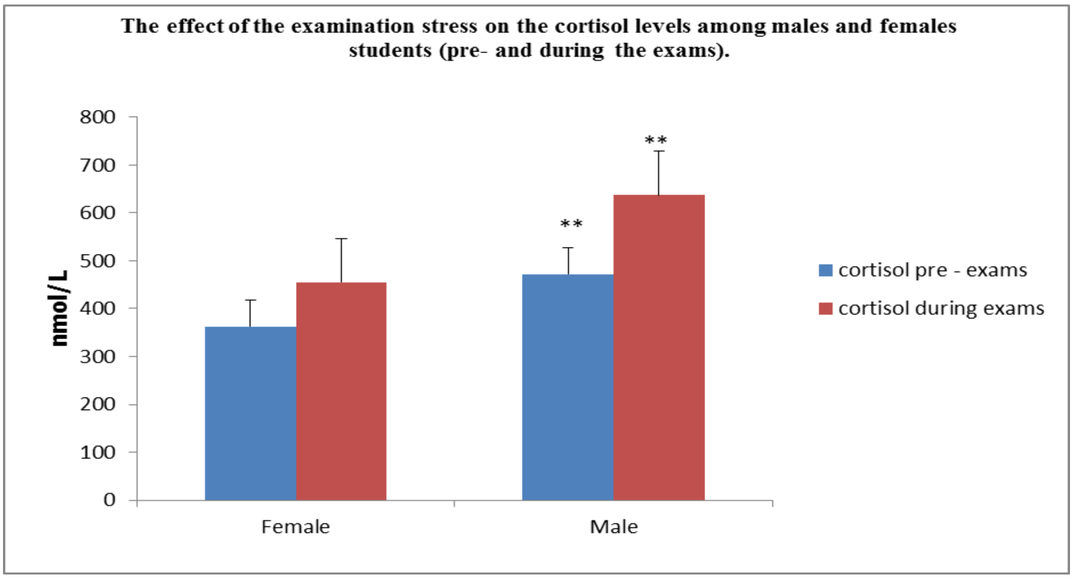

Figure 3: Shows the effect of the examination stress on the cortisol levels pre- and during the exams among both sex students.

There was a significant increase in the level of the cortisol among male students during the exams in comparison to its level before the exams, where the level of cortisol increased from 471.78 nmol/L to 637.4 nmol/L (P = <0.01 and r = 0.774). Also, the level of the cortisol in female students elevated from 362.16 nmol/L pre-exams to 455.37 nmol/L during the exams, which was a significant increase (P = <0.01 and r = 0.625) (table 1 & figure3).

5.2 The effect of the examination stress on the WHR values among males and females students (pre- and during and after the exams).

Table 2: Shows the changes in the WHR (cm) as a result of examination stress (pre- and during exams) among male and female students; and correlation coefficient(r).

Sex	Sample number	The mean± SD of WHR (cm) pre-exams	The mean± SD of WHR (cm) during and after-exams	Correlation coefficient (r) of the WHR	P-Value
Male	14	0.8114 ± 0.081	0.8140± .0810	0.098	
Female	27	0.730 ± 0.186	0.791± 0.162	0.755	<0.01

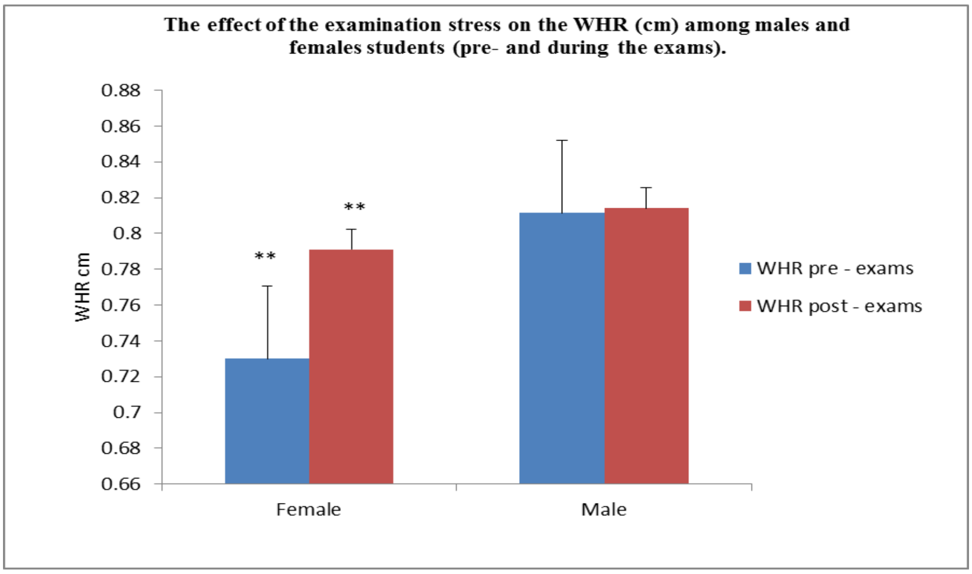

Figure 4: Shows the effect of the examination stress on the WHR (cm) pre- and during the exams among both sex students.

There was a non-significant relation between the value of WHR pre-exam and the value of WHR during and after exam in male students (r = 0.098). The values of the WHR among male students during and after the exams increased in comparison to the value of the WHR before the exams (pre-exams) where this value increased from 0.8114 cm to 0.8140 cm. In contrast, there was a significant relation between the value of WHR pre-exam and the value of WHR during and after exam in female students (P = ≤0.01 and r = 0.755), where the. The value of the WHR in female students increased from 0.730 cm pre-exams to 0.791cm during and after exams (table 2 & figure 4).

5.3 The effect of the examination stress on the BMI values among males and females students (pre- and during the exams).

Table 3: Shows the changes in the BMI (Kg/m²) as a result of examination stress (pre- and during exams) among male and female students; and correlation coefficient(r).

Sex	Sample number	The mean± SD of BMI (Kg/m²) pre-exams	The mean± SD of BMI (Kg/m²) during and after the exams	Correlation coefficient (r) of BMI	P-Value
Male	14	21.919 ± 3.252	21.925 ± 3.236	0.998	<0.01
Female	27	21.746 ± 3.518	21.782± 3.510	1.00	<0.01

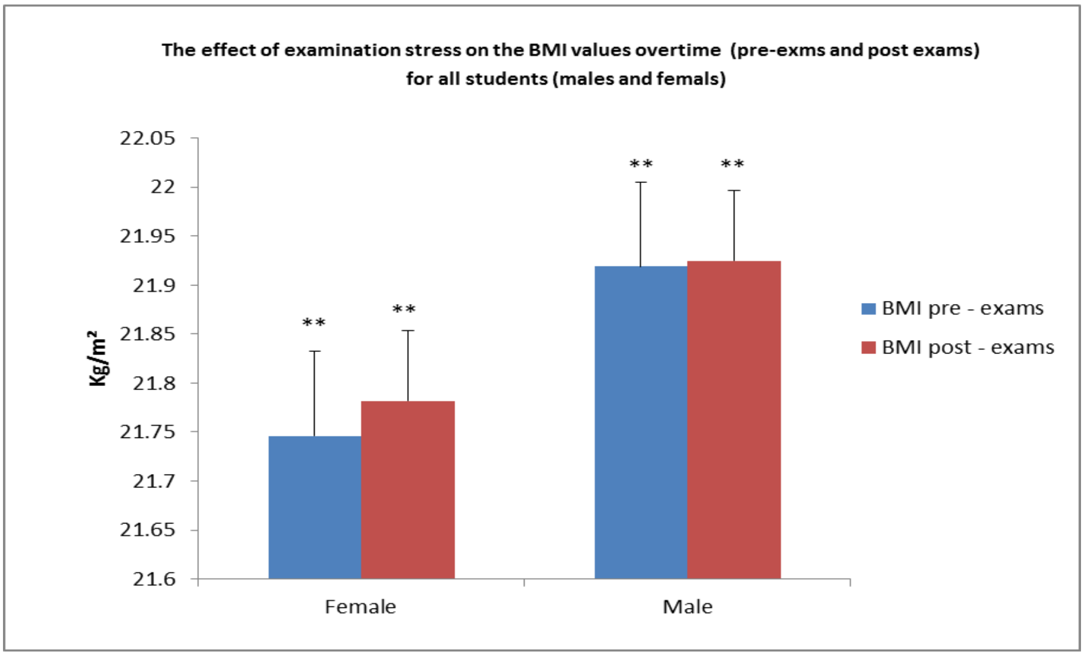

Figure 5: Shows the effect of the examination stress on the BMI (Kg/m²) pre- and during the exams among both sex students.

There was a significant relation between the mean value of BMI pre-exam and the mean value of BMI during and after the exam in male students (P = <0.01 and r = 0.998), and in female students (P = <0.01 and r = 1.00). The mean BMI values increased during and after the exams in both males and female students compare with the mean BMI values before the exams (pre-exams). 21.919 Kg/m² was the mean value of BMI in male students pre-exams, this value increased to 21.925 Kg/m² during and after the exams. In female students the mean BMI value pre-exams was 21.746 Kg/m and increased during and after the exams to 21.782 Kg/m (table 3 & figure 5).

5.4 The relation between cortisol level (nmol/L) and WHR (cm) in the time of pre-exams stress and during exams stress among male and female students.

Table 4: shows the relation between cortisol levels and WHR before the exams stress (pre-exams) among male and female students.

Sex	Sample number	Cortisol level pre - exams stress	WHR (cm) pre-exams stress	Correlation coefficient (r) of cortisol and WHR	P-Value
Male	14	471.78 ±184.78	0.8114 ± 0.081	0. 118	
Female	27	362.16 ± 108.61	0.730 ± 0.186	-0.167	

Table 4: shows the relation between cortisol levels and WHR during and after the exams stress among male and female students.

Sex	Sample number	Cortisol level during the exams stress	WHR (cm) during and after the exams stress	Correlation coefficient (r) of cortisol and WHR	P-Value
Male	14	637.4 ±202.67	0.8140± .0810	0.444	<0.01
Female	27	455.37 ±154.79	0.791± 0.162	0.840	<0.05

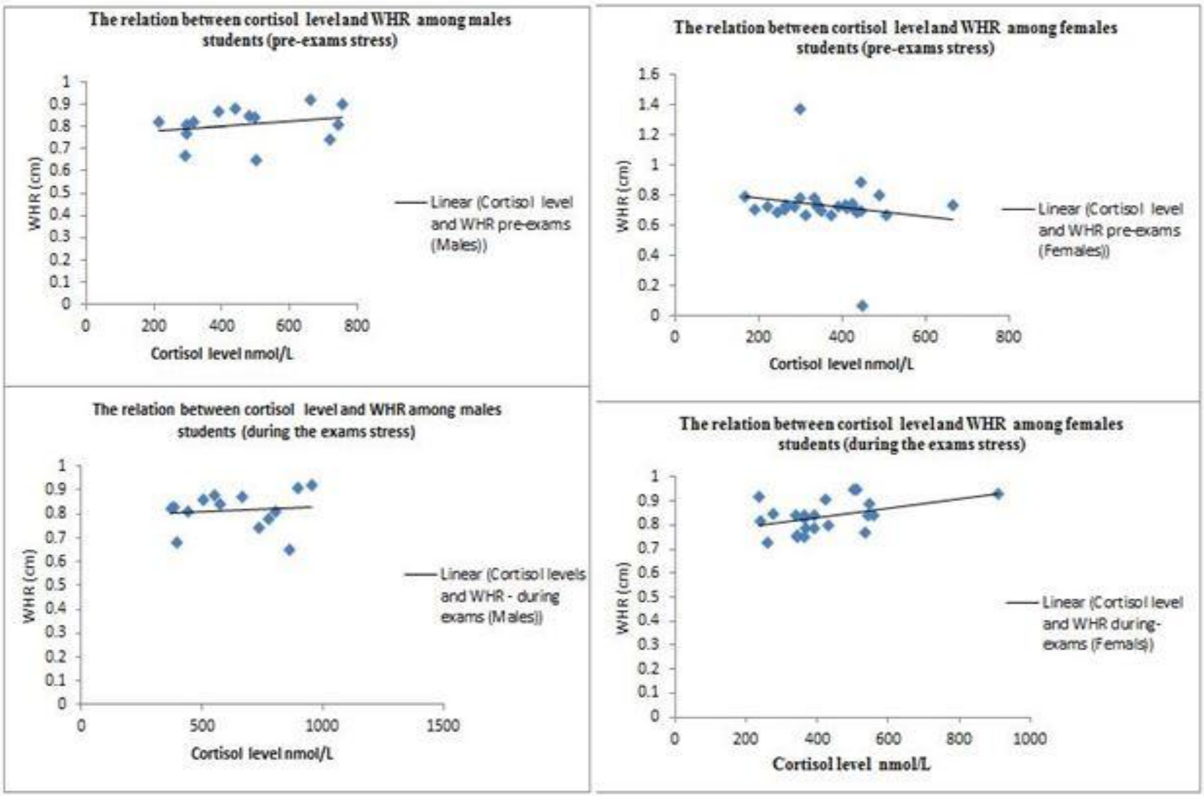

Figure 6: scatter diagram showing the relation between cortisol levels and the WHR pre- and during the examination stress among males and females students.

The mean values of the cortisol level and WHR during and after the exams in both genders increased in comparison to their values before the exams (table 4). Interestingly among male students the relation between the cortisol level and WHR before exams was a positive non-significant relation(r = 0.118) while during and after the exams was positive significant relation (P = <0.01 and r = 0.444). However, among female students, the relation between cortisol level and WHR pre exams was non-positive relation (r = -0.167), whereas, during and after the exams such relation was strong positive significant (P = ≤0.05 and r = 0.840) (figure 6).

5.5 The relation between cortisol levels (nmol/L) and BMI in the time of pre-exams stress and during exams stress among male and female students

Table 5: shows the relation between cortisol levels and BMI in the time of pre the exams stress among male and female students.

Sex	Sample number	Cortisol level pre - exams	BMI (Kg/m²) pre - exams	Correlation coefficient (r) of cortisol and BMI	P-Value
Male	14	471.78 ±184.78	21.919 ± 3.252	0.110	
Female	27	362.16 ± 108.61	21.746 ± 3.518	0.242	

Table 6: shows the relation between cortisol levels and BMI during the time of exams stress among male and female students.

Sex	Sample number	Cortisol level during the exams	BMI (Kg/m²) during and after the exams	Correlation coefficient (r) of cortisol and BMI	P-Value
Male	14	637.40 ±202.67	21.925 ± 3.236	0.320	<0.05
Female	27	455.37 ±154.79	21.782± 3.510	0.382	<0.05

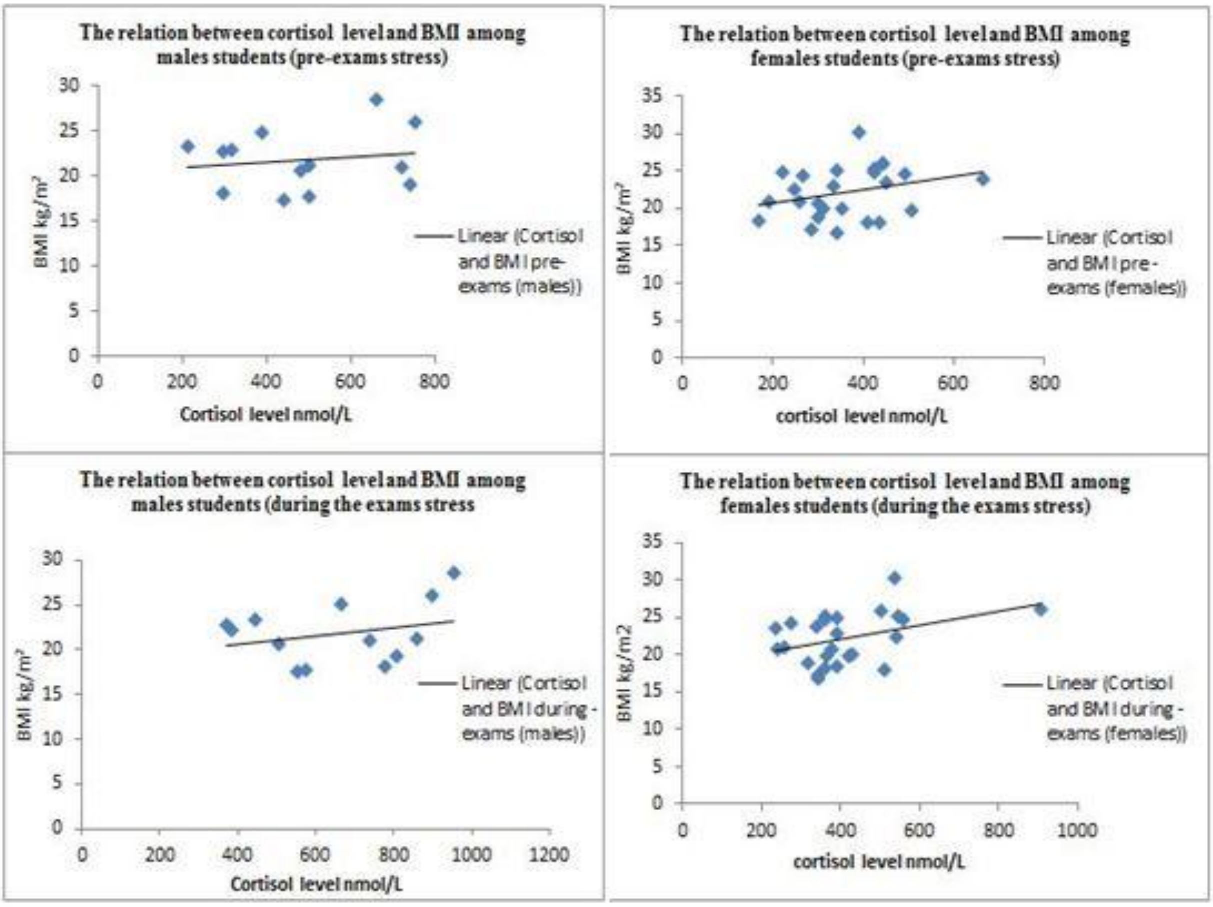

Figure 7: scatter diagram showing the relation between cortisol levels and the BMI in the time of pre- and during the examination stress among male and female students.

The mean values of the cortisol level and BMI in male before the exams were 471.78±184.78 nmol/L and 21.919±3.252 Kg/m² respectively. These values increased during and after the exams and recorded 637.40±202.67 nmol/L for cortisol and 21.925±3.236 Kg/m² for BMI. In female students also the mean values of the cortisol level and BMI during and after the exams increased in comparison to their values before the exams (table 5&6). The relation between the cortisol level and BMI in male students before the exams was non-significant relation ($r = 0.110$), while this relation during and after the exams was strong significant positive relation ($P = <0.01$ and $r = 0.320$). However, the relation between the cortisol level and BMI in females students pre-the exams was positive non-significant relation ($r = 0.242$), but between the cortisol level and BMI in females students during and after the exams was strong significant positive relation ($P = <0.05$ and $r = 0.382$) (figure 7).

6.0 DISCUSSION

The primary aim of this study was to investigate whether the academic examination stress affects the cortisol levels and anthropometric variables such as body fat distribution (WHR), and body mass index (BMI) among academic university students. Many studies have demonstrated that, medical university students exhibit higher level of stress during exams than prior to exams which may has an effect on the student's performance (Mehfooz and Haider 2017). This finding is consistent with existing evidence in which the level of stress was high during examination period.

In the present study, when the students did not undergo examination stress at the beginning of the academic semester (12 weeks prior to the exams), they showed normal levels of the cortisol hormones. However, as soon as the students had the exams and underwent the stress, the levels of cortisol hormone increased significantly and showed a high increase in comparison to its level three months before the exams (figure 3). These results are in agreement with a study by Joshi (2012) who stated that, academic examinations act as an unavoidable natural stressor and lead to increased stress, anxiety and depression in students, consequently excited HPA axis, resulting in increased release of cortisol levels among the students who taking the exams. Additionally, the cortisol levels in the students were significantly higher in stressful situations in comparison to pre or post-stressful situation. This indicates a high stress notice by the students during academic exams stress (Pozos-Radillo *et al*., 2014).

In addition, the abdomen fat distribution (central fat) which is measured by waist to hip ratio (WHR) in this study revealed significant increase in male students during and after the exam (<0.01), also showed non-significant increase among female students during and after the exam in comparison to the WHR values before the exams (figure 4). These results are in line with other research study findings, which highlighted that increased abdominal fat has been shown to be associated with poor coping with stress, for men in particular, increasing waist-hip ratio, a measure of abdominal fat distribution, is associated with school-related stress which may contribute to disease increasing risk of cardiovascular disease, regardless of body mass index tend (Baltrus *et al.,* 2010).

The current study suggested that the stress led the students to gain weight during and after the time of exams, where there was a significant increase (P = < 0.01) in the BMI measurements in both male and female students during and after the exams when compared with the BMI measurements at the beginning of the academic semester (three months prior to the exams) (figure 5). These results support the evidence that the direct linkage between academic university exams stress and abdominal obesity reported in a study carried out by Doustjalali *et al.*, (2016) who proved that during stress, hypothalamic-pituitary-adrenal axis will be activated to produce adrenocorticotropic hormone (ACTH), mainly cortisol hormone which is believed to be related directly with obesity and BMI (Doustjalali *et al.,* 2016).

Moreover, Gupta, Ray and Saha (2009) reported that gaining in body weight and BMI was more likely caused by undergoing to stress and the most important life style factor responsible for obesity and increasing the BMI indicator was frequent exposure to all types of stress, which will lead to increase cortisol secretion and in its turn lead to gaining weight. In addition to that university medical education is stressful throughout the whole course of training, and the pressure of examination in particular can be anticipated to bring psychological stress (Gupta, Ray and Saha 2009). Hence, the influence in body weight such as increased BMI and the prevalence of obesity among undergraduate medical students is more likely to be as a result of the university examination stress (Gupta, Ray and Saha 2009).

Many studies have highlighted that a greater vulnerability to stress increases exposure to stress-induced cortisol, which in turn fuels central fat deposition. During stress, the stress hormone cortisol is released in the blood this can be affecting many mechanisms in the body leading to increase the fat in belly (Epel *et al.,* 2000 and Dahdouli 2015). Examination stress induced cortisol secretion which may lead to increase central fat deposition; such increase may be risky to develop many diseases (Epel *et al.,* 2000). Epel *et al.,* (2000) found that the men and women with high WHR, responded to stress and they secreted significantly more total cortisol on the stress day. These studies are agreed with the current study which found that the relation between cortisol level and WHR measurements during and after the exams was a significant in male and female students (P = <0.01). However, this relation was non-significant at the beginning of the academic semester (figure 6). This might suggest that the cortisol level increased during the examination stress and then distributes more fat in the central abdomen region affecting the WHR measurements.

The results in this study demonstrated that the relation between the cortisol level and BMI in male and female students during and after the exams was strong positive significant relation (P = <0.05). In contrast, at the beginning of the academic semester (12 weeks before the exams) this relation was non-significant relation (figure 7). These results are in line with a study done by Harding *et al.,* (2014) who highlighted that psychosocial stress resulting from academic examination is considered as a risk factor for weight gain. This stress may lead to weight gain through the cortisol reactivity pathway, where the stress is implicated in increasing the cortisol level that may increase the BMI and abdominal adiposity (Harding *et al.,* 2014). Furthermore, Harding *et al.,* (2014) stated that psychosocial stress, including both examination stress and life events stress, was positively associated with weight gain but not weight loss. These associations varied by age, smoking, obesity, and multiple sources of stressors. High level of examination stress could lead to BMI increase in overweight and obese girls, suggesting that female youths are susceptible population of psychosocial stress induced obesity (Lu *et al.,* 20016).

However, contrary studies have pointed out that blood cortisol was lower in people with high BMI than in people with normal BMI, even though this was not at a significant level as shown in other. The serum concentration of cortisol is generally normal in obesity, however, some literature suggests that obese subjects may have lower than expected cortisol levels (Odeniyi *et al.,* 2015). Prior research has suggested that the effects of stress on weight gain may differ by sex, baseline BMI and cortisol reactivity (Harding *et al.,* 2014). These factors may cause some people to gain more weight under stressful circumstances, whilst others may gain less weight or even lose weight when stressed. Indeed, the extent to which the association between stress and weight change differs according to other factors remains unclear (Harding *et al.,* 2014). In addition to that Rabasa and Dickson (2016) reported that acute intense stress is commonly associated with feeding suppression and reduced body weight gain. Likewise, Adam and Epel (2007) stated that not everyone gains weight under stress and the effects of stress on body weight and food intake are still controversial.

7. 0 Limitation of study

The samples number of this study were limited due to the scarcity of the participates, particularly male students therefore, more participates should be included to achieve more reliable results. Also, study duration was really not sufficient to perform this research without committing any errors. The errors committed in this research could be technical errors during measuring the weight and the height to calculate the BMI or during measurement the waist or the hip to calculate WHR. Due to certain circumstances, we were not able to assess post examination changes cortisol levels for longer duration, which may be evaluated on a large sample size along with various other factors.

8.0 Recommendation and further work

It is highly recommended to perform this study with more samples number and for longer duration to allow more changes in the WHR and BMI to occur as a result of stress which will help in confirming the results and avoid any inconvenient in the results. The study should be done under controlled situation to avoid the interferences of any external stress that may influence or interfere with the examination stress.

9.0 CONCLUSION

In this study, examination stress was associated with weight gain but not weight loss. Examination stress can influence the students' health by increasing the secretion of cortisol hormone through the hyperactivity of HPA axis activity. Emerging data continues to suggest that stress induced cortisol secretion during the exams among university academic students has been shown to increase central fat and weight gain which may put the student at greater risk of disease. There is growing recognition that overexposure to cortisol can have pathophysiological consequences on many organ systems which can eventually result in many disease such as atherosclerosis and many stocks as a result of increased central fats distribution (WHR) and obesity (BMI). Thus, more emphasis is needed on understanding the impact of examinations on students, on identifying vulnerable individuals, and on the appropriateness of the current examination process. Also, education system might need to develop better evaluation techniques avoiding the stress produced through the exams which cause distress among students.

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