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The Impact of Cortisol Levels on Occupational Stress Among Workers

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ABSTRACT

Objectives: The aim of the present study was to test whether coal mine workers, who are known to have a higher risk of cardiovascular disease (CVD), have higher concentrations of cortisol in their serum. Cortisol is a stress hormone that increases under stress. It is produced from the adrenal cortex, and due to high levels of cortisol, the physiology of the body changes. We found that the level of cortisol increased with stress. The present study evaluated the effects of coal toxicants on biomarkers of stress (cortisol) among occupational coal mine workers. Methods: Data from two groups of coal mine workers with physically demanding job stress, morning shift workers (N=40) and night shift workers (40), were collected. The workers in the mines were mostly shift workers. Result: Most workers did not use protective measures such as face masks, goggles or gloves. We identified different problems in mine workers. These patients experienced weight loss (42%), body rash (65.4%), body swelling (39.5%), body pain (70%), headache (32%), sputum (71.6%), allergies (46.9%), cough (37%), and fever. (35.8%), eye pain (80.2%), back pain (27.2%), skin diseases (75.3%), vomiting (74.1%), convulsions (80.2%), asthma (59.3%), pneumonia (88.9%), and arrhythmia (51.9%). The levels of cortisol were high among workers who weighed 61–80 kg. The level of cortisol is greater among individuals who are obese. We evaluated the high level of cortisol among workers who had worked for more than 8 hours. The duration of working hours is responsible for increasing stress. We observed low levels of cortisol among workers with low liver fat contents. The levels of cortisol decrease with increasing service duration and age of workers. Therefore, more experienced workers have low levels of cortisol. Conclusion: The results suggest that the level of cortisol is greater among those who have worked for more than 8 hours and remain under more stressful conditions.

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INTRODUCTION

Occupational stress has become a serious problem for workers as well as the government [1]. When job demand is too high, occupational stress can occur in a short period of time, which can cause problems for individuals [2].

Occupational stress has a dangerous effect on the human body. It causes physiological and biochemical changes and even symptoms of illness and various diseases that ultimately lead to death [3]. Occupational stress is the most important factor and is related to hypertension, ischaemic heart disease, depression, anxiety, and blood coagulation. Stress causes fight and flight responses, such as physiological changes, increased hormonal activity and increased heart rate [4].

Shift work is a major contributor to stress. Shift work causes disturbances in sleep, such as disturbances in sleep rhythm. Shift workers usually have high levels of triglycerides in their blood [5]. Stress can initiate a cascade of endocrine responses to improve individual fitness. These hormones include glucocorticoids and catecholamines. During adverse conditions, the secretion of catecholamine and cortisol from the adrenal gland increases. These hormones defend the individual against stressful satiation [6].

Cortisol is not only a powerful biomarker of the circadian cycle but also a criterion for determining stress within normal conditions. Normally, at night, the cortisol level decreases, but during the day, it increases. An imbalance in cortisol causes poor functioning of the immune system, depression and exhaustion Night shift workers have lower cortisol secretion in the morning and higher cortisol secretion at night than permanent day workers do [7]. In urine, saliva and serum, cortisol can be measured. The HPA axis causes the secretion of cortisol from the adrenal cortex under stress, and it returns to normal when stress has been removed [8].

Chronic stress also increases the waist–hip ratio. Under stress, more cortisol is released, which induces more fat deposition [9]. Depression and anxiety are related to the distribution of central fat in the body [10]. The mobilization of fatty acids from adipose tissue by cortisol can lead to obesity [11]. Measurement of serum cortisol in occupational workers can be used for the diagnosis of diseases such as hypocortisolism, Cushing syndrome and Addison disease. A deficiency in cortisol appears among individuals affected by Addison's disease. It lowers blood pressure and causes weakness, dizziness and nausea. Semiconscious and unconscious states occur under severe condition [11].

STUDY POPULATION AND METHODS

STUDY SITE AND DATA COLLECTION

The present study was carried out to identify biomarkers of occupational stress among coal workers. The coal mines of Basharat District, Chakwal, were selected randomly. Blood samples were collected from coal workers. Workers were categorized on the basis of age, height, weight, and shift work experience. A questionnaire that contained information regarding monthly income, lifestyle, family background, and service duration was used to collect information about work duration. Blood sampling along with face-to-face interviews were conducted from each worker.

PROCEDURE

We used sterile disposable syringes for blood collection from each member. Blood samples were collected from the subcalvin vein of all members. Three milliliters of blood was taken into EDTA-coated tubes for complete blood analysis. For the collection of blood samples, one trained person from a district hospital was recruited. Anticoagulant-free tubes were filled with 7 ml of blood. This blood was used for serum separation via centrifugation.

SERUM SEPARATION

For separation of the serum, each tube containing 6–5 ml of blood was centrifuged at 10,000 rpm in a centrifuge. A CBC automated analyser was used for the analysis of red blood cell count (RBC), hemoglobin concentration (Hb), total leukocyte count (TLC), white blood cell count (RBC), mean corpuscular volume (MCV), differential-crit, leukocyte count (DLC), mean corpuscular hemoglobin concentration (MCHC), packed cell volume (PCV/hematoplatelet count), and mean corpuscular hemoglobin (MCH).

PRINCIPLE OF THE MEASUREMENT OF SERUM CORTISOL

The assay is based on competition between fixed quantities of 125I labelled cortisol and unlabelled cortisol, mainly for a limited number of binding sites on a cortisol-specific antibody. Allowing the reaction of a fixed amount of tracer with different amounts of unlabelled ligand. The amount of antibody attached to the tracer is inversely proportional to the concentration of unlabelled ligand. The immune complex is inactivated on the reactive surface of test tubes with continuous agitation during a 2 hour incubation period. The radioactivity measured in test tubes is inversely proportional to the concentration of antigen. A series of calibrators that contain known amounts of cortisol were plotted against the binding values. Unspecified concentrations of cortisol among occupational worker samples can be determined from the constructed curve of calibration.

CORTISOL PROCEDURE

A radioimmunoassay kit was used for the measurement of serum cortisol. Monoclonal antibody-coated tubes labelled with a cortisol tracer. The extracted serum, calibrators and the control were incubated in these tubes. After incubation, the radioactivity was measured from the bound and aspirated liquid contents of the tube.

REAGENTS

The reagents used in the radioimmunoassay kit included an anti-cortisol monoclonal antibody-coated tube (2x 50 tubes), a 125[-] labelled cortisol tracer (one 55 mL vial), a calibrator (5 vials with 0.5 mL and 5 mL of calibrator), and a control sample (0.5 ml material).

DIRECT ASSAY OF SERUM CORTISOL

For the direct assay of serum cortisol, a precision micropipette (50 UL), semiautomatic pipette (500 UL), vortex-type mixer, horizontal or orbital shaker, aspiration system, and gamma counter set for 125 iodine were used.

SAMPLE COLLECTION, PROCEDURE, STORAGE AND DILUTION

Samples of coal mine workers were taken. Blood was collected from EDTA-coated tubes. By centrifugation, the plasma is separated from the cells or the serum. If the assay was performed within 1 day, then the serum samples and plasma were stored at 2-8 °C. The samples were kept frozen (<-20°C for 3 months maximum) for longer storage after liquation. The samples were thawed at room temperature. Samples must be diluted in the zero calibrator if they have a concentration greater than the highest calibrator.

STEPS

1: **INSERTION**

Add constantly antibody-coated tubes , control and serum or Calibrators were kept 50*u*L.

For tracer calibrators or control, serum and tubes for total count were kept 500uL

2: INCUBATION

For 60 minute at 18-25°C with shaking (≥400 rpm)

3: COUNT

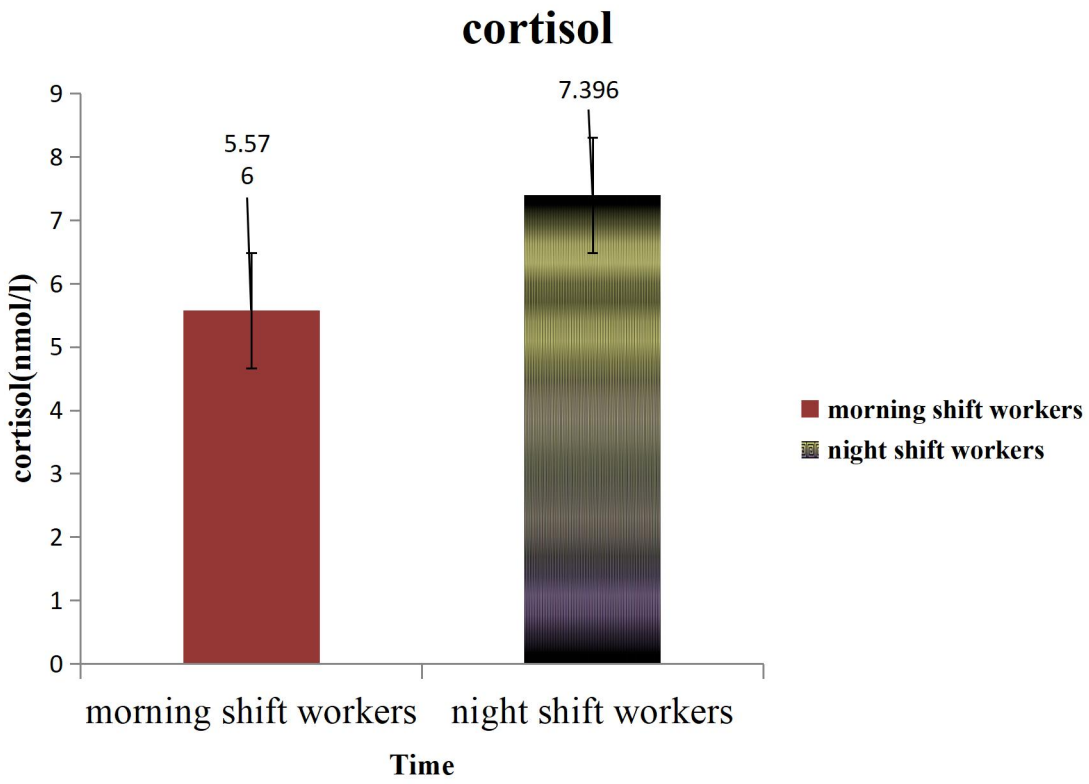
Suck in carefully contents of tubes (except of two tubes for total count), Calculate total cpm (T) and cpm bound (B).

During stressful conditions cortisol induced following changes in body. High level of cortisol responsible for sever mood swings, suppressed immune system, and depression, sever hypertension and insomnia. The low level of cortisol hormone causes hypo-tension.

Demographic data in table .1 indicates one group that contains 38 numbers of individuals within age of 30 to 50 have body mass index 30.2. The workers in this group are regular workers and smoking ratio among them are 50%. The second group includes 42 individuals within age 25 to 40 have body mass index 28.9. The workers in this group are shift workers and smoking ratio among them are 80%.

COMPARISON OF CORTISOL AMONG COAL WORKERS

GRAPHICAL REPRESENTATION



This table indicates the comparison of variance between two groups. One group include morning shift worker and other group include night shift worker. This shows significant difference between two groups and their equal of variance has not been accepted. So I assumed the value of variance is not equal. Independent sample test indicate significant value of cortisol. It has been under stress the value of cortisol increased among night shift workers. The t – value is 3.084 and difference among two groups. This shows the level of cortisol high in night shift workers.

TABLE 1 (A), (B): DEMOGRAPHIC DATA FOR REGULAR WORKERS AND SHIFT WORKERS AGE OF SMOKERS

(A)

(BMI=body mass index)	N	Age	BMI	Smokers
Regular workers	38	30-50	30.2	50%
Shift workers	42	25-40	28.9	80%

(B)

Working hours ..... Body weight	Mean	Df	Std-deviation	t-value	No of individuals	cortisol
< 8 hours	6.06	78	1.83	-3.015*		Low
61-80kg						
>8 hours						
40-60kg	7.68	66.5	2.84	-3.015*		High
Normal lever fat	6.70	78	2.22	-.887		Low
Content						
Abnormal lever fat	7.25	33.5	3.10	-.846		High
Services Duration						
1-10 years	6.97		2.31			moderate
11-20 years	7.10		2.84			High
21-30years	5.56		1.57			Low
Age						
20-30	7.43		2.44		29	High
40-50	7.15		2.78		31	Moderate
60-70	5.61		1.72		20	Low
Normal fat content	6.709	2.22	--	---	-----	----
Abnormal Fat content	7.25	3.10	--	---	-----	----
Weight	--	---	-----	----	--	---
61-80kg						
40-60kg						

This table indicates the body mass index of regular and shift workers. The number of regular workers were 38 their body mass index were 30.2 and 50% individual among them were smokers. The number of shift workers was 42 their body mass index were 28.9 and 80individual among them were smokers.

We found that workers who had a service duration of 1–10 years had a mean Std. deviation of 6.97 and 2.31, respectively. The workers who have service durations of 11-20 years have a mean level of 7.104286, with a standard deviation of 2.84. The workers who have service durations of 21-30 years have a mean level of 5.568889, with a standard deviation of 1.57. This table shows comparisons between groups and within groups on the basis of service duration and the level of cortisol. The F value is 1.402 and not significant. This means that, owing to an increase in service duration, the level of cortisol decreases among these workers.

We compared three groups: one group contained 29 individuals aged 20-30, and the mean index was 7.43, with a standard deviation of 2.44. The second group contains 31 individuals aged 40–-50 years and has a mean index of 7.158710, with a standard deviation of 2.78. The third group contains 20 individuals whose ages range from 60–-70 years, with a mean index of 5.61 and a standard deviation of 1.72. This table shows comparisons between groups and within groups on the basis of age and level of cortisol. The value of Table F is 3.638, which is not significant. This means that as the age of workers increases, the level of cortisol decreases.

SERUM CORTISOL CONCENTRATIONS AMONG SHIFT WORKERS

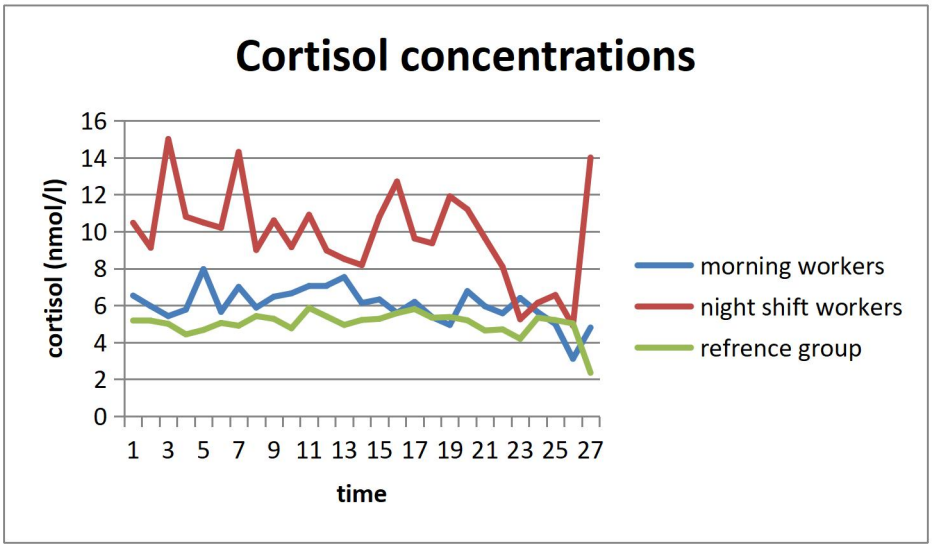


FIGURE 2: SERUM CORTISOL CONCENTRATIONS AMONG MORNING AND NIGHT SHIFT WORKERS.

The figure 2 indicates that morning workers have lower levels of cortisol than do night shift workers, who have high serum cortisol. In a work place, stress can be determined by the job task being performed [12]. Shift workers are often unprotected from stress, such as the physical work environment, social structure or economic conditions [13].

The contributing factor to stress at the work spot was sound. A survey revealed that shift workers have health issues due to increased blood pressure [14] and a changed circadian cycle and highly active body hormones during their work activity within a twenty-four-hour period [15]. Stress is associated with the release of the hormone cortisol by the adrenal glands. It is referred to as a stress hormone only because of its ability to be secreted when the human body responds to sensual and physiologic mental strain [16].

The high level of the hormone cortisol and its correlation with stress should be monitored and listed for shift workers, and the cortisol hormone levels for night shift workers should also be higher than those for morning shift workers. Under normal secretion conditions among shift workers, cortisol secretions are high during the day and low at night [17].

Researchers previously reported that health indices such as CVD, smoking and physical activity were significantly correlated with cortisol. Cortisol is discharged according to a circadian rhythm characterized by a low level at night and a high level in the early morning, such as waking up and the minimum value by the end of the day [18].

The results indicated that the circadian rhythmicity of increased cortisol in security guards workers is influenced by night shift work and by various activities performed. This finding suggests that the endogenous physical feedback of cortisol is influenced by both the working situation, which changes the waking rhythm, and the hazard of the activity performed [19].

DISCUSSION

The present study was conducted to evaluate the effects of coal toxicants on cortisol.

The current study revealed that the level of cortisol under stress increases among coal workers. We found that, owing to abnormal fat contents, the level of cortisol decreased. We also found that, owing to increases in service duration and age, the level of cortisol decreased in coal workers.

A recent study revealed that the levels of cortisol and ACTH increase under acute physiological stress. Among workers, their hormonal response to job stress was observed, and salivary cortisol parameters were studied. In another approach, serum cortisol was also used as a

parameter of job stress. Job stress and cortisol are positively related [20].

We detected high levels of cortisol among workers weighing 61–80 kg. In Cushing syndrome patients, more fat accumulates in the neck, visceral organ and face due to high levels of cortisol [21].

We evaluated high levels of cortisol among workers who had worked for more than 8 hours. Cortisol hormone is produced from the adrenal gland. It controls immunosuppressive, anti-inflammatory and gluconeogenesis responses. Stress stimulates the anterior part of the pituitary gland to release adrenocorticotrophic hormone (ACTH), which provokes the adrenal gland to secrete the hormone cortisol. This is known as the hypothalamic pituitary adrenal axis [22]. Under normal conditions, the HPA axis controls circadian rhythms. During early morning, cortisol production peaks, which gradually decreases, and at night, it reaches its lowest value [23].

Stress disturbs the normal cycle of the HPA axis. Alterations in sleep due to stress and cortisol hormones are affected by sleep. Among shift workers, disturbances in circadian rhythm alter the production of cortisol, which is a factor in various diseases, such as diabetes, cancer and heart problems [24]. Owing to sleep deprivation, increased levels of the hormone cortisol indicate stress factors [25]. Similar results were observed in rats subjected to sleep deprivation for 96 h, indicating that the levels of cortisol increased and that the levels of cortisol returned to normal after 48 h of sleep. More working hours act as stressors, and the level of cortisol increases [26].

High levels of cortisol can affect mental power, memory and the brain and have detrimental effects on personal health. During nonworking hours, the level of cortisol is low among workers [27].

We found that the level of cortisol was low among workers who had low liver fat contents. A high level of cortisol can increase triglyceride contents in the liver [28]. In shift workers, the change in sleep pattern is directly related to weight gain [29]. Similar results have been reported in humans and other animals, in which sleep deprivation leads to obesity [30].

We found that, owing to increases in service duration and age, the level of cortisol decreased. Van Cauter et al. (1996) reported high levels of cortisol in the morning and evening in men [31]. Age and the level of cortisol are positively related [32].

CONCLUSION

The present study clearly indicates that the level of cortisol increases among occupational

workers. Owing to stress, the level of cortisol increases among coal mine workers. Among shift workers, the level of cortisol fluctuates. In night workers, due to increased stress from sleep deprivation, the level of cortisol becomes high. Among obese individuals, high levels of cortisol are observed. In coal workers, the levels of cortisol decrease as the age and service duration of workers increase.

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