

Plasma Catecholamine's and Blood Pressure Changes after Prolonged Exposure to Stressful Stimuli (Heat)

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Abstract : The aim of this study was to evaluate the relationships between heat stress and indicators of autonomic nervous system activity in workers of the Thermal Power Station. A total of 123 employees between 12-58yrs of age from a company that produces electricity were recruited for participation in this study. Thermal stress was assessed in workers exposed to heat to temperature between 38⁰ C to 43⁰C in Boiler section . The workers were divided into four groups depending on duration of exposure. Systolic and Diastolic Blood pressure was recorded and plasma catecholamine's concentration was measured by an HPLC-ECD. Information on demographic characteristics, previous job history, smoking status and alcohol consumption was also collected. Blood pressure was significantly higher with prolonged duration of stressful (heat) stimuli. The plasma catecholamine's levels increases significantly. The results of the present study indicate that these modifications are related with the duration of exposure to heat. It is presumed that these effects are due to activation of autonomic nervous system and Hypothalamo-Hypophyseal adrenal axis and resultant release of catecholamine's from adrenal medulla due to heat stress. These suggest that the risk of hypertension and Coronary Heart Disease (CHD) is greater in these workers.

Key words: heat stress, systolic Blood Pressure, Diastolic Blood pressure plasma epinephrine, plasma nor-epinephrine, CHD

I. INTRODUCTION

Stress may be defined as "non specific result of any demand upon the body". It can be mental or physical. [1] Stress can be considered as state of disharmony or threatened Homeostasis. Stress conditions vary and can range from physical to psychological, from mild to severe and from acute to chronic. [2] Cardiovascular responses during and after psychological stressful situation have been frequently investigated with an objective to correlate behavioural and physiological aspects of stress [3]. Several kind of mental stress are associated with temporary rise in blood pressure and plasma catecholamine's [4,5,6,7] Previous studies have revealed significant relation between occupational exposure to noise and cardiovascular changes [8,9] but there is little information about the association between occupational exposure to heat and cardiovascular changes. Fire is one of the most serious problems that affect the modern life. The workers are entrusted with important task of firing the boiler in boiler section. So, they are continuously exposed to heat emitted by the boilers. This job is stressful and thus prompted us to study the influence of varying duration of heat exposure on plasma catecholamine's and blood pressure. The employees work round the clock in shifts and studies have shown that workers employed in three shift jobs suffer more from work-related stress than do day workers. [10]

II. MATERIAL AND METHOD

2.1 Subjects

The subjects were 123 male healthy employees in between age group of 21-58 yrs from a Thermal power plant that produces electricity. Only males were included in the study as the company employs very less females. The employees work one of three shifts (morning, afternoon or night). The workers were exposed to heat emitted by boiler in boiler section for 8hours daily and six days a week. Temperature to which they are exposed is in between 38⁰ C to 43⁰C. Self-administered questionnaires were used to gather information on demographic characteristics, job history, smoking history and alcohol consumption. All the subjects selected were free from diabetes, cardiovascular or other systemic disorders. Also the smokers and alcoholic were excluded.

The workers were grouped into four Groups depending on duration of exposure as shown in Table No.1

Groups	I	II	III	IV
Age (yrs)	21-30	31-40	41-50	51-58
Duration of Exposure (yrs)	5-10	11-15	16-20	>20
No. of Workers	16	42	45	20

2.2 Plasma Catecholamine Assay

To obtain quantitative measurements of autonomic nervous system response, epinephrine and nor epinephrine levels were measured from a single 5 ml venous blood sample, collected into plasma blood tubes after obtaining a informed consent. Participants were instructed to fast 2 hours prior to test and blood sample were collected in supine position (30mins) at same time of the day to minimize circadian and diurnal fluctuations in the biomarkers. Plasma was mixed and spun, serum was allowed to clot for 30 minutes and they were then centrifuged for 10 minutes. The quantitative measurement of epinephrine and norepinephrine were assayed by means of HPLC with fluorimetric detection after isolation from plasma by a specific liquid/liquid extraction method. [11]

2.3 Blood pressure measurement

Because large variations in blood pressure have been shown to exist with a given subject, it is difficult to detect differences between groups that may lead to misclassification of individuals. Therefore, multiple blood pressure measurements using standard procedures were implemented in this investigation. Their blood pressure was recorded in supine position using mercury sphygmomanometer. Three readings were taken 10minutes apart and mean was taken as blood pressure.

2.4 Statistical analysis

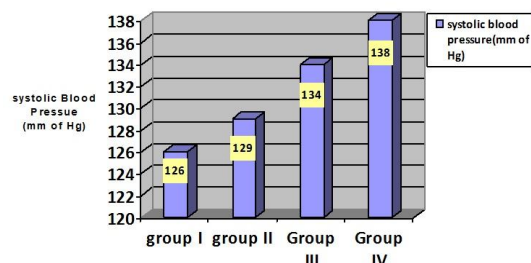
Statistical comparisons between various groups were made by analysis of variance (ANOVA). ANOVA was performed in order to evaluate the difference in blood pressure and plasma catecholamine's in the four groups according to the duration of exposure to heat.

III. RESULTS

3.1 Prevalence of hypertension

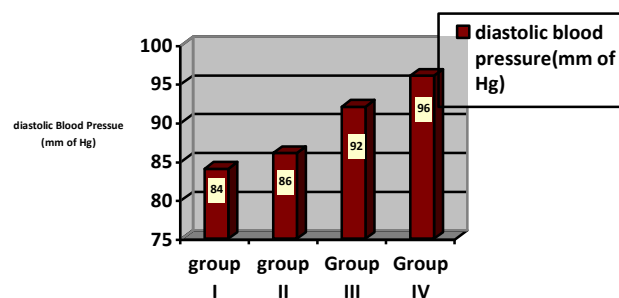
The cardiovascular parameters measured in workers exposed to heat depending upon duration of exposure is demonstrated in Fig. No.1 &2. When the workers were categorized into four groups depending upon duration of exposure, systolic and diastolic blood pressure increases significantly as duration of exposure to heat increases.

Fig. No.1 :-Changes in systolic Blood Pressure amongst the workers depending upon duration of exposure.



Highly significant increase in systolic blood pressure is observed in fig. no.1 as duration of exposure to heat goes on increasing form group I to group IV in workers.

Fig. No.2 :-Changes in diastolic Blood Pressure amongst the workers depending upon duration of exposure.



Significant increase in diastolic blood pressure is observed in fig. no.2 as duration of exposure to heat goes on increasing from group I to group IV in workers.

3.2 Changes in the Plasma Catecholamine's

Figure No.2 summarizes the results of occupational studies on the association between heat and stress hormones. When the levels of plasma catecholamine's such as epinephrine and nor epinephrine were compared in each group depending on duration of exposure to heat, there is significant rise in plasma catecholamine's as the duration of exposure goes on increasing.

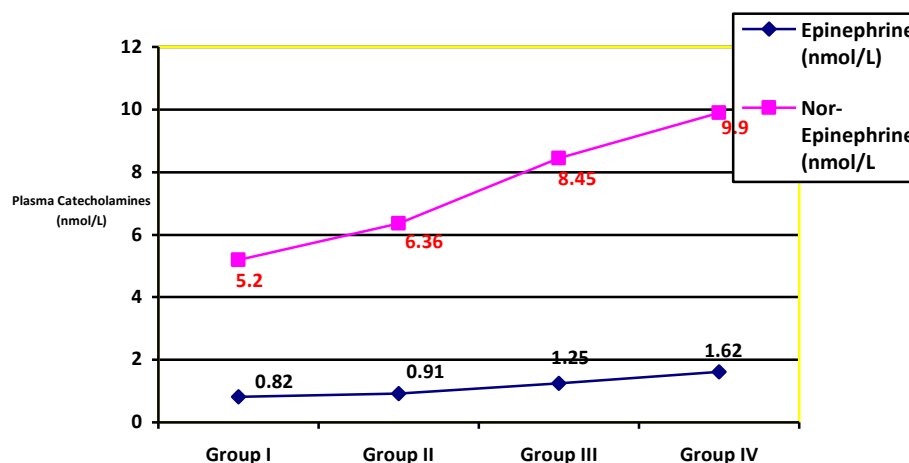


Figure No. 2 :-plasma Catecholamine's levels amongst workers with respect to duration of exposure to heat.

IV. DISCUSSION

The present study indicates an influence of prolonged exposure to heat on the blood pressure. The primary finding of this study is that autonomic responses during occupational exposure to heat are significantly altered by heat stress.

In the present study, systolic and diastolic blood pressure showed significant increase after prolonged exposure to heat stress. In previous studies, blood pressure increase in acute heat stress in both animals and humans has been described.^[12,13,14] Parvizpoor et al^[15] conducted a study of noise exposure and prevalence of high blood pressure among 821 Iranian weavers in a textile mill. A clear increase in the prevalence of both borderline and definite hypertension was observed in relation to length of employment, an increase over and above would be due to age alone. Kavoussi et al^[16] in a study of 465 males occupationally exposed to noise observed that hypertension increases with increase years on the job. Hypertension was more prevalent among men aged 55-64 with 25 or more experience. Anders Jonsson et al(1977)^[17] and Talbott et al (1985)^[18] in their work on prolonged exposure to stressful stimuli (noise) suggested that continues exposure to stressful stimuli may have caused repeated cardiovascular reactions to psychological rise in blood pressure. A similar hypothesis put forth by Andrew Steptoe et al (1986)^[19] that autonomically mediated cardiovascular reactions to psychosocial challenges may initiate progression towards sustained blood pressure in susceptible individuals. Saha S et al (1996) suggested that the rise in blood pressure with increased duration of exposure to noise is attributed to increase release of plasma catecholamines.^[20]

In our study, the rise plasma catecholamines concentration become more significant with increasing duration of exposure to heat. A similar statistical significant increase in plasma and urine levels of catecholamines was reported by Kyoung-Ho LEE et al (2010)^[21] Dimsdale JE et al(1980)^[22] Fibiger W et al (1988)^[23] Chang HR et al (1996)^[24] in acute and chronic cases of different types of stresses.

Norepinephrine secreted by sympathetic nerve endings binds to receptors on neighbouring organs and influences their function and then undergoes re-uptake at the sympathetic nerve endings. Epinephrine and norepinephrine secreted by the adrenal medulla enter the bloodstream and exert their effects on organs farther away. These hormones work by stimulating the α and β receptors, each having a specific effect at each receptor type. Adrenal medulla also secretes epinephrine and norepinephrine as well. Epinephrine secretion can, therefore, be used as a reflex of sympathetic nerve function, as well as adrenal medulla function. In addition, catecholamine increases can be seen in essential hypertension, malignant hypertension, and congestive heart failure, but catecholamine monitoring in these diseases is not diagnostically useful. Under stress, catecholamine levels can also be increased.^[25]

V. Conclusion

From the present study it may thus be concluded that heat stress causes increased sympathetic activity thereby leading to significant increase in systolic and diastolic blood pressure. It can also be concluded that prevalence of hypertension, CHD and its risk is higher in workers exposed to heat as a stressful stimuli for longer duration

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