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DOES THERMAL STRESS ALTERS THE AUTONOMIC FUNCTIONS IN MEN EXPOSED TO HEAT?

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ABSTRACT

Aim and objectives :-The aim of the study was to evaluate the relationship between exposure to heat (stressful stimuli) and indicators of autonomic functions in workers of thermal power station. **Material and method :-**133 male workers were selected out of whom 65 workers were exposed to heat (40⁰C to 45⁰C) emitted by boiler in boiler section for 8 hrs daily and 6 days in a week for estimation of plasma catecholamines and blood pressure. The control group consists of office workers and staff who were not exposed to extreme heat. Depending on age, they were divided into four groups. Estimation of plasma adrenaline and nor-adrenaline was carried out by HPLC method with fluorimetre detection and blood pressure by mercury sphygmomanometer between cases and controls to observe the effect of heat stress on autonomic functions. **Results:-** It was observed that there is highly significant increase in plasma level of the adrenaline and nor-adrenaline in workers. Systolic and diastolic blood pressure raised significantly in workers. **Conclusion :-**The general hypothesis to emerge is that automatically mediated cardiovascular reactions to stressful stimuli (heat) may initiate progression towards sustained hypertension and coronary heart disease (CHD) in susceptible individuals

Keywords :- adrenaline, nor-adrenaline pressure, diastolic blood, systolic blood pressure, thermal stress.

INTRODUCTION

Stress is the reaction of body to stimuli that disturb its normal physiological equilibrium or homeostasis. In our daily lives, some stress prepares us to meet certain challenges. The productive stress is called Eustress while the other harmful stress is called Distress¹. Stress causes mental, emotional and physical responses in humans. When stressed, an organism first experiences arousal of the sympathetic nervous system, followed by activation of the musculoskeletal, cardiovascular and endocrine systems. The outcome of this process is a series of non-specific psycho-physiologic changes such as an increase of certain neurotransmitters in the bloodstream, and results in adverse effects associated with the negative aspect of

stress.² Several kind of mental stress are associated with temporary rise in blood pressure. In animal experiments, it has been shown that repeated exposure to stressful stimuli can cause permanent rise in blood pressure. Such a relationship between repeated stressful stimuli and a permanent rise in blood pressure is obviously not so easy to establish in man, partly due to the fact that environmental stress is difficult to measure and quantitate.³ Over the past decade due to the view that stressful stimuli may influence the onset and progression of number of disorders in human beings leading to hypertension, stroke, depression etc. There is a considerable evidence that heightened autonomic nervous system activity may be present early in the aetiology of hypertension. It has become clear over recent years that autonomic regulation of the

cardiovascular system is not confined to the brain stem cardiovascular centres, but it is organised longitudinally within the central nervous system with higher cortical and sub cortical regions having an important influence. The general hypothesis to emerge is that automatically mediated cardiovascular reactions to psychological challenges may initiate progression towards sustained hypertension in susceptible individuals.⁴ Effect of different stresses on autonomic changes has been studied widely, but occupational exposure to heat stress is least studied part of the subject.

MATERIAL AND METHOD:

The subjects were 133 workers from thermal power plant in the age group of 30-50yrs. This study group was divided into control (68) and experimental groups (65) based on their exposure to heat.

selection criteria

Cases - Only those workers were selected who were exposed to heat emitted by boiler in "Boiler section". The workers were exposed for 8 hrs daily and 6 days a week and temperature to which they are exposed is in between 40⁰c to 45⁰c.

Control -The control group consists of office workers and staff who were not exposed to extreme heat.

In the present study, each subject were made familiar with the procedure to alleviate any fear or apprehension and before starting the procedure, they were asked to relax for five minutes. Screening of each volunteer was done with the help of proforma. After Screening, following

volunteers were excluded from the study. Those having major cardiovascular illness or Diabetes mellitus in the past or present, with the H/O consumption of tobacco, alcohol, smoking, history of any systemic illness, history of drug treatment.

METHODOLOGY

Collection of blood sample :- Venous plasma adrenaline and nor-adrenaline concentration were used as a indices of adreno-medullary and sympathoneural regulation respectively. 5ml blood sample was collected in supine position (30mins) from anti-cubital vein of the non-dominant forearm for determination of plasma adrenaline and noradrenaline concentration. The blood samples were centrifuged at 4⁰C and catecholamines were assayed by means of HPLC with fluorimetre detection after isolation from plasma by a specific liquid/ liquid extraction method.⁵

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 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.

Statistical analysis:- For statistical analysis we have applied t-test to compare cases with controls.

RESULTS

Table 1:- Comparison of plasma adrenaline (pg/ml) in supine (30mins) between cases and control belonging to different age group

Groups	31-35yrs (Group-I)		35-40yrs (Group-II)		41-45yrs (Group-III)		46-50yrs (Group-IV)	
	Control	Cases	Control	Cases	Control	Cases	Control	Cases
No. of Cases	17	16	18	16	20	21	13	12
Mean	9	12	11	18	26	34	43	47
±SD	3	5	5	9	15	16	16	19
t- test	P < 0.05		P < 0.001		P < 0.001		P < 0.05	
Significant	S		H.S.		H.S.		S	

Table no. 1 shows highly significant increase in plasma adrenaline level in workers exposed to heat in Group II and III while significant increase in Group I and IV.

Table 2:- Comparison of plasma noradrenaline (pg/ml) in supine (30mins) between cases and control belonging to different age group

Groups	31-35yrs (Group-I)		35-40yrs (Group-II)		41-45yrs (Group-III)		46-50yrs (Group-IV)	
	Control	Cases	Control	Cases	Control	Cases	Control	Cases
No. of Cases	17	16	18	16	20	21	13	12
Mean	159	163	226	234	416	422	386	390
±SD	44	47	45	47	108	114	86	91
t- test	P < 0.05		P < 0.001		P < 0.05		P < 0.05	
Significant	S		H.S.		S		S	

Table no. 2 shows significant increase in plasma nor-adrenaline level in workers exposed to heat as compared to controls in Group I, III and IV while highly significant increase in Group II.

Fig. 1:- Comparison of Systolic blood pressure (mm of Hg) between cases and control belonging to different age group

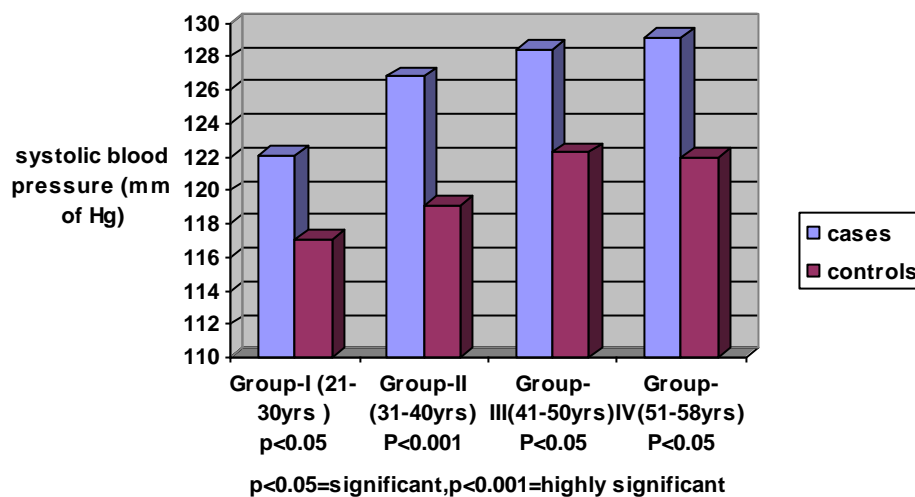
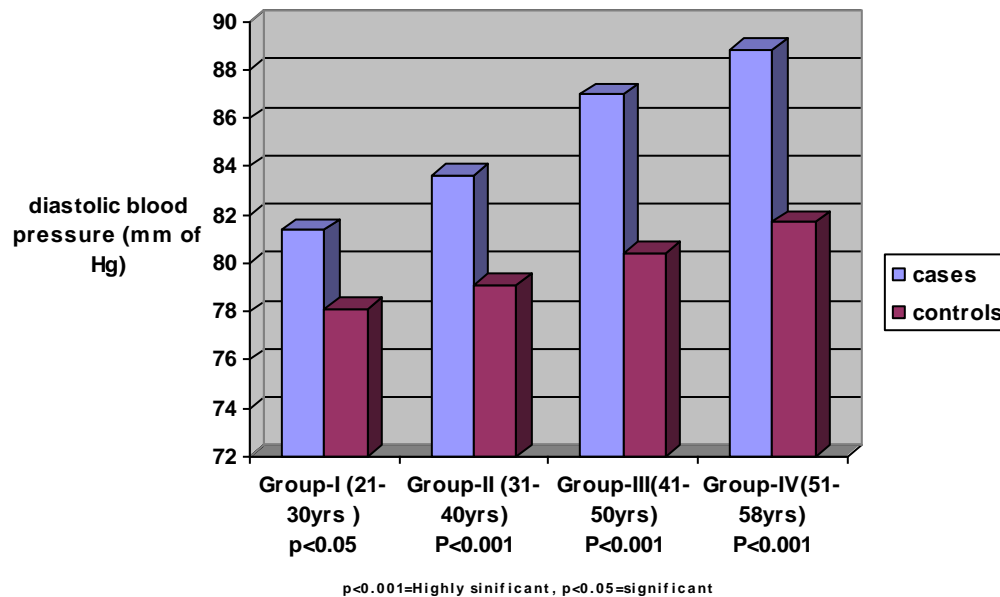


Fig. No.1 shows highly significant increase in systolic pressure in Group II while significant increase in Group in I, II and IV.

Fig. 2:- Comparison of Diastolic blood pressure (mm of Hg) between cases and control belonging to different age group



In fig.no.2 diastolic pressure shows highly significant increase in Group II, III and IV.

DISCUSSION

The present study was conducted to explore whether exposure to heat is altering the autonomic functions of the body. Our study shows highly significant increase in plasma catecholamine concentration when compared with age matched controls of all the four age groups. A similar statistical significant increase in plasma catecholamine concentration was reported by Dimsdale JE et al(1980)⁶ Fibiger W et al (1988),⁷ Lefur C et al (1999)⁸, Shinji Y. Amamoto et al(2007),⁹ Milakofsky L et al(1993),¹⁰ De Turck KH et al (1980)¹¹ in acute and chronic cases of different types of stresses.

Stress is known to induce more secretion of adrenaline and noradrenaline from adrenal medulla which is due to uniform arousal of both the flight-fight sympathoadrenal systems.^{12,13,14} In the present study, systolic and diastolic pressure showed significant increase after exposure to stressful stimuli (heat) which matches with the studies done by Parvizpoor D et al (1976)¹⁵ Talbott et al (1985),¹⁶ Jian Cu et al (2010),¹⁷ Mathew et al (1995)¹⁸

Anders Jonsson et al (1977)³ in their work on prolonged exposure to stressful stimuli (noise) suggested that prolonged exposure to stressful stimuli may have caused repeated rise in blood pressure leading to circulatory adaptation and a permanent rise in blood pressure. A similar hypothesis put forth by Andrew Steptoe et al (1986)⁴ that autonomically mediated cardiovascular reactions to psychosocial challenges may initiate progression towards sustained blood pressure in susceptible individuals.

The other possible cause of increase in blood pressure during exposure to heat stress may be increased hematocrit which proportionally increases blood viscosity, which is associated with increased blood pressure¹⁸ Stress induced increase blood pressure can also be due to overactivity of hypothalamo adrenal medullary axis.^{12,13}

CONCLUSION

From the present study it may thus be concluded that exposure to heat (stressful stimuli) 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 stress as compared to controls.

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