Biological Forum — An International Journal, **2**(2): 42-45(2010) **ISSN : 0975-1130**

Physiological profile of foundry workers in response to work place environment

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ABSTRACT : Foundry environment is characterized by a multitude of concomitantly occurring exposures, such as silica dust, various chemicals, noise, heat, radiations, etc. Physiological profile of workers indicates variations in heart rate, blood pressure as well as body temperature.

Keywords : Foundry environment, workers, physical fitness

INTRODUCTION

New technological developments in industry today produce seven times more goods than it did some fifty years ago. While industrial developments have brought obvious benefits, it has also frequently increased risk of damage to the human health and environment. Foundry industry gives direct employment to about 25% of all industrial labors. So problems of comfort and health of foundry workers are of paramount importance. The work place environment influences significantly the health status of workers Toru *et. al.,* (1986).

In previous study More and Sawant (2001) have observed that the workplace environment in foundry was extremely adverse due to high concentration of coal dust, silica dust, extremely high temperature and noise.In the present study efforts have been made to correlate the physiologic responses of foundry workers and their work place environment.

MATERIALS AND METHODS

The present study was undertaken at private foundry unit in Kolhapur M.I.D.C area. Workers were assessed for the study of work physiology and stress effects for socioeconomic information. The assessment methods also included personal interviews with workers. A standard, questionnaire was used to collect information of workers concerned with age, experience, marital status, family size, monthly income, habits, health status and health problems and information related with occupational stresses. The physiological evaluation of randomly selected workers was carried out from different sections. Most of the work in the foundry unit was of repetitive nature, which was carried out in three shifts. Persons working in the office were treated as control subjects (C).

Work place environment. Sound levels at different sections in foundry unit were recorded by sound level meter in decibel (db). Record of thermal data such as dry bulb and wet bulb temperatures were made in various foundry sections during working hours. Assessment of thermal load with special reference to different physiological responses of foundry workers was carried out. The illumination levels at different sections inside the foundry unit were recorded by a lux meter. Assessment of foundry dust was carried out by Rotorod Air Sampler.

Physical characteristics of workers. The physical characteristics (anthropometric measurement) height and weight of workers were recorded with standard technique of occupational safety and health Kohn *et. al.,* (1996).

Physical fitness. The physical fitness of some randomly selected workers was carried out by Harward Modified Step Test.

Grip strength study. In randomly selected workers physical fitness was studied for grip strength by grip dynamometer.

Physiological responses. The physiological responses of an individual changes with the work and working condition of the workers was studied. Twenty five selected workers studied for physiological responses on any working day. The pulse rate/min of subject were recorded from carotid pulse. The blood pressures were recorded by sphygmomanometer. The axial temperature of subject and body temperature were recorded by clinical thermometer.

RESULTS AND DISCUSSION

In foundry industry thousands of workers was working in various sections like sand plant, core shop, moulding section, furnace section and fettling shop, performing repetitive identical cycles of operations. The socioeconomic study of workers reveals that most of the workers working in foundry are illiterate, smoker, alcoholic and earning less for work done. Work environment was extremely adverse with prevalence of high temperature, high noise intensity, dust concentration, poor ventilation, and variety of fumes as well as excessive work load. These conditions make it

extremely difficult to maintain the appropriate level of health status of foundry workers

**Foundry indoor environment : ** Survey of indoor working environment in foundry indicates that the work environment was extremely adverse. The noise level in fettling shop ranges from 102-105 dB, in furnace section it was about 85 dB and in core shop 80 dB. Light is important environmental factor. Illumation level recorded in office 1000 lux, furnace section 750 lux and core shop 735 lux which was adequate. Inadequate illumination leads poor coordination of eyes and makes the situation more complicated. Workers complain about visual strain. Illumination level in sand plant was 190 lux and in moulding section it was 230 lux.

Heat stress is important environmental stress factor which affects the health status of workers. Working conditions in foundry were too hot near the core furnace and in melting area. Dust from foundry shakeout and returns sand hardening system is composed of sand particles which are fractured by heat, binders such as bentonite. Dust from cleaning equipments such a shot blasting machines, vibrators and grinders contains all these particles and large percentage of iron particles.

Table 1 shows number of workers in various sections of foundry. The length of service varies from minimum 8 years to maximum 12.2 years. Mean body height ranges from 158.5 cm to maximum 162.33 cm and body weight of workers ranges from 48 to 65.25 kg.

Table 1: Physical characteristics of foundry workers in different sections.

Name of Section	No. of Subjects	Period of service in yrs	Mean body height in cm	Mean body wt. in kg
Office	05 (C)	12.0 ± 5.09	164.5 ± 2.69	65.25 ± 4.14
Sand plant	08	11.66 ± 3.39	155.66 ± 0.94	48 ± 6.68
Core shop	09	09.00 ± 2.78	162.33 ± 2.05	50 ± 2.94
Mouldingsection	10	12.2 ± 4.81	162.27 ± 5.39	49.3 ± 3.92
Furnace section	10	9.7 ± 3.83	160.7 ± 5.60	51.9 ± 5.10
Fettling shop	08	8.16 ± 2.47	158.5 ± 5.96	48.33 ± 2.28

Table 2 shows physical fitness score and it was observed less in workers whose exposure period was above 15 years.

Table 2: Mean physical fitness score of workers according to work exposure.

Work exposure in years	No. of workers	Mean physical fitness score
Control	05	108.62
Up to 5	10	99.00
5 to 10	17	98.38
10 – 15	09	82.87
Above 15	09	82.00

Table 3 shows fitness performance of work force in foundry. As newly joined workers were young and healthy percentage of fitness performance was excellent *i.e.,* 52 % and number of workers above 40 years was less *i.e.,* 2%. Fitness performance decreases with increase in service period.

Table 3 : Fitness performance of the work force in foundry.

Fitness Performance	Percentage
Poor	2 %
Low Average	8 %
High Average	2 %
Good	36 %
Excellent	52 %

Table 4 indicates means body temperature values in °C according to work exposure. Body temperature of workers was less than control. It may be due to acclimatization to working conditions.

Table 4 : Mean body temperature values in °C according to work exposure.

Work Exposure in Years	No. of Workers	Temperature in °C
Up to – 5	10	36.27 ± 0.094
5-10	17	36.22 ± 0.080
10-15	09	36.08 ± 0.142

Control – 37.14 ± 0.0812 ± Standard error (S.E.)

Table 5 shows mean pulse rate per minute. The pulse rate found to be lower as compared to control.

Table 5: Mean pulse rate/min according to work exposure.

Work Exposure in Years	No. of Workers	Pulse rate/min
Up to – 5	10	71.14 ± 0.99
5–10	17	69.57 ± 2.00
10–15	09	70.83 ± 3.33
Above 15	09	70.02 ± 2.62

Control – 75.00 ± 1.11 ± Standard error (S. E.)

Similar observations with respect to dust exposure and impairment of lung function at iron foundry and the effects of silica dust on ventilatory function of foundry workers were found to be recorded by Gomes *et. al.,* (2001)and Koo *et. al.,* (2000).

Although in the working environment of foundry, radiant heat is present, but workers do not show increase in body temperature. Due to heavy work load, workers sweat profusely hence, the body temperature at surface declines and there is no significant increase in the central body temperature. Excessive sweating indicates that there is stress on thermoregulatory system of body Zhang *et. al.,* (2010). Acute heat stress was found to lead to dehydration and loss of electrolytes. Hot environment was also found to increase oxygen consumption Bandopadhay *et. al.,* (1989), pulmonary ventilation and decrease in work performance. In industrial operations, measurement of pulse rate is the simple method for evaluating stress of job on workers. Due to repetitive hard work, pulse rate and blood pressure values are not much affected, but work exposure, heat stress, high concentration of dust, intensity of work as well as duration of work, intensity of noise the cardiovascular responses are significantly affected.

Pulse rate responses of individual workers in a group were different. A number of workers indicated a steady state of pulse rate and recovery time was shorter indicating good physical fitness.

Physical fitness score of the foundry workers suggest that 2% workers show very poor physical fitness score, 8% show low average, 2% show high average, 36% show good physical fitness score and 52% show excellent physical fitness score. Physical fitness score gradually reduces according to period of work exposure. The work load in the foundry industry is higher. A significant observation is that the physiological responses like heart rate, blood pressure and body temperature are related to working conditions. Recovery heart rate comes to normal level quickly, but blood pressure shows sustained increased condition according to work exposure. Body temperature was found to be normal. It may be due to acclimatization to specific working conditions. The work environment in the foundry is characterized by a multitude of concomitantly occurring exposures, such as silica dust, various chemicals, noise, heat, radiation, etc. as well as strenuous physical work and poor working conditions Mathew (1984), Low and Mitchella (1988). The health effects of many of these exposures lead to discomfort and when they act alone, possible non specific effects, caused by the interaction of the multiple stress factors and manifested as a change in normal morbidity and mortality patterns, have not received much attention Govindarajulu and Pillai (1989). Furthermore, many of the chemicals present in the air, including various products of pyrolysis, may have hitherto unrecognized effects. Out of these factors the most significant problematic factor is dust containing silica leading to silicosis. In India much research has been conducted related to effect of cotton dust in textile industry Gupta (1986) affecting lung functions, organic flour dust Sultan (2004), silica dust Koo (2000) and foundry dust Gomes et al (2001). As observed in the present study exposure to respirable dust was higher among foundry workers and among these particularly in fettling section and moulding section.

This exposure to foundry dust has also been strongly associated with reduction in PEFR More (2003). Similar combined occupational exposures to dusts, gases and fumes have been also reported resulting into reduction for peak expiratory flow rate by Xu X et al (1992), Gomes et al (2001). The values of the fitness score as well as fitness performance index of these foundry workers exposed to foundry dusts in various sections of foundry as well as exposed to the occupational stresses such as temperature and noise significantly low as compared to there counterparts in office (Control). Implementation of occupational hygiene and proper ergonomic process management with efficient use of personal protective equipments while at work could help to keep those foundry workers comfortable and healthy.In order to gets detailed information about physiological responses of foundry workers during various work processes and to correlate them with the existence of stressors affecting the work efficiency of foundry workers. There is a need of development of animal model.

ACKNOWLEDGEMENT

The first author is much thankful to U.G.C. New Delhi, for granting Teacher Fellowship. Authors are thankful to Professor and Head, Dept. of Zoology, Shivaji University, Kolhapur (M.S.) for providing necessary laboratory facilities and to Prof. T.V. Sathe Dept. of Zoology, S.U. Kolhapur for his keen interest in the study.

REFERENCES

Bandopadhay, P., Banerjee, P.K., Dikshit, M.B., and Iyer, M.E. (1989). Effect of glucose electrolyte Ingestion on physiological changes due to severe heat stress. *Indian Journal Physiology and Pharmacology.* **33:** 163-167.

Gomes, J., Lioyd, O.L. Norman, N.J.,Pabwa, P. (2001). Dust exposure and impairement of lung Functions at a small iron Foundry in a rapidly developing country.*Occupational Environmental Med.,* **58:** 656-662.

Govindarajulu and Pillai R.M. (1989). Indian Foundry- Current out look and future scenario. Foundry Engineering, I Ed., By Utility Publications Ltd.

Gupta, J.S., Swamy, Y.V., Dimri, G. P. and Pichan, G. (1984). Physiological responses during work in hot humid environment. *Indian Journal Physiology and Pharmacology,* **25:** 339-347.

Kohn, J., Friend, M., Winter, B.C., (1996). Fundamentals of 0ccupational safety and health. Rokville, *M.D.: Govt. Institute Press.*

Koo, J.W., Chung, C.K., Chung, Y.P., Lee.S.H, Lee, K.S., Roh, Y.M., YIM, H.W., (2000). The effect of Silica dust on ventilatory functions of foundry workers. *Journal Occupational Health,* **42:** 251-257.

Low, I., and Mitchella, C. (1985). Respiratory diseases in foundry workers, *British Journal of Industrial Medicines.* **42:** 101-105.

Mathew, K.C.(1984). Air pollution in foundries. *Indian Foundry Journal,* **30:** 11-19.

More, R.B., (2003). M. Phil. Thesis: Physiological studies on foundry workers in relation to work and stress submitted to *Shivaji University, Kolhapur.*

More, R.B. and Sawant, V.A. (2001). Paper presented at National Seminar on "Stress and Homeostasis" organized by Dept. of Zoology, Osmania University, Hyderabad on 29th. and 30th March,

Sultan, A M. (2004). Dose responses of years of exposures on lung functions in floor mill workers. *Journal of Occupational Heath* **46:** 187-191.

Xu, X., Christiani, D.C., Dockery, D.W. *et. al.,* (1992). Exposure response relations between occupational exposures and chronic respiratory illness: a community based study. *American Review of Respiratory Diseases.* **146:** 413-418.