

## Original article:

# Cardiorespiratory fitness: Study among workers engaged in refractory industry

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### Abstract:

**Introduction:** The western part of Odisha, since the inception of Hirakud Dam project has seen a lot of industrial growth. Also this area is a rich source of raw materials used in refractory industry. The manufacture of refractory bricks results in high levels of free silica, a recognised occupational hazard. This study was undertaken to assess the cardiorespiratory fitness in apparently healthy workers of refractory industry.

**Material & Methods:** The parameters measured were Physical Fitness Index (PFI) with the Harvard's step test and Maximal Oxygen Consumption (VO<sub>2</sub> max) using Queens College step test.

**Results & Conclusion:** Both the parameters were found to be significantly lower in case of refractory industry workers as compared to normal controls.

**Keywords:** Refractory Industry workers, Physical Fitness Index ( PFI ), Maximal Oxygen Consumption

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### INTRODUCTION:

Environmental pollution is a worldwide phenomenon. There are 100 million occupational injuries causing 0.1 million deaths in the world according to WHO. Out of 11 million cases of occupational diseases in the world 1.9 million cases (17%) are contributed by India and out of 0.7 million deaths in the world 0.12 (17%) is contributed by India. Estimates suggest that the annual incidence of occupational disease is between 924700 and 1902300 and 121000 deaths in India. Most of the studies done on exposure to silica dust have been carried out sand stone quarry workers and quartz mill stone grinding workers etc.. The refractory industry is also a potential source of silica dust .The process of manufacture of refractory bricks involves crushing, mixing, shaping, drying and firing. Workers involved in crushing and grinding of raw materials, mixing and press are the ones most exposed to dusts. The current study was done to assess the cardiorespiratory fitness among workers of refractory industry who are apparently healthy. The sample study of the place was a representational one of the whole community as people from different parts of the state as well as the country

reside in this area for their livelihood. Further the justification rises manifold due to the high prevalence of occupational diseases in this area of study. The present study was planned to compare Physical Fitness Index ( PFI ) and Maximal Oxygen Consumption ( VO<sub>2</sub> max ) of refractory industry workers and normal controls.

### MATERIAL AND METHODS:

60 male workers from a refractory industry in western Odisha, employed in crushing, grinding and mixing departments were selected as subjects. 60 healthy normal males not directly exposed to dust during occupational activities except their regular exposure to ambient particulate matter pollution were treated as controls. The controls were selected from the type of occupations where activities were quite similar to refractory industry workers as classified by ICMR expert group of 1988 on the basis of activities in the occupations

Inclusion criteria :

- All subjects were between 20 – 40 years
- No history of cardiopulmonary disorders
- No thoracic and vertebral column deformities

- No history of neuromuscular disorders

Prior to testing, a questionnaire was completed regarding the site of exposure, duration of exposure per day, total duration of exposure in years and history of smoking and previous illness.

Age,height, weight and blood pressure were recorded for all subjects. Body surface area was calculated using Dubois nomogram. All measurements were taken between 10 a.m. and 12 noon.

**Measurement of PFI :**

PFI was measured using Harvards step test ( Mc Ardle W.D. et al, 2000 ). The standard procedure for the original step test was modified and used with a difference that the stepping height was reduced from 20” to 18 inches for evaluating subjects with body surface area below 1.85m<sup>2</sup>( Gallagher JR et al ).The subjects stepped up and down a stool at a rate of 30

complete steps per minute keeping time to a metronome for duration of 5 minutes unless one stopped due to exhaustion. The recovery pulse counts were taken at 1 – 1<sup>1</sup>/<sub>2</sub> min, 2 - 2<sup>1</sup>/<sub>2</sub> min,3<sup>1</sup>/<sub>2</sub>min of recovery. PFI was calculated using the formula-

$$PFI = \text{Duration of exercise in seconds} \times 100 / 2x (\text{total heartbeats in the recovery periods})$$

**Measurement of Maximal Oxygen Consumption :**

VO<sub>2</sub> max was measured indirectly by Queen’s College step test. Subjects stepped up and down on 16.25 inch stool for 3min. with cadence of 24 beats / min. using a metronome.After 3 min. of exercise, recovery pulse rate was taken for 5 – 20 secs. VO<sub>2</sub> max was calculated using equation –

$$VO_2 \text{ max} = 111.33 - 0.42 (\text{pulse count in 15secs.} \times 4)$$

Results were tabulated and statistical analysis was done using Z test.

**OBSERVATION AND RESULTS :**

n = 60	PFI	VO <sub>2</sub> max ( ml/kg/min )
Factory Workers	43.07 ± 8.76	33.83 ± 5.08
Controls	52.97 ± 7.84	43.21 ± 6.87
	Z = 4.6	Z = 6

Z > 2 – significant

It was seen that PFI and VO<sub>2</sub> max were significantly lower as compared to controls.

Duration of work for factory workers	PFI	VO <sub>2</sub> max ( ml/kg/min )
>10 years ( n = 40 )	41.24 ± 4.32	30.05 ± 2.87
< 10 years ( n = 20 )	46.74 ± 3.36	35.39 ± 2.02
	Z = 5	Z = 2.04

Effect of duration of work in factory workers:

It shows that factory workers who had worked for more than 10 years had significantly reduced parameters.

**DISCUSSION:**

The prevalence of occupational health hazards and mortality has been reported to be unusually high among people of India. Although developed countries are very careful about occupational health, it is quite neglected in India. The study proves that even though the workers do not have symptoms of respiratory diseases, the

constant exposure to dust in refractory industry definitely affects them as shown by their reduced physical fitness index and maximal oxygen consumption.

The mean PFI observed in controls in the present study was 52.97 ± 7.84 , which corresponds to values obtained by Dey et al ( 54.02 ± 12.02 ) . in both the

studies 18 inches stool height was used. Mean  $VO_2$  max ( ml/kg/min ) of controls in the present study was  $43.21 \pm 6.87$  ml/kg/min. Sengupta et al reported  $VO_2$  max ( ml/kg/min ) of active Indian males between age group of 20 – 40 years was 42.1 ml/kg/min which corresponds well to values obtained in controls in the present study. Different studies have proved that the  $VO_2$  max and maximum heart rate remain relatively constant between 20 -40 years of age ( Sengupta et al, Shephard et al, Murray et al ). Therefore age as a reason for reduced parameters can be excluded as all the subjects were between 20 – 40 years of age.

The present study showed that PFI and  $VO_2$  max in refractory industry workers were significantly lower as compared to controls. Reduced parameters were found by Jayadev Mishra et al , working among stone grinders, weavers and agricultural workers. Multiple studies have shown increased morbidity and mortality among workers exposed to silica dust from various sources ( Chaudhry et al, Athavale et al, Tiwari R R et al ).

Also the current study showed that increased duration of exposure to industry pollutants reduced cardiorespiratory fitness parameters even further. Bajaj et al found the mean duration of work with silica exposed workers with ventilator impairment to be slightly more

than 10.9 years. Rajnarayan et al found significantly reduced Lung function among silica workers who have worked for >4 years but the study also included subjects more than 40 years of age.

#### **CONCLUSION:**

It can be concluded from the present study that exposure to dust from refractory industry significantly reduces cardio respiratory fitness of workers and longer duration of exposure further reduces these parameters. In order to prevent further deterioration, certain measures can be advocated-

- Advice to use dust mask of proper pore size at all times during work
- Regular pulmonary function tests and Chest X-Rays at proper intervals
- Those with greater deterioration of parameters may be shifted to other department where the exposure is less.
- Rotation nature of work. As most of these workers are unskilled labourers working as daily wages, they can be shifted to other departments at regular intervals
- Companies can work out a plan to involve workers in breathing exercises which have been proved to improve ventilator and cardiac functions.

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