Aerobic Capacity of the Brick-field Workers in Eastern India

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Abstract: Forty two male brick-field workers of two age groups, viz. 20–29 and 30–39 yrs were studied with a view to determine their aerobic capacity ($\dot{V}O_{2\,max}$). The average values of $\dot{V}O_{2\,max}$ in l.min^{-1} showed only small change between the young and the aged groups, but the values of the $\dot{V}O_{2\,max}$ in ml.kg.$^{-1}$min^{-1} showed significant difference between the groups due to body weight increase in the aged group. The aerobic capacity of the workers engaged in heavy manual work such as puddlers and load carriers were found to be comparatively higher and a positive significant relationship has been established between the aerobic capacity and different occupations in the brick-field workers.

Key words: Aerobic capacity — $\dot{V}O_{2\,max}$ — Brick-field workers — Heavy work — Load carriers — Light to moderate work — Ageing

The aerobic capacity or the maximal oxygen uptake ($\dot{V}O_{2\,max}$) has been accepted to be the most reliable and efficient measure of one's cardio-respiratory function, physical fitness as well as of maximum work output by large groups of muscle during maximum work of short duration. Investigations in different countries reveal that there is wide variation in aerobic capacity depending upon the physical fitness and the activity of the subjects (Lange-Anderson *et al.*[1]), Åstrand[2]), Epstein *et al.*[3])). With this respect, however, very limited studied have been done on Indian industrial workers primarily because the manpower in India is easily available and the need for proper use of manpower is not much needed. As the brick-field work involves heavy manual

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work and provides occupation for a large unskilled Indian population, there is need to evaluate the aerobic capacity of the brick-field workers to assess their physical fitness and also to compare their physiological fitness with those of workers working in various categories of the brick-fields.

Selection of Subjects: Bricks, one of the primary materials required for any type of permanent construction in India, are manufactured through systematic process by collective works of various categories of workers engaged in the brick-fields throughout the country. As most of the workers covered the age group 20–39 yrs, for the present study 42 male workers divided into two age groups — the young age group from 20–29 years of age and the aged group from 30–39 years of age were selected from the various categories of the workers engaged in different operations in two brick-fields in Eastern India. The selected workers were healthy subjects with an average physical build having no history of illness. Emphasis was given on the willingness of the workers to volunteer to be the subjects in the present study, the nature of which was explained to them.

Preparation of Subjects: the subjects were requested to take rest for at least two hours before the experiment. After the initial rest period is over, the pre-exercise heart rate of the subjects were determined by counting the palpation of the carotid artery. The physical parameters of the subjects were then measured and summarised in Table 1.

Determination of Aerobic Capacity: The exercise was performed on a magnetic friction type bicycle ergometer (Model of Prof. E.A. Muller, Max Planck Institute For Work Physiology). A preliminary warming up for 5 min at a rate of 600 $kg.m.min^{-1}$ was given to each subject before the application of the set workload fixed at 720 $kg.m.min^{-1}$. The pedalling rate was kept constant at 60 r.p.m. following a metronome. The workload was thereafter increased by 120 $kg.m.min^{-1}$ every three minutes till the subjects terminated their work on the basis of subjective exhaustion. The heart rate was measured by timing 10 beats during the last 30 seconds of each workload. The value for $\dot{V}O_{2\ max}$ was considered to be the highest incremental oxygen intake due to the increase in workload which was less than 150 $ml.min^{-1}$ in comparison to the second highest load. A low resistance, high velocity Collins "Triple J" type plastic valve was used for collection of expired air by open circuit method in Douglas Bag, the volume of which was measured by a wet gasometer. An aliquot of the expired air was analysed by Scholander Micro Gas Analyser following the norms as described by Consolazio *et al.*[4]. The experiments were performed at a room temperature varying

Table 1: Physical characteristics (mean ± S.D) of the brick-field workers selected for the present study

Age Group (yr)	No. of Subjects	Age (yr)	Body weight (kg)	Height (cm)	Body Surface Area (m^2)
20–29	21	24.24 ± 2.72	*49.20 ± 3.95	161.0 ± 6.01	1.49 ± 0.08
30–39	21	35.57 ± 2.84	54.82 ± 2.63	163.81 ± 3.79	1.59 ± 0.05

't'-test *p ∠ 0.001

Table 2: Mean values and standard deviations for pre-exercise heart rate, maximum aerobic capacity and related caroio-respiratory parameters of the brick-field workers of two age groups of irrespective of categories of the workers

Parameters	20–29 yr (n = 21)	30–39 yr (n = 21)
Pre-exercise heart rate (beats min^{-1})	70.05 ± 4.10	72.86 ± 3.82
HR_{max} (beats min^{-1})	*193.52 ± 9.84	186.48 ± 7.95
$\dot{V}O_{2\,max}$ ($l.min^{-1}$)	2.20 ± 0.23	2.21 ± 0.19
$\dot{V}O_{2\,max}$ ($ml.kg.^{-1}\ min^{-1}$)	**44.80 ± 3.65	40.21 ± 2.56
$\dot{V}E_{max}$ ($l.min^{-1}$)	65.41 ± 9.83	63.32 ± 5.64
O_2 pulse ($ml.beat^{-1}$)	11.39 ± 0.85	11.83 ± 0.77
Ventilatory equivalent	29.92 ± 5.05	28.79 ± 2.33

't'-test *p ∠ 0.05
**p ∠ 0.001

from 27–29°C with relative humidity varying from 60–70%.

Table 1 shows the physical characteristics and age of the subjects. The small body weights and heights of the subjects are typical of the average labouring population in Eastern India. Table 2 provides the mean values of the observed physiological parameters. A significant negative correlation is obtained between the age and $\dot{V}O_{2\,max}$ $ml.kg.^{-1}min^{-1}$ ($r = -0.68$ in younger and $r = -0.66$ in the aged group). When the $\dot{V}O_{2\,max}$ is expressed in $l.min^{-1}$, the difference between the two age groups was insignificant. A significant positive correlation is obtained between body weight and $\dot{V}O_{2\,max}$ $l.min^{-1}$ in both the age groups ($r = 0.68$ in young group and $r = 0.63$ in aged group). A significant positive correlation is found between HRmax and $\dot{V}O_{2\,max}$ $l.min^{-1}$ in each group ($r = 0.71$ in the younger and $r = 0.69$ in the aged group). The average ventilatory equivalent is lower in the aged group than the younger group and the difference is

Table 3: Comparison of the max. aerobic capacity, pulmonary ventilation and HR_{max} between various categories of the brick-field workers of the age group 20–39 yr

Parameters	20–29 yr			30–39 yr		
	Gr.A	Gr.B	Gr.C	Gr.A_1	Gr.B_1	Gr.C_1
	Puddlers n = 7	Load Carriers n = 7	Firemen & Stackers n = 7 (2 + 5)	Puddlers n = 7	Load Carriers n = 7	Firemen & Stackers n = 7 (2 + 5)
Body weight (kg)	**46.86 ± 2.93	51.11 ± 4.10	*49.64 ± 3.95	55.04 ± 3.02	54.16 ± 2.12	55.27 ± 2.92
$\dot{V}O_{2\,max}$ ($l.min^{-1}$)	2.19 ± 0.15	2.33 ± 0.22	2.09 ± 0.28	2.32 ± 0.15	2.18 ± 0.19	2.11 ± 0.19
$\dot{V}O_{2\,max}$ ($ml.kg.^{-1}\ min^{-1}$)	**46.81 ± 3.69	**45.56 ± 3.13	*42.02 ± 2.57	42.23 ± 2.00	40.24 ± 2.17	38.15 ± 1.86
$\dot{V}E_{max}$ ($l.min^{-1}$)	64.09 ± 10.91	69.66 ± 5.44	62.49 ± 11.85	67.63 ± 4.79	61.86 ± 5.85	60.48 ± 3.93
HR_{max} (beats min^{-1})	197.71 ± 5.09	**198.29 ± 3.90	184.57 ± 11.87	190.86 ± 9.15	186.86 ± 6.41	181.71 ± 6.05

't'-tests compared between Grs. A and A_1, Grs. B and B_1, Grs. C and C_1.

*p ∠ 0.05, **p ∠ 0.01

non-significant. O_2 pulse was almost similar in both the groups.

Table 3 provides a comparative account of the $\dot{V}O_{2\,max}$, $\dot{V}E_{max}$ and HR_{max} of various categories of the brick-field workers in the both groups. The HR_{max}, $\dot{V}O_{2\,max/Bw}$, $\dot{V}E_{max}$ all are found to decrease accordingly with age in each category of workers.

In the present study the workers of the two age groups in the brick-fields were compared on their physical characteristics. The ageing diminishes the maximum oxygen uptake. Åstrand[5], Sengupta *et al.*[6] and William *et al.*[7] have reported that the maximum oxygen uptake is significantly correlated with body weight. Henschel *et al.*[8] observed that maximum oxygen uptake increased with rise in body weight. A linear relationship between body weight and oxygen consumption is now well established (Wyndham *et al.*[9]). However, the result of this study reveals that the maximum oxygen uptake is not changed in the two groups though the body weight increase in the aged group is significant.

The higher average values of the aerobic capacity in Indian Dock workers (Saha[10]), Railway porters (Samanta *et al.*[11]) indicate superiority of their physical fitness over those of the brick-field workers. This low value of aerobic capacity in the brick-field workers may be due to their poor physical build, natural endowment besides adverse climatic factors and hazardous job description. On the contrary the average values of the aerobic capacity in the present subjects indicate their superiority in respect of physical fitness over the Indian miners (Chakraborty *et al.*[12]) and this may be due to relatively better working condition in the brick-fields than those in underground mines.

When the aerobic capacity of the brick-field workers is presented in relation to the heaviness of the job performed in the brick-fields, it is found that $\dot{V}O_{2\ max}$ is also occupation dependent. Puddlers and Load carriers have been assigned for heavy to very heavy occupations, and Stackers and Firemen for light to moderately heavy occupations. Table 3 shows higher mean value of $\dot{V}O_{2\ max}$ in Puddlers and Load carriers in comparison to Firemen and Stackers. The values of the total oxygen consumption/minute shows an increase in Puddlers/Firemen and Stackers and decrease in Load carriers in the aged group. This appears to be due to anomalous rise in body weight. As the rise in total oxygen consumption/minute is not consistent with the rise in body weight in the aged workers, there is decrease in oxygen utilisation/kg.body wt./minute, and this may attribute to lower $\dot{V}O_{2\ max}$ $ml.kg.^{-1}min^{-1}$ in all sections of aged brick-field workers. The age of maturity of peak $\dot{V}O_{2\ max}$ $ml.kg.^{-1}min^{-1}$ is attained at 15–17 years and maintained through 17–20 years of age (Banerjee *et al.*[13]).

The $\dot{V}O_{2\ max}$ is the major determinants of the severity of the load carrying tasks which can be sustained for a prolonged period (Haisman[14]). As $\dot{V}O_{2\ max}$ is usually correlated with body weight, individual with a high $\dot{V}O_{2\ max}$ $l.min^{-1}$ and large load carriage capacity will also tend to have large body weight. The type of fitness required for prolonged muscular work is well correlated to individual aerobic capacity (Åstrand[15, 16]). It is, therefore, assumed that the lower value of $\dot{V}O_{2\ max}$ $ml.kg.^{-1}min^{-1}$ in aged brick-field workers is incompatible with the fitness required to perform heavy work in the brick-fields. This is why a limited number of Load carriers and Puddlers are available in the brick-fields beyond 40–45 years of age.

As the capacity to perform light to moderately heavy work is not grossly age dependent, so as to avoid fatigue and to safeguard the health of the workers, proper rehabilitation of workers and restructuring of the job schedule in the brick-field work are very much necessitated.

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