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PHYSICAL FITNESS OF INDIAN AND EGYPTIAN WORKERS AND PERMISSIBLE LEVEL OF WORK OUTPUT

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ABSTRACT

Forty-six miners (India), 30 dock workers (India) and 30 foundry workers (Egypt) were tested in optimum climatic conditions using the methods recommended for the investigation of physical fitness by the Human Adaptability Section of the I.B. Programme, and a very good level of physical fitness was found. The values of $\dot{V}_{O_2}$ max (ml· kg^{-1} in the age group 20–30 were as follows: miners ($\bar{X} = 48.1$ S.D. = 6.9), dock workers ($\bar{X} = 47.2$, S.D. = 6.1), foundry workers ($\bar{X} = 45.1$, S.D. = 7.2).

Physical fitness can be understood as the ability of the organism to maintain a perfect balance closest to the state of rest during load and to achieve rest balance after load as soon as possible[4]. This ability depends on the general state of health and the function of several organs[2,3]. However, usually only the circulatory and respiratory systems are tested[1].

There are two reasons for this: first, both systems indicate the level of adaptation of the whole organism to the dynamic physical load, and secondly, the reactibility of these systems can be measured comparatively easily and exactly. The results are very useful for further investigations and/or recommendations which could help to organize the best possible system of work and recovery[6,7,8].

WORKERS AND METHODS

The workers were tested on a Monark-Crescent (Sweden) bicycle ergometer or by means of the step test (Table 1) and were subjected to three submaximum loads with the heart-rate (HR) in the third load between 140 and 160 beats min^{-1}. Heart rate and pulmonary ventilation were measured continuously[5] for 7 minutes under each load, and the expired air was sampled at rest and during the last two minutes of the workload.

Some of the examined workers were also subjected to maximum load, which followed immediately the third submaximum load (direct measurement of

$\dot{V}_{O_2}$max). For the workers not subjected to maximum load, $\dot{V}_{O_2}$max was calculated by extrapolation from the submaximum loads, whereby for HR max we used the standards recommended for the respective age groups[11].

TABLE 1
Basic characteristics of persons tested.

Serial number of the groups	Occupation	Country and region	N	Type of test	Age (years)*	Body mass (kg)*	Height (cm)*
1	Coal miners	India, Bihar, Dhanbad	12	ergometer, direct measurement	25.2 (20–29)	52.7 (48.5–56.0)	163.3 (157–173)
2	Coal miners	India, Bihar, Dhanbad	12	ergometer, indirect measurement	24.1 (20–29)	43.8 (36.5–48.8)	159.6 (148–168)
3	Coal miners	India, Bihar, Dhanbad	11	step-test, indirect measurement	23.9 (20–29)	48.8 (41.0–55.0)	161.2 (155–166)
4	Gold miners	India, Mysore, Kolar-Gold Fields	11	step-test, indirect measurement	24.4 (21–30)	51.1 (43.5–62.5)	165.9 (161–173)
5	Dock workers	India, Maharastra, Bombay	30	ergometer, indirect measurement	27.1 (20–32)	54.7 (49.5–61.2)	164.4 (161–169)
6	Foundry workers	Egypt, Cairo	15	step-test, indirect measurement	15 (20–29)	70.9 (54.2–79.6)	173.9 (158–180)
7	Foundry workers	Egypt, Cairo	15	step-test, indirect measurement	15 (30–44)	63.6 (49.5–74.5)	165.6 (151–177)

*mean and range

The tested miners were occupied mainly with digging holes for pit-props (Prop Mazdoors) with digging coal by means of pick axes (Pick Axe Miners), or with shovelling the coal (or ore, in gold mines) into baskets and carrying and emptying the full baskets into tubes (Loaders, Muckers) The dock workers mainly carried bags with 80 to 100 kg of grain on their backs. In the foundry the younger group of workers (helpers) were occupied with the transport of ladles (150 kg) containing molten material; each full ladle was carried by 4 men, so that one man handled about 37 kg. The men from the older group worked in the enamelling section of the foundry.

RESULTS AND DISCUSSION

The maximum oxygen consumption ($\dot{V}_{O_2}max$), which was measured (group of subjects with serial number 1) or calculated from submaximum loads (groups with serial number 207), is shown in Table 2.

TABLE 2
Maximum oxygen consumption of the subjects investigated.

Serial number of the group	$\dot{V}_{O_2}max$ (ml kg^{-1})		$\dot{V}_{O_2}max$ (ml)		HR max
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
1	49.5	4.56	2 610	250	192.0 ± 7.6*
2	48.5	3.76	2 124	190	190**
3	47.1	5.65	2 298	260	190**
4	47.2	2.46	2 412	140	190**
5	47.2	6.1	2 582	260	190**
6	45.1	7.2	3 198	295	190**
7	41.2	6.9	2 620	280	185**

*measured, $\bar{X} \pm$ S.D.
**standard

The tests were conducted under optimum climatic conditions (globe thermometer under 25 °C, relative humidity less than 65%). Physical fitness in all groups of the subjects investigated was found to be very good in comparison with the results obtained in the Czechoslovak population in general[11], if the values of $\dot{V}_{O_2}max$ are calculated for kg of body mass. The absolute values, however, differed because of differences in anthropometrical data. The present Czechoslovak standards[9] for man are shown in Table 3. The physical fitness of the subjects investigated is not, of course, representative for the population as a whole. All workers were trained for physical load, and after the medical examination only healthy men were tested. In the general medical examination, interest was focused on blood picture, hemoglobin in blood and on parasites; subjects with schistosomiasis (Egypt) and with acute forms of ankilostoma duodenale or entamoeba histolitica were excluded. The basic anthropometrical data are in good relation to the findings of other authors, especially in the case of Indian workers[10,12].

On the basis of studies carried out on workers occupationally doing medium heavy or heavy physical work we came[7,8] to the conclusion that the minute shift energy expenditure (mean value from the whole shift) is tolerable for one shift and also for the whole productive life time, if this value is equivalent to 33% of $\dot{V}_{O_2}max$, and that the upper limit of minute energy consumption in one operation, which is tolerable without special medical examination and health control, is 70% $\dot{V}_{O_2}max$.

TABLE 3
Standards of $\dot{V}_{O_2}max$ (X ± S.D.) and energy expenditure for men used in Czechoslovakia.

		Age group			
		20–29	30–39	40–49	50–59
$\dot{V}_{O_2}max$ (ml·kg^{-1})		43.2 ± 8.0	39.3 ± 8.0	35.8 ± 8.0	32.6 ± 8.0
$\dot{V}_{O_2}max$ (l)		3.24 ± 0.51	3.01 ± 0.51	2.75 ± 0.51	2.49 ± 0.51
Energy expenditure*	Mean value (MJ)	8.25	7.5	6.75	6.0
	Tolerable (MJ)	9.9	9.0	8.0	7.2
Energy expenditure**	Mean value from the whole shift	275 W 3.94***	250 W 3.53	225 W 3.22	200 W 2.87
	Tolerable for the operation	685 W 9.82***	635 W 9.10	575 W 8.24	515 W 7.38

*in one shift of 500 min. duration
**for one minute
***Kcal·min^{-1}

These values of energy expenditure are applicable at optimum climatic conditions and have to be reduced in accordance with the thermal stress level. From this point of view the recommended work output for the investigated workers in optimum climatic conditions is calculated and presented in Table 4.

TABLE 4
Recommendable energy expenditure for studied Indian and Egyptian workers.

Energy expenditure		Serial number of group			
		1–4	5	6	7
Per one minute	Mean value from the whole shift	197 W 2.83*	222 W 3.19	275 W 3.94	225 W 3.22
	Tolerable for the operation	496 W 7.1*	549 W 7.86	685 W 9.82	575 W 8.24
In one shift of 500 min duration	Mean value (MJ)	5.9	6.65	8.2	6.7
	Tolerable value (MJ)	7.1	8.0	9.8	8.0

*Kcal·min^{-1}

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