Ethnic differences in Physiological responses to maximal effort in Malaysian Adolescents

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ABSTRACT

A sample of twenty-six boys of different ethnic origins taken from one selected urban school in Kuala Lumpur were exercised to exhaustion to measure their aerobic capacities. 9 Malay, 9 Indian and 8 Chinese boys aged between 12 – 18 years, all living under similar environmental and ecological conditions performed from submaximal to maximal work loads on a step-ergometer of two risers, each 0.4m high. Statistical treatment of the data did not show any significant differences between all the parameters measured. The Malay boys had a maximum aerobic power of 49.5 ± 10.6; the Indian boys, 47.2 ± 5.1; and the Chinese boys, 43.6 ± 4.6 ml/min/kg respectively. The maximum heart rates recorded during the last 10 seconds of maximal exercise also showed no significant differences being, 193 ± 10; 198 ± 5 and 196 ± 8 beats/min respectively. The blood lactate and pH levels were inconclusive and range from 78 ± 30 and 7.24 for Malays; 69 ± 24 and pH 7.27 for Indinas; and 85 ± 30 and pH 7.23 for Chinese. Thus, ethnic differences in adaptation to maximal effort could not be demonstrated. Differences in adaptability such as have been reported could have been due to differences in habitual activity, as has been indicated here, and that the factors which determine aerobic power are postulated to be natural selection operating under contrasting environments and modified by genetic endowment. Races do not diverge in adaptive capabilities without selective external pressures.

INTRODUCTION

Racial differences in physical working capacity have not been demonstrated as yet, although many studies have been done. The work on primitive societies also do not show the expected adaptation to outdoor life. The Arctic Indians (Andersen *et al*, 1960), the nomadic Lapps (Andersen *et al*, 1961), the Eskimoes (Andersen and Hart, 1963); the Pascuan women of Easter Island (Andersen, 1967); the Eskimo hunters of Greenland (Lammert, 1972) and the Malaysian Temiars (Chan *et al*, 1974) have shown insignificant differences in maximal aerobic power. The studies of aerobic power of selected populations has been reviewed by Andersen (1966).

Ethnic differences have also not been shown in

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working capacity in studies where different ethnic groups work under similar ecological and environmental conditions. Adaptation between negro and white share-croppers (Robinson *et al*, 1941); between African bushmen and whites in Africa (Wyndham *et al*, 1963), between Czechoslavakian physicians and Vietnamese (Skrang and Havel, 1964), and between European caucasians, Nigerian natives of Yaruba and Kurdish and Yemenite Jews (Davies *et al*, 1972) have also not revealed significant differences in aerobic power.

The present study was undertaken on Malaysian schoolboys sampled from the same school in Petaling Jaya randomly, to study any differences in their physiological and metabolic reactions to graded exercise that might result from ethnic differences.

MATERIALS AND METHODS

SUBJECTS

A random sample of 26 schoolboys aged between 12 to 18 years were selected from the same school in Petaling Jaya, comprising 9 of Malay origin, 9 of Indian origin and 8 of Chinese origin. As far as possible, they were living under identical ecological and environmental conditions, and indulged in the same types of activity in and out of school. A physical medical examination and electrocardiogram was carried out in each case to exclude those unfit for exercise.

EXPERIMENTAL PROCEDURE

All the tests were carried out on a step-ergometer of two risers, each 0.4 m high, in the school gynamsium where the ambient temperature was about 26°C throughout the year. Electrocardiographic electrodes were placed at positions V_1, V_4 and V_5 and records were read from a portable Cardiostat T (Siemens) electrocardiogram. The subjects were made to perform work loads in identical fashion, with three work loads of 18, 23 and 28 cycles per minute on the single step. Subsequently, two work loads, at 22 and 26 cycles per minute were performed on the double step. Each workload was performed for 5 min with an interval of 10 min rest in between, except the last when the duration depended upon the work tolerance of the individual. Heart rate was monitored throughout the test, especially the last 10 sec before the end of each test. Expired air was collected through a one-way value into a Douglas Bag during the last minute of each exercise period. The volume of expired air was measured by a calibrated gasometer and the expired air was analysed by a Haldane Gas Analyser in duplicate.

Blood from a finger prick was sucked up a capillary tube immeidately on cessation of exercise for later measurement of pH using an Estrup machine. 0.1 ml of blood taken 4 min after exercise was measured for blood lactate using the standard Sigma Kit for lactic dehydrogenase.

RESULTS

PHYSICAL CHARACTERISTICS

The physical characteristics of the subjects are given in Table 1, where it can be seen that the average somatotype is not significantly different. However, on closer examination, there seems to be some variability within the groups of different racial origins.

TABLE 1: PHYSICAL CHARACTERISTICS OF THE DIFFERENT ETHNIC GROUPS

ETHNIC GROUPS	AGE (yrs)	WEIGHT (kg)	HEIGHT (cm)
MALAY	14.0 ± 2	43.6 ± 12.8	155 ± 12.7
INDIAN	15.0 ± 1.8	43.4 ± 9.8	161 ± 13.3
CHINESE	15.0 ± 2.2	48.0 ± 10.5	163 ± 10.2

MAXIMUM AEROBIC POWER

The physiological and metabolic responses of the three ethnic groups are given in Table 2, where it can be seen that there were no significantly different values for maximal aerobic power maximum heart rate and blood pH and lactate values amongst the three ethnic groups studied.

The mean values of maximal oxygen consumption (Fig. 1.) blood pH and blood lactate (Fig. 2) demonstrate clearly the insignificant differences found. It was also shown that blood pH levels tended to fall whilst blood lactate values rise in accordance with the proportionate amount of oxygen consumed at their maximal levels (Fig. 3).

TABLE II: PHYSIOLOGICAL AND METABOLIC RESPONSES TO MAXIMAL EFFORT

SUBJECT	WORK OUTPUT	AEROBIC WORK		ANAEROBIC WORK	
	Kg-m/min	V_{02} max (ml/min/kg)	Hf (beats/min)	PH	La(mg %)
MALAYS					
1	1178	53.6	194	7.21	104
2	905	57.4	194	7.25	96
3	528	44.4	176	7.24	42
4	538	62.66	198	7.20	73.6
5	533	55.6	191	7.26	46
6	1155	50.5	212	7.23	98
7	661	55.2	188	7.21	72
8	855	34.6	180	7.28	72
9	630	31.3	199	7.33	62
	708.4 ± 282.6	49.5 ± 10.6	192.9 ± 9.9	7.24 ± 0.04	78.2 ± 29.6
INDIANS					
1	796	56.6	203	7.3	66
2	915	42.3	198	7.18	94
3	598	46.8	198	7.25	40.8
4	501	48.5	200	7.32	444
5	780	44.8	188	7.22	68
6	683	49.2	198	7.30	50
7	841	48.0	199	7.33	64
8	564	38.4	196	7.26	86.8
9	1093	49.8	196	7.31	74
	727.4 ± 181.2	47.2 ± 5.1	198.1 ± 4.8	7.27 ± 0.05	68.6 ± 29.6
CHINESE					
1	850	47.2	191	7.13	126
2	1054	45.3	202	7.24	94
3	982	47.9	207	7.18	96
4	341	36.6	189	7.29	49
5	610	36.6	191	7.29	36
6	848	46.6	194	7.24	78.4
7	1007	46.1	194	7.29	106
8	994	42.6	188	7.19	96
	747 ± 222	43.6 ± 4.6	196.3 ± 2.9	7.23 ± 0.06	85 ± 29.7

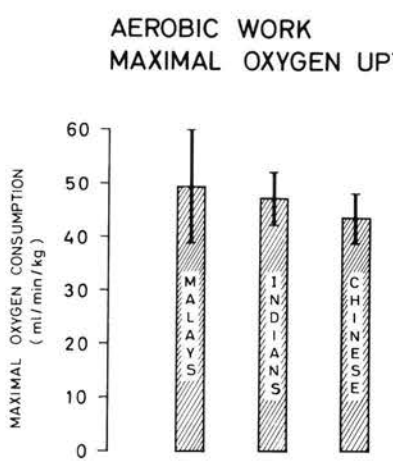

FIG. 1. DIAGRAM OF AEROBIC WORK OF THREE ETHNIC GROUPS

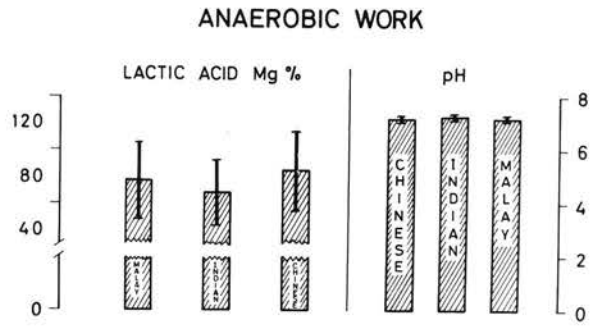

FIG. 2: DIAGRAM OF ANAEROBIC WORK

COMPARISON OF LACTIC ACID LEVELS REACHED AND pH OF BLOOD IN THE THREE ETHNIC GROUPS

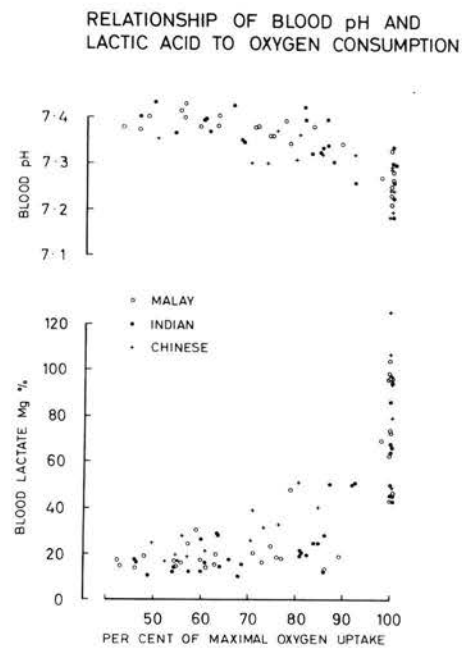

FIG. 3: RELATIONSHIP OF BLOOD pH AND LACTATE TO MAXIMAL OXYGEN CONSUMPTION.

DISCUSSION

Studies that attempt to correlate racially or ethnically inherited characteristics that predetermine maximum aerobic power require large population samples to be meaningful. However in a multitude of studies, several criteria have been laid down so that results obtained from one study can be validly compared with those obtained in other studies (Shephard *et al,* 1968; Andersen *et al,* 1971) whether the step ergometer, the bicycle ergometer or the treadmill is used.

The above criteria have been religiously followed, in that the subjects were tested in identical fashion, and were living under very similar conditions, environmentally, socio-economically and indulged in the same type of physical training exercises. That there has been no significant differences shown in both physiological and metabolic parameters observed in this study does not make it more or less valid. Similar studies between ethnically different groups also show no significant differences in work capacity (Wyndham et al, 1963; Skrang and Havel, 1964; Davies *et* al, 1972).

However, some differences in physical adaptability have been demonstrated within the same sample of a homogenous population, e.g., differences in work capacity due to sex and age (Astrand, 1960) or due to age alone (Rodahl and Issekutz Jr, 1962). It is also well known that well-trained endurance athletes have much higher aerobic capacities than do untrained persons or even groups of people employed in different occupations such as the bus conductor having a higher aerobic capacity than his bus driver (Astrand and Rodahl, 1970). In a similar fashion, examination of the whole sample of schoolboys revealed that according to the amount of physical activity undertaken, as adjudged by a history of the level of sports they play (Fig. 4) (e.g. whether representing school or combined school or house), it was found that there was a correlation between physical activity and high aerobic power. It can therefore be argued that whatever differences of aerobic power that can be demonstrated, would be derived from the daily physical routine of that particular group of people, without regard to ethnic heredity, and that these groups of people habitually tax their oxygen transport system whether because of work or by design such as athletes.

In conclusion, variability from the above statement of the correlation between high-activity life and high aerobic power can sometimes be found, and this has been explained by the limits to which a person is genetically endowed with his capacity to consume oxygen (Klissouras, 1971).

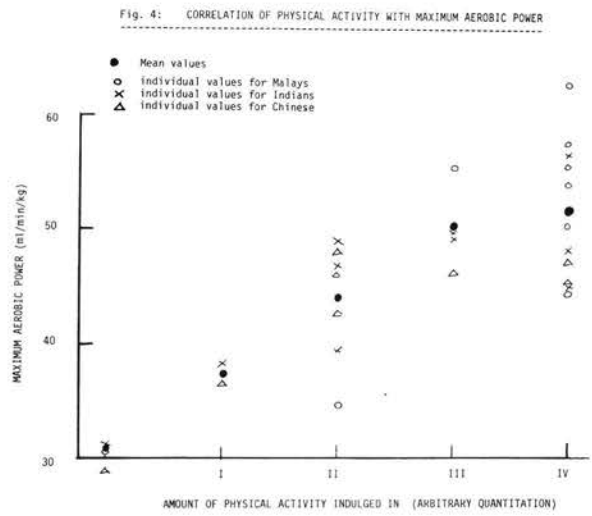

FIG. 4: CORRELATION OF PHYSICAL ACTIVITY WITH MAXIMUM AEROBIC POWDER

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The authors gratefully acknowledge the financial grant given by the Ministry of Culture, Youth and Sports for this project; Encik Peter Velappan of the Schools Inspectorate Division and the Ministry of Education for the use of the material subjects and the Sultan Abdul Samad Secondary School, Petaling Jaya, to the Faculty of Medicine for the use of its laboratory and medical illustration facilities, to Chan Choy Har, Chen Lee Lee, Chong Yoke Kheng, Margaret Leong, S. Nagappan and V. Ramasamy for technical assistance; to Miss Yvonne Pavee for typing the manuscript, and to Dr M. Jegathesan, Hon. Secretary of the Malaysian Association of Sports Medicine under whose auspices the work was performed.

REFERENCES

ANDERSEN, K.L. (1967) Ethnic group differences in fitness for sustained muscular exercise. *Canad. Med. Assoc. J.,* 96: 832-835.

ANDERSEN, K.L. (1966) Work capacity of selected populations. In: *The biology of human adaptability* ed. Baker, P.T. and Weiner, J.S. pp 67-90. Clarendon Press, Oxford.

ANDERSEN, K.L., BOLSTAD, ATLE, LOYNING, YNGE and IRVING, L. (1960) Physical fitness of Arctic Indians. *J. Appl. Physiol.,* 15 : 645-648.

ANDERSEN, K.L., ELSNER, R., SALTIN, B. and HERMANSEN, L. (1961) Physical fitness in terms of maximal oxygen intake in nomadic Lapps. *Report of U.S.A.F. under Grant AF-EOARDS.*

ANDERSEN, K.L. and HART, J.S. (1963) Aerobic working capacity of Eskimoes. *J. Appl. Physiol.*, 18 : 764-768.

ANDERSEN, K.L., SHEPHARD, R.J., DENOLIN, H., VARNAUSKAS, E., and MASIRONY, R. (1971) Fundamentals of exercise testing. *W.H.O.* Geneva.

ASTRAND, I. (1960) Aerobic working capacity in men and women with special reference to sex and age. *Acta Physiol. scandinav.* 49: *(suppl.* 169).

ASTRAND, P-O, and RODAHL, K. (1970) Textbook of work physiology. McGraw-Hill Book Co. New York.

CHAN, Onn-leng, Thinakaran, T., Mohd Nor, Sundsten, J. W., Duncan, M.T. and Klissouras, V. (1974) Work capacity of the Temiar: a primitive jungle tribe in Malaysia. *Abstracts, XXth World Congress in Sports Medicine, Melbourne,* A23.

DAVIES, C.T.M., BARNES, C., FOX, R.H., Ojikutu, O., and Samueloff, A.S. (1972) Ethnic differences in physical working capacity. *J. Appl. Physiol.,* 33: 726 – 732.

KLISSOURAS, V. (1971) Hereditability of adaptive variation. *J. Appl. Physiol.,* 31 : 338-344.

LAMMERT, O. (1972) Maximal aerobic power and energy expenditure of eskimo hunters in Greenland. *J. Appl. Physiol.,* 33: 184-188.

ROBINSON, S., Dill, D.B., HARMON, P.M., HALL, F.C. and WILSON, J.W. (1941) Adaptation to exercise of negro and white share croppers in comparison with Northern whites. *Human Biol.,* 13: 139-158.

RODAHL, K. and ISSEKUTZ, Jr. (1962) Physical performance capacity in the older individual. In: *Muscle and Tissue.* XV, McGraw-Hill Book Co., New York.

SHEPHARD, R.J., ALLEN, C., BENADE, A.J.S., DAVIES, C.T.M., diPAMPERO, P.E., HEDMAN, R., MERRIMAN, J.E., MYHRE, K., and SIMONS, R. (1968) The maximum oxygen intake: an International Reference Standard of cardiorespiratory fitness. *Bull. W.H.O.* 38: 757-764.

SKRANG, O. and HAVEL, V. (1964) Fitness of Czechoslovakian and Vietnamese physicians under graded workload. *Inter. Z. Angew Physiol.,* 20: 412-419.

WYNDHAM, C.H., STRYDOM, N.B. MORRISON, J.F., PETER, J., WILLIAMS, C.G., BREDALL, G.A.G. and JOFFE, A. (1963) Differences between ethnic groups in working capacity. *J. Appl. Physiol.,* 18: 361-366.