

COMPARATIVE MAXIMAL EXERCISE RESPONSE OF MALAYSIA ETHNIC GROUPS

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SYNOPSIS

Cardiorespiratory adjustments to maximal treadmill exercise were studied in young untrained Malaysia men representative of the three major ethnic groups in Malaysia and Singapore. Maximal values for oxygen uptake and cardiac performance were essentially similar in the three groups and were comparable to those reported for other populations.

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INTRODUCTION

Present knowledge regarding physiological adjustments in man to exercise is extensive. Exercise stress testing has become an essential component in the practice of sports medicine. Assessment of patient findings in a stress test includes evaluation of the degree of deviation from normal standards. Maximal exercise responses indicative of functional cardiopulmonary capacities for young adult populations with no known history of cardiovascular disease and primary risk factors have been well established for Caucasian subjects of European ancestry. However, information on

maximal exercise responses of oriental populations in South-East Asia is relatively limited.

The present study examines various cardiopulmonary parameters during maximal exercise in representative samples of healthy untrained adult males of Malay, Indian and Chinese ethnic origin who are life-long residents of Malaysia. Their responses are compared with those reported for other populations.

METHODS

Experimental subjects were composed of ten Malays, ten

Table 1
ANTHROPOMETRIC AND PULMONARY PARAMETERS
(MEAN ± SD WITH RANGE IN Parenthesis)

n	Malay 10	Indian 10	Chinese 10	X ²	F
Height (cm)	163.8 ± 3.8 (157.5-168.4)	168.6 ± 4.1 (162.5 ± 177.0)	168.8 ± 4.0 (162.0 ± 173.5)	0.05	5.16
Weight (kg)	55.3 ± 5.0 (46.1-61.8)	54.0 ± 5.3 (43.4-63.0)	56.7 ± 5.7 (51.6-69.6)	0.15	0.65
Body Surface Area (m ²)	1.58 ± 0.07 (1.45-1.70)	1.59 ± 0.09 (1.43-1.74)	1.64 ± 0.08 (1.56-1.80)	0.54	1.53
Vital Capacity (ml)	3306 ± 360 (2908-4097)	3270 ± 521 (2770-4296)	3863 ± 426 (3283-4599)	1.17	5.69
FEV _{1.0} (ml)	2683 ± 279 (2311-3132)	2792 ± 327 (2322-3380)	3528 ± 330 (3154-4188)	0.29	21.58

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Indians and ten Chinese, aged between 20 — 30 years old. Basic anthropometric and pulmonary parameters are presented in Table 1. The subjects were drawn from a typical urban community of middle socio-economic level with sedentary indoor occupants and had no history of participation in a regular exercise training program.

Treadmill exercise was performed at an ambient temperature of 26°C dry bulb, according to the following protocol: treadmill speed at 5.4 Km/h; treadmill grade increased every 4 min in steps of 4% to 20%; thereafter in steps of 2% until the subject reached exhaustion. Additional criteria to establish that the subject has reached maximal effort include a minimal consecutive increase or no further increase in heart rate and oxygen uptake with increasing work load, blood lactate levels

exceeding 7.7 mEq/l indicating severe anaerobic metabolism and subject's inability to continue.

Heart rate (HR) was monitored by EKG chest leads and expired air was collected by the open-circuit method at the last minute of each work level. Ventilatory volumes (\dot{V}_E) were measured with a dry gas meter. Expired air was analyzed by the Haldane gas analysis technique. The Highest rate of O_2 consumption ($\dot{V}O_2$) attained during the exercise protocol was taken to represent maximal O_2 uptake or aerobic capacity ($\dot{V}O_{2\max}$).

Cardiac output (\dot{Q}) was determined by the CO_2 re-breathing Intraportation method.⁽¹⁾ O_2 pulse was derived from ($\dot{V}O_2$) divided by (HR).

Statistical analysis of ethnic differences in selected parameters examined were tested with Bartlett's approximation to Chi-square (X^2).⁽²⁾ If a significant F value was found, Duncan's multiple range test⁽³⁾ was used to locate the signifi-

cant mean difference. Significance levels were set at 5% ($p < 0.05$).

RESULTS

All 10 subjects from each ethnic group were able to complete incremental work loads to the 20% grade. Thereafter, inability to continue due to fatigue resulted in subject dropout. A positive linear relation between O_2 uptake ($\dot{V}O_2$) heart rate (HR), pulmonary ventilation (\dot{V}_E) and work level was apparent until the 20% grade for most individuals. As exercise intensity increased further, the subjects showed greater variability in the above responses.

Measurement of maximal O_2 uptake were obtained in 30 subjects whereas estimations of maximal cardiac output were obtained in 15 subjects.

Table 2
MAXIMAL MEASUREMENTS IN MAXIMAL WORK CAPACITY TEST
(MEAN \pm SD WITH RANGE IN PARENTHESIS)

	Malay	Indian	Chinese	Total	X^2	F
$\dot{V}O_2$ (l/min)	2.319 \pm 0.299 (1.859-2.961)	2.318 \pm 0.501 (1.712-3.138)	2.458 \pm 0.385 (1.849-2.954)	2.365 \pm 0.395 (1.712-3.138)	2.24	0.40
(ml/kg/min)	40.7 \pm 5 (33.52)	42.8 \pm 8 (33.52)	43.3 \pm 8 (31.55)	42.3 \pm 7	2.22	0.39
	n = 10	n = 10	n = 10	n = 30		
HR (beats/min)	177.7 \pm 12 (154-196)	182.7 \pm 8 (176-200)	188.9 \pm 10 (168-200)	183.1 \pm 1 (154-200)	1.38	3.12
	n = 10	n = 10	n = 10	n = 30		
\dot{V}_E (l/min)	86.6 \pm 13.5 (61.4-108.9)	91.1 \pm 21.1 (65.5-118.8)	101.4 \pm 14.1 (83.4-123.7)	93.0 \pm 16.9 (61.4-123.7)	2.22	2.09
	n = 10	n = 10	n = 10	n = 30		
$\dot{V}_E/\dot{V}O_2$	408 \pm 5.5 (28.6-46.2)	42.4 \pm 9.6 (28.4-63.3)	43.8 \pm 9.0 (32.2-62.7)	42.3 \pm 7.9 (28.4-63.3)	2.76	0.33
	n = 10	n = 10	n = 10	n = 30		
O_2 pulse (ml/beat)	130 \pm .8 (105-15.5)	13.2 \pm 2.7 (9.4-17.6)	13.1 \pm 2.2 (10.3-17.3)	13.1 \pm 2.1 (9.4-17.6)	1.39	0.01
	n = 10	n = 10	n = 10	n = 30		
\dot{Q} (l/min)	20.1 \pm 2.8 (15.9-25.2)	17.6 \pm 3.2 (14.4-22.8)	22.5 \pm 4.8 (19.5-28.0)	19.7 \pm 3.6 (14.4-28.0)		
	n = 7	n = 5	n = 3	n = 15		
SV (ml/beat)	131 \pm 30 (102-186)	123 \pm 23 (104-160)	119 \pm 23 (104-146)	126 \pm 25 (102-186)		
	n = 7	n = 5	n = 3	n = 15		
(a-v) O_2 diff. (ml/l)	134 \pm 23 (111-169)	143 \pm 42 (100-197)	123 \pm 34 (84-148)	135 \pm 31 (84-197)		
	n = 7	n = 5	n = 3	n = 15		

$\dot{V}O_2$ = Oxygen uptake, HR = heart rate, \dot{V}_E = minute ventilation

$\dot{V}_E/\dot{V}O_2$ = Ventilatory equivalent for Oxygen, O_2 pulse = Oxygen pulse

\dot{Q} = Cardiac output, SV = Stroke volume

(a-v) O_2 -diff = arterio-venous oxygen difference

Table 4
**COMPARISON OF ANTHROPOMETRIC CHARACTERISTICS AND PHYSIOLOGICAL PARAMETERS DURING MAXIMAL EXERCISE
 IN YOUNG MEN**
 (mean \pm SD with range in Parenthesis)

Reference	No.	Height cm	Weight kg	BSA m ²	\dot{Q} max l/min	HR max beats/min	SV max ml	\dot{V}_{O_2} max l/min	(a.v) \dot{V}_{O_2} diff. ml/l	\dot{Q} max BSA	\dot{Q} max Weight	Race
Duncan, present study	15	165 (157-171)	55 (51-62)	1.58 (1.4-1.7)	19.7 \pm 3.6 (14.4-28.0)	180	126 \pm 25 (102-160)	2.268	135 \pm 31 (84-197)	12.2 \pm 2.2 (9.7-17.9)	0.36 \pm 0.06 (0.28-0.52)	Malay, Indian and Chinese
Astrand et al. ⁽¹⁶⁾	12	180	75	1.92	24.1 (16.3-29.9)	186	134	4.05	170	12.6	0.32	Caucasian
Faulkner et al. ⁽¹⁷⁾	8	181	78	1.98	23.3 \pm 3.0	174	137 \pm 19	3.82	164 \pm 18	10.8 (11.2-13.4)	0.30	Caucasian
Hermansen et al. ⁽¹⁸⁾	4	184	77	2.0	23.2 \pm 3.6 (19.3-27.3)	186	126	4.08	176 (160-183)	11.6	0.30	Caucasian
Miyamura et al. ⁽¹⁹⁾	17	172	63	1.74	24.6 \pm 2.0	192	128 \pm 11	3.95	161 \pm 8	14.1	0.39	Japanese
Edwards et al. ⁽²⁰⁾	12	179	79	1.98	25.8 \pm 2.8	181	137 \pm 24	3.06		13.0	0.33	Caucasian
Douglas et al. ⁽²¹⁾	4	168	82	1.92	19.9 \pm 1.5 (17.2-21.0)	184		3.85		11.2	0.24	Caucasian
Hanson et al. ⁽²²⁾	25	176	77	1.92	21.6	176	122	2.95		11.2	0.28	Caucasian
Dixon et al. ⁽²³⁾ (1971)	6	178	73	1.90	22.6 \pm 5.4	181	125	3.58	156	11.9	0.31	Caucasian
Eklom et al. ⁽²⁴⁾	8	180	69	1.86	22.4 \pm 2.1 (18.9-25.5)	200	112	3.15	138	12.0	0.32	Caucasian

BSA = Body surface area, for the other abbreviations see Table 2.

Maximal values for various physiological parameters obtained during performance of the maximal O₂ uptake test are presented in Table 2.

The combined values of all the subjects (n = 30) for \dot{V}_{O_2} max in l/min were 2.36 ± 0.39 (mean \pm SD), coefficient of variation was 16.7%; \dot{V}_{O_2} max normalised for body weight was equivalent to 42.3 ± 7 ml/kg/min (mean \pm SD).

Maximal cardiac output (\dot{Q} max) for 15 subjects averaged 19.7 l/min; maximal stroke volume (SV) was 126 ml/beat and maximal arterio-venous O₂ difference was (a-v) O₂ diff.) was 135 ml/l. Cardiac Index (l.min⁻¹. m⁻²) and maximal Stroke Index (ml/beat m⁻²) were 12.2 ± 2.2 and 79.6 ± 15 respectively (mean \pm SD).

Ethnic differences in the above responses were evaluated for statistical significance whenever the number of subject in each ethnic groups reached 10 and found to be non-significant (values for X² and F are presented in Table 2).

DISCUSSION

The importance of basic information on parameters of physical fitness with respect to cardiovascular and pulmonary functions in the field of sports medicine is well established. In view of the ethnic, socioeconomic and geographical similarities between Malaysia and Singapore, the data obtained in the present study can be taken to represent a pioneer attempt to gather some of the above information from a representative population resident in Malaysia and Singapore which can be used by local physicians and exercise specialists.

An extensive listing of the aerobic capacity of various populations, predominantly of Caucasians of European stock, has been compiled by Andersen⁽⁴⁾ and Taguchi et al.⁽⁵⁾ Table 3 presents a sample of published values for maximal: O₂ uptake representative of various ethnic groups. Most of the group means, including those of the Malaysians, were between 40-50 ml/kg/min, which would be assessed as being fair to average with respect to cardiovascular fitness according to a criterion set by Astrand.⁽⁶⁾

Comparisons of cardiac response during maximal exercise are presented in Table 4. Available information is mostly limited to data from Caucasian subjects. Maximal cardiac outputs obtained in the present study were within the range obtained by other investigators when normalized for anthropometric characteristics (body surface area and body weight).

In conclusion, comparisons of selected parameters in the present study suggest that ethnic differences in the population examined in terms of maximal exercise response are minimal. The present subjects were equivalent to other populations similarly examined with respect to physical fitness levels and cardiopulmonary responses. However, Malaysians would be less able to tolerate physical work with a fixed metabolic demand because of a smaller total physical capacity (\dot{V}_{O_2} in l/min) on account of a smaller total body mass.

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Table 3
COMPARISONS OF MAXIMAL OXYGEN UPTAKE OF UNTRAINED YOUNG MEN

Ethnic group	Subject No.	VO ₂ max ml/kg/min	Reference
American White	50	55.4	Slonim et al., ⁽⁷⁾
British	23	48.5	Cotes et al., ⁽⁸⁾
Swedish	42	58.6	Astrand, ⁽⁶⁾
American negro	14	49.9	Robinson et al., ⁽⁹⁾
Japanese	32	46.4	Taguchi et al., ⁽⁵⁾
Lapps	16	56.0	Andersen et al., ⁽¹⁰⁾
Arctic Indians	8	49.1	Andersen et al., ⁽¹¹⁾
Peruvian Indians	8	51.8	Kollias et al., ⁽¹²⁾
Asiatic Indians	9	27.6	Sengupta et al., ⁽¹³⁾
Vietnamese	9	33.0	Skranc et al., ⁽¹⁴⁾
Malaysians	8	35.0	Duncan ⁽¹⁵⁾
Malaysian Malays	10	40.7	Duncan, present study
Malaysian Indians	10	42.8	Duncan, present study
Malaysian Chinese	10	43.3	Duncan, present study

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