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Physical and physiological profiles of Malaysian dragon boat rowers

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Maximal oxygen consumption ($\dot{V}O_{2\,max}$) and maximal workload attained (WL_{max}) were determined in 28 Malaysian dragon boat rowers who were exercised to exhaustion on an arm ergometer. Mean $\dot{V}O_{2\,max}$ was 2.75 l min^{-1} at a mean WL_{max} of 195.5 W. Anaerobic endurance power of the arms, determined by cranking at 100 RPM at a workload of 400 W and the time taken to maintain the cadence until it fell to 75 RPM, was 34.9(±2.3) s. Leg performance, as determined by standing long jump and vertical jump, was 140.0(±4.5) kg m and 100.3(±3.1) kg m s^{-1} respectively. Right hand grip strength was significantly ($p<0.001$) greater than the left hand. Percentage body fat of the rowers was 11.8(±0.6)%. These values represent the first measurements of their kind performed on dragon boat rowers in Malaysia.

Keywords: dragon boat rowers, maximal oxygen consumption, vertical jump, standing long jump, anaerobic endurance power, arm-crank exercise

The dragon boat race is the highlight of the annual International Penang Boat Festival. Teams from Japan, Hong Kong, Macau, Thailand, Brunei, Indonesia, Australia, New Zealand, Denmark, Sweden, Norway, West Germany, Britain and the United States participate in the event. Dragon boat racing in Penang is believed to have started in the early 1800s. However, the tradition dates back to the 4th Century BC in China, when some fisherman in their boats made a valiant attempt to rescue a minister who, in grief over his banishment from the royal courts, had drowned himself. The fishermen failed in their attempt, but the rescue in the form of these races continues.

The race is usually held over 600 m and the boat resembles a long snake-like canoe with a dragon head and tail. It accommodates 18 paddlers, a coxswain and a drummer.

In spite of its long tradition in Penang, little data exists on the physical and physiological profiles of the dragon boat rowers in Malaysia.

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Materials and methods

A total of 28 members of the Malaysian dragon boat team consented to participate in this study. All tests were conducted at least 2 h after a light meal. Maximal oxygen consumption ($\dot{V}O_{2\,max}$), maximal oxygen pulse (O_2P_{max}) and maximal workload attained (WL_{max}) were determined during arm cranking exercise following a graded exercise on a modified electromagnetically braked ergocycle (Lode NV L-77 Lode Instrumenten BV, Groningen, The Netherlands). Subjects were seated upright with their feet flat on the floor. A non-rebreathing valve (Vacumed R2700B Hans Rodolph Inc, Kansas City, USA) was placed in the mouth and the nose was clamped. The subject was connected to an electrocardiograph (Kontron Medical Cardiac monitor 151 Kontron Ltd, Zurich, Switzerland) and the heart rate monitored throughout the procedure. After the gas concentrations in the expired air and heart rate had reached a steady state, resting measurements for 2 min were commenced. The exercise test involved cranking an ergocycle at a speed of 60 RPM until exhaustion. Initial workload was set at 50 W, which was then increased by 16 W at the beginning of every subsequent minute until the subject reached exhaustion. The volume of expired air and concentrations of oxygen and carbon dioxide in it were recorded at the end of each minute during exercise (Singer DTM 151, Sensor Medics OM-15 and Beckman LB-3 for measurement of volume, oxygen and carbon dioxide concentrations respectively [Ealing Corp, Edenbridge, UK; Sensor Medics Corp, Yorba Linda, USA; and Beckman Instruments Inc, Anaheim, USA]). Heart rate (beat min^{-1}) was calculated from five to six recorded ventricular complexes over the last 10 s of each minute. From these, ventilation per minute (VE), oxygen consumption per minute ($\dot{V}O_2$), carbon dioxide production per minute ($\dot{V}CO_2$) and oxygen pulse (O_2P) were calculated. The highest rates of VE, $\dot{V}O_2$ and O_2P measured during maximal exercise were considered as VE_{max}, $\dot{V}O_{2\,max}$ and O_2P_{max} respectively.

Upper body performance and endurance were determined by the number of dips performed on parallel beams in 2 min. Grip strengths of both the right (GSR) and left (GSL) hands were measured using a hand grip dynamometer (Harpenden Holtain Ltd, Crymych, UK). Leg performance was determined by vertical jump (VJ) and standing long jump

(SLJ). Distances jumped were converted to performance (VJP and SLJP). VJP was derived using the Lewis Normogram[1] and SLJP by multiplying the distance jumped with body weight[2]. Anaerobic endurance power (AEP) of the arms was determined by a modified cycle anaerobic endurance test[3]. Here, the subjects were asked to arm crank at 100 RPM at 0 W for 30 s after which the load was increased abruptly to 400 W. The time taken, in seconds, to maintain the cadence until it fell to 75 RPM was taken as the score for AEP. 2 min after the cessation of the AEP test, venous blood (1 ml) was taken from the anticubetal vein for the determination of peak blood lactate concentration. Blood lactate concentration was measured with a YSI Model 23L lactate analyser (Yellow Spring Instruments, Yellow Spring, OH, USA). Percent body fat was predicted from triceps and subscapular skinfold measurements (obtained with a Harpeden caliper Holtain Ltd, Crymych, UK) after Katch and McArdle[4].

Results

Mean ± standard error of mean for age and anthropometric data are presented in *Table 1*.

Table 2 presents the mean maximum workload (WL_{max}), $\dot{V}O_{2\,max}$ in $ml\,kg^{-1}\,min^{-1}$ and $l\,min^{-1}$, O_2P_{max} ($ml\,beat^{-1}$) and anaerobic endurance power (AEP) together with peak lactate.

Table 3 presents the strength and performance of upper and lower body. Mean grip strength was significantly higher ($p<0.001$) in the right hand as the subjects were predominantly right-handed.

Table 1. Anthropometric characteristics of the 28 Malaysian dragon boat rowers.

Variables	*Mean(±s.e.m.)*
Age (years)	25.4(±1.2)
Height (cm)	169.9(±1.3)
Weight (kg)	64.9(±1.2)
Body fat (%)	11.8(±0.6)

Table 2. Cardiopulmonary capacities and peak lactate of the 28 dragon boat rowers

Parameters	*Mean(±s.e.m.)*
WL_{max} (W)	195.5(±3.5)
$\dot{V}O_{2\,max}$ ($l\,min^{-1}$)	2.8(±0.1)
$\dot{V}O_{2\,max}$ ($ml\,kg^{-1}\,min^{-1}$)	42.3(±0.7)
O_2P_{max} ($ml\,beat^{-1}$)	15.1(±0.5)
AEP (sec)	34.9(±2.3)
Peak lactate, 2 min after AEP ($mmol\,l^{-1}$)	8.4(±0.4)

Table 3. Upper and lower body strength and performance of the 28 dragon boat rowers

Parameters	*Mean(±s.e.m.)*
VJ (cm)	49.8(±1.4)
VJP ($kg\,m\,sec^{-1}$)	100.3(±3.1)
SLJ (cm)	215.5(±4.6)
SLJP (kg m)	140.0(±4.5)
Dips (number in 2 min)	30.1(±1.7)
GSR (kg)	47.3(±1.2)
GSL (kg)	44.0(±1.1)

Discussion

Rowing is a physically demanding sport requiring well-developed aerobic qualities and the performances of most rowers correlate highly with their maximum oxygen uptakes[5,6]. In fact, aerobic capacity is one of the main criteria used by scientists to assist in identifying and selecting rowers.

Little data exist on the aerobic capacities of international dragon boat rowers with which this data could be compared. A mean $\dot{V}O_{2\,max}$ of 2.75 l min^{-1} (42.3 ml kg^{-1} min^{-1}) obtained in this study is higher than that reported for normal human subjects following continuous arm ergometry[7–13] but lower than that reported for well-trained upper body athletes or élite wrestlers during arm cranking exercise[13,14]. Furthermore, it is considerably lower than the aerobic capacities of 5–6 l min^{-1} recorded in some élite oarsmen[15,16] during simulated rowing. The reason for this big difference in aerobic capacities is uncertain. It is, however, speculated that the lower $\dot{V}O_{2\,max}$ may be due to the manner of its determination. The cycle ergometer used to determine $\dot{V}O_{2\,max}$ mainly exercises the upper body while simulated rowing, as used by other investigators, involves both upper and lower body muscles. The involvement of a larger muscle mass therefore may account for the observed difference in the $\dot{V}O_{2\,max}$. This is accentuated since dragon boat rowing differs from other rowing events as it mainly involves upper body movement.

In addition to a high aerobic capacity, élite rowers are also required to have the ability to sustain a very high oxygen consumption and a high anaerobic endurance, based on the fact that during a race most oarsmen usually perform near their maximal aerobic capacity for the entire duration of the race[6]. Dragon boat races may vary from 2.5 to 3 min duration. We measured the arm anaerobic endurance in these rowers by recording the length of time a rower could maintain a cadence of above 75 RPM at a workload of 400 W. By this, a mean AEP of 34.9(±2.3) sec (ranging from 22.0–63.5 sec) was recorded for the 28 rowers. It is not possible for us to compare this with other data in the literature as no-one has actually determined the anaerobic endurance of rowers in this manner before. It was a simple method and we felt it was necessary to measure the AEP for purposes of team selection. Based on the distance covered during a race we, however, feel that a mean AEP of 34.9 sec is good. AEP also correlated significantly with $\dot{V}O_{2\,max}$ in this study ($r = 0.79$; $p<0.001$) suggesting rowers with a higher $\dot{V}O_{2\,max}$ also had a higher anaerobic endurance perhaps as a consequence of their endurance training[17]. No significant correlation was evident between AEP and dips or grip strength. The mean peak blood lactate concentration achieved after 2 min of completion of the AEP test was 8.4 mmol l^{-1}, again correlating significantly with AEP ($r = 0.62$; $p<0.001$).

Selection of rowers based on the $\dot{V}O_{2,max}$ and anaerobic endurance power certainly helped improve the team's achievements when compared to their achievement in the previous years. In fact, these measurements are the first to be performed on the dragon boat rowers in Malaysia and we hope to continue with these in the hope of establishing the exact levels of these parameters required to succeed in this competition.

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