Youth Talent Identification in Rowing Project

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Abstract

Little is known about the identification of athletic talent in Chinese youngsters from Hong Kong. In comparison with the development of identification programmes elsewhere, Hong Kong has much to learn. Those programmes developed in Australia and the former Eastern Block countries are generally for taller groups of youngsters who are being screened for open (usually heavy weight) competitive sports and may be inappropriately transferred to the Hong Kong population. Hong Kong have excelled in lightweight rowing and the need to develop a suitable programme which could identify the rowers of the future is paramount.

To date no laboratory determined peak$\dot{V}O_2$ data exist for Hong Kong Chinese adolescent girls and only limited data are available for adolescent boys (Barnett et al., 1995; Barnett et al., 1993). This paucity of published data for Hong Kong children and adolescents is confounded by the inappropriate use of prediction peak$\dot{V}O_2$ tests and interpretation problems.

To further develop future rowing talent and identify talented youngsters for other sports in Hong Kong, knowledge of cardiopulmonary responses to exercise is essential, as well as the identification of appropriate field measures which would make mass school screening a simpler task.

This study supports the conclusions of earlier work (Barnett et al., 1995) that the peak$\dot{V}O_2$ of Hong Kong adolescents is not a cause for concern. However,

further cross-sectional and longitudinal research should be conducted to generate a representative data base of peak$\dot{V}O_2$ norms for Hong Kong Chinese children and adolescents.

The use of a 3 minute indoor rowing test was found to be appropriate for adolescent boys and is an identifier of the more aerobically fit. This protocol may need some modification with adolescent girls, however, it still provides a good identifier of the more aerobically fit girls.

Those who performed better on the indoor rowing task were generally taller, and more aerobically fit. Differing anthropometric variables were related to distance traveled during the 3 minute indoor rowing task for boys and girls, however, only height can be recommended as an identifier of potential rowers.

As such development of talent identification programmes should concentrate on finding the most appropriate field performance measure, and upon peak$\dot{V}O_2$ rather than anthropometric variables.

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1.0 The problem.

The identification of future athletic talent is complex and although in some countries projects focusing upon the identification of talent have been underway for a number of years (Australia), little is known about the identification of athletic talent in Chinese youngsters from Hong Kong.

Olympic athletes have been shown to have definite body characteristics and bioenergetic profiles that are clearly specific for the event in which they compete (Tanner, 1964). Although it is not imperative that an athlete conforms to this physique and certain physiological traits, Khosla (1983) has demonstrated that although an ideal physique and appropriate physiological traits do not necessarily guarantee elite performance, the lack of them may be a contributing limiting factor to the potential athlete.

Talent identification programmes for adolescents are now extensively used by many sports in Australia. Such programmes are labour intensive involving mass screening in schools and despite their wide use, have had mixed success. The exception is the programme which was started in 1987 for identifying open rowing talent. This programme identified a group of boys and girls, who after only 16 months finished second in the junior fours at the national championships, with some of the girls going on to form Olympic crews. It is interesting that despite such success, the programme coordinators still conclude that "the selection process was difficult" (Hahn, 1990; p11) and "much remains to be learned" (Hahn, 1990; p11).

Although these data were difficult to interpret, Hahn (1990) does summarize that a person with a high maximum oxygen uptake, who is tall and long-limbed may be the ideal rower.

Maximal oxygen uptake has also been found to best predict performance during rowing competition in adults (Secher, 1993; Reilly and Secher, 1990). Oxygen uptake is influenced by a complex combination of factors which include all the pulmonary, cardiac, vascular and haematological determinants of oxygen delivery and tissue consumption. Maximal oxygen uptake ($\dot{V}O_2\,max$) is therefore widely recognized as the best single indicator of overall cardiopulmonary fitness. The interpretation of $\dot{V}O_2\,max$ in children and adolescents is, however, confounded by growth, maturity, method of assessment and interpretation. Maximal oxygen uptake is conventionally determined as the point at which oxygen consumption ceases to rise despite an increase in exercise intensity. However, only a minority of children and adolescents exhibit a true $\dot{V}O_2\,max$ plateau and the appropriate term to use with children and youth is therefore $peak\dot{V}O_2$ which represents the highest $\dot{V}O_2$ elicited during an exercise test to exhaustion (Armstrong *et al.*, 1991). Our previous work with children and adolescents (Armstrong et al., 1995) have demonstrated that different statistical techniques can fundamentally affect the interpretation of the effects of growth and body size on $peak\dot{V}O_2$ and ultimately the $peak\dot{V}O_2$ score. This may have significant ramifications for the prediction of future ability upon conventionally expressed $peak\dot{V}O_2$ data in adolescents.

We still know very little about the physiological responses of our younger population in Hong Kong to exercise. To date no laboratory determined $peak\dot{V}O_2$ data exist for Hong Kong Chinese adolescent girls and only limited data are available for adolescent boys (Barnett et al., 1995; Barnett et al., 1993). Our potential programmes for talent identification in rowing are based on other populations who are generally taller, and selected for heavy weight competition. Hong Kong in contrast has excelled at lightweight rowing. We believe that to further develop future rowing talent and identify talented youngsters for other sports in Hong Kong, knowledge of cardiopulmonary responses to exercise is essential.

This study was therefore designed to investigate the relationship between a field measure designed to identify potential lightweight rowing talent, anthropometric profiles and cardiopulmonary response to maximal exercise in adolescent girls and boys.

The study addressed the following questions:

1. Are the anthropometric characteristics and peak oxygen uptake of those girls and boys above the 50th percentile for indoor rowing performance significantly different to those of girls and boys below the 50th percentile.

2. Are different anthropometric and bioenergetic profiles related to indoor rowing performance for adolescent boys compared to adolescent girls.

3. Is indoor rowing performance more related to peak oxygen uptake than to other anthropometric characteristics in Hong Kong adolescents.

2.0 Methodology

a) *Ethical considerations*

The rationale underlying the proposed work was approved by the Head Rowing Coach at the Sports Institute and support from the Hong Kong Amateur Rowing Association was also obtained. An excellent relationship had been developed with the schools in the Shatin area of the New Territories by the Amateur Rowing Association schools development program. A total 6,000 13-16 year old girls and boys had performed a three minute indoor rowing ergometer test in school as part of this programme. Those students in secondary year three were selected from this initial group and schools were invited to participate further in this programme. Before working with a school the headteacher and physical education teaching staff were briefed fully. The research was discussed with the children and every effort was made to make their involvement a valuable educational experience. Written informed consent was required from both parent and child for each participant invited to continue with the project. Those who agreed had the opportunity to withdraw at any time.

b) *subjects*

From the year three students invited to participate, those top twenty five boys and twenty-five girls above the 50th percentile, for distance scored on the 3 minute indoor rowing task, were invited to form a potential rowing group . Twenty five boys and girls who scored below the 50th percentile were also invited to participate to provide a reference group. Only those students who successfully completed the laboratory tests were included in the final data analyses. This gave a group of 15 boys and 9 girls above the 50th percentile, and a group of 15 boys and 12 girls below the 50th percentile.

Laboratory Measurement Techniques.

We use techniques and protocols which have been developed over ten years of paediatric exercise testing in the Children's Health and Exercise Research Centre, UK. All the students visited the exercise physiology laboratory at the Hong Kong Sports Institute once.

On their arrival at the laboratory the students were introduced to all procedures and allowed to practise running on the treadmill.

Anthropometric Assessment

Age was computed from the date of birth and laboratory test date.

Height was measured to the nearest 0.01m using a Harpenden stadiometer. The participant stood on the foot plate in bare feet with heels together, whilst gentle upward pressure was placed on the mastoid processes. The child was encouraged to "stand tall, take a deep breath and relax" (Weiner and Lourie, 1981).

Body mass was measured to the nearest 100g using beam balance calibrated scales. the student wore minimal clothing and no footwear.

Skinfold thicknesses were taken by the same person using calibrated Harpenden calipers. Skinfold thicknesses over the triceps, biceps, subscapular and suprailiac regions were obtained. The skinfold was held between the thumb and forefinger and was taken two seconds after the calipers had been applied. The skinfold sites were taken at points outlined by Lohman (1992).

Biacromial width was taken as the distance measured between the most lateral points of the acromion processes, with the shoulder region in a normal position.

Bitrochantric width was the distance measured between the trochantirc notches with firm pressure applied on the overlying tissue.

Upper arm length was measured from the acromion process to the most lateral elbow projection with the arm held at a 90 degree angle.

Lower arm length was measured from the most bony elbow projection with the amr held at a 90 degree angle, to the first full crease on the wrist.

Cardiopulmonary Measures During Exercise:

Each child had his/her peak $\dot{V}O_2$ assessed using an incremental, discontinuous treadmill test to voluntary exhaustion. The test consisted of a 3 min. warm-up at a belt speed of between 5 to 6 $km.h^{-1}$, followed by a rest period. The first stage of the test consisted of a 3 min run at a belt speed of 1.82 $m.s^{-1}$ (6 $km.h^{-1}$) and was increased to 1.96 $m.s^{-1}$ (7 $km.h^{-1}$) after three minutes. The belt speed was then increased again to 2.24 $m.s^{-1}$ (8 $km.h^{-1}$) for another 3 min, thereafter the belt speed was held constant and initially the gradient was raised by 2.5% for a further 3 min period. Subsequently, the treadmill gradient was raised by increments of 2.5% every 3 min until the child reached voluntary exhaustion. Each exercise stage was interspersed with a 1 min rest period. Throughout the test respiratory gases were monitored using a SensorMedics Metabolic Cart which was calibrated prior to each test. Heart rate was monitored using a Rigel Electrocardiograph and Polar 4000 SportsTester.

It is widely documented that only a minority of children exhibit a conventional $\dot{V}O_2$ plateau during exercise to voluntary exhaustion (Armstrong et al., 1995; Astrand, 1952). Recent studies have demonstrated that the requirement of a $\dot{V}O_2$ plateau before peak $\dot{V}O_2$ can be regarded as a maximal index of children's aerobic fitness is not tenable (Armstrong et al., 1996; Rowland, 1993). Peak heart rate and respiratory exchange ratio are useful objective criteria that experimenters can use to support subjective observations when deciding whether the child has demonstrated a maximal effort. In accord with recent literature reviews (Armstrong and Welsman, 1994; Rowland, 1996; Leger, 1996) peak$\dot{V}O_2$ was accepted as a maximal index in this study if the child exhibited visual signs of exhaustion, a heart rate 95% of the age-predicted maximum and a respiratory exchange ratio greater than unity.

Statistical Analyses:

Date were stored and analyzed using SPSS 6.1 statistical package.

Descriptive statistics for anthropometric and peak exercise variables were computed for the girls and boys. Differences between those above the 50th percentile and those below were tested for using analysis of variance (ANOVA).

Peak oxygen uptake was subsequently examined using the least-squares linear relationship between body mass and peak $\dot{V}O_2$ using analysis of covariance (ANCOVA).

3.0 Results

Table 1 Characteristics of adolescent boys and girls

	Age (y)	Height (cm)	Body mass (kg)	Sum Skinfolds (mm)
Boys(n=30)	13.67 (.37)	163.2 (7.7)	53.7 (9.9)	34.2 (17.2)
Girls (n=21)	13.57 (.27)	156.5 (6.7)	49.0 (10.2)	53.7 (36)

Values are mean (standard deviation)

Table 2 Peak Data for adolescents boys and girls

	RER	HR (bpm)	peak $\dot{V}O_2$ $L.min^{-1}$	peak$\dot{V}O_2$ $mL.kg.^{-1} min^{-1}$
Boys (n=30)	1.03 (.06)	200 (6)	2.66 (.44)	50.3 (6.4)
Girls (n=21)	1.04 (.05)	202 (5)	1.96 (.35)	40.1 (3.34)

Values are mean (standard deviation)

Table 3 **Anthropometric data for boys above 50th percentile compared to those below the 50th percentile for distance covered in the 3 minute rowing task.**

	Above 50th percentile (n=12)	Below 50th percentile
Age (y)	13.8 (.35)	13.6 (.38)
Height (cm)	167.6 (4.4)	159.1 (79)*
Body mass (kg)	59.0 (7.7)	48.4 (9.1)*
Biacromial width (cm)	37.7 (1.5)	35.6 (5.1)
Bitrochantirc width (cm)	31.9 (5.3)	28.1 (5.5)
Lower arm (cm)	26.5 (1.2)	24.1 (2.8)*
Upper arm length (cm)	32.7 (6.3)	28.7 (3.6)*
Sum Skinfolds (mm)	34.6 (15.3)	22.6 (19.3)

Values are mean (standard deviation)

* significant at $P<0.05$

Table 4 **Peak data and distance covered for boys above the 50th percentile compared to those below the 50th percentile for distance covered in the 3 minute rowing task.**

	Above 50th percentile (n=12)	Below 50th percentile
peak $\dot{V}O_2$ $L.min^{-1}$	3.00 (.30)	2.32 (.27)*
peak $\dot{V}O_2$ $mL.kg.^{-1} min^{-1}$	51.2 (4.9)	49.3 (7.7)
Distance (m)	688 (27)	560 (3)

Values are mean (standard deviation)

* significant at $P<0.05$

Table 5 **Anthropometric data for girls above 50th percentile compared to those below the 50th percentile for distance covered in the 3 minute rowing task.**

	Above 50th percentile (n=9)	Below 50th percentile (n=12)
Age (y)	13.6 (.25)	13.6 (.31)
Height (cm)	160.3 (4.2)	153.6 (6.8)*
Body mass (kg)	52.0 (10.3)	46.7 (9.9)
Biacromial width (cm)	35.6 (1.9)	34.8 (1.9)
Bitrochantirc width (cm)	29.8 (2.3)	28.8 (2.3)
Lower arm (cm)	24.3 (1.1)	23.8 (0.7)
Upper arm length (cm)	30.7 (2.2)	28.6 (3.3)
Sum Skinfolds (mm)	50.0 (26.7)	56.0 (43.5)

Values are mean (standard deviation)

* significant at $P<0.05$

Table 6 **Peak data and distance covered for girls above the 50th percentile compared to those below the 50th percentile for distance covered in the 3 minute rowing task.**

	Above 50th percentile (n=12)	Below 50th percentile
peak $\dot{V}O_2$ $L.min^{-1}$	2.2 (0.4)	1.8 (0.2)*
peak$\dot{V}O_2$ $mL.kg.^{-1} min^{-1}$	41.8 (2.7)	39.3 (3.5)
Distance (m)	614.7 (26.8)	521.3 (1.6)*

Values are mean (standard deviation)

* significant at $P<0.05$

4.0 Discussion and Implications of Results.

4.1 Peak Oxygen Uptake - an introduction

Our cardiopulmonary limit during maximal exercise was described by Hill and Lupton in 1923 as the point at which

> "However much the speed be increased beyond this limit, no further increase in oxygen intake can occur..."(p156)

This point was represented by an asymptotic curve or plateau, giving a clear indicator of maximum cardiopulmonary function. $\dot{V}O_2$ max. has generally been regarded as the best single indicator of cardiopulmonary fitness and used extensively since these earliest exercise physiology investigations. Interestingly rowers were one of the primary groups of subjects for these experiments (Liljestrand and Lindhard, 1920).

As with much paediatric exercise testing, this non-invasive measure established with adults was adopted for use in children. Since the pioneering work of Robinson (1938) numerous cross-sectional and comparatively fewer longitudinal studies (See Krahenbuhl *et al.,* 1985 and Armstrong & Welsman, 1994) have been carried out with children and adolescents. To date only two studies exist which have used Hong Kong Chinese adolescents as subjects (Barrnett et al., 1993; Barnett et al., 1995) and both of these are confined to boys. This paucity of published work for Hong Kong children and adolescents is confounded by the inappropriate use of prediction $\dot{V}O_2$ max. tests and interpretation problems.

The costs in terms of expertise, essential equipment, relative subject discomfort and the financial and time constraints of $\dot{V}O_2$ max. testing has led to the introduction of a variety of alternative test protocols. These claim to offer an indirect assessment of $\dot{V}O_2$ max.

without the use of sophisticated laboratory equipment and gas analysis and provide the majority of the data available for Hong Kong adolescents and children.

Most popular in Hong Kong have been the use of traditional performance tests which require the child to cover a distance in a predetermined time (Cooper 12 minute run, 1968), or record the time taken to cover a predetermined distance. Since these tasks involve a large muscle mass contracting in a rhythmic manner they are considered to be taxing the same physiological attributes assessed during a laboratory based $\dot{V}O_2$ max. test. It has been assumed therefore, that high scores in these performance measures are analogous with a high $\dot{V}O_2$ max. values.

The strength of this relationship has been questioned (Shephard, 1984; Cunningham, 1980). The actual predictive accuracy of these tests should not be obtained from correlation coefficients and few report the standard error of the estimate (SEE). Buono *et al.* (1991) and Massicotte *et al.* (1985) report SEEs for the 1-mile run. These authors advocate the predictive accuracy of the mile run time for $\dot{V}O_2$ max., yet the SEEs are between 9% and 13%, which would result in $\dot{V}O_2$ max. differences of a similar magnitude to those reported following aerobic training in pre-pubescent children.

A more recent introduction has been the 20m shuttle run developed by Leger and Lambert (1982), which has become increasingly popular in schools. Like other performance tests, the 20m shuttle run is highly dependent upon the willingness of the subject to give a maximal effort and again is influenced by motivation, skill, practice, maturity and environmental factors. Shuttle run values for $\dot{V}O_2$ max. have been found to differ significantly from measured $\dot{V}O_2$ max. values (Anderson, 1992). Armstrong *et al.* (1988) concluded that $\dot{V}O_2$ max. "cannot be accurately predicted from performance in a 20m progressive shuttle run" (p.11).

Contrary results have been reported though (Boreham *et al.,* 1987; Barnett *et al.,* 1993; Anderson, 1992). Barnett *et al.,* (1993) support the use of the 20m shuttle run as a predictor of peak$\dot{V}O_2$ with Hong Kong Chinese male adolescents. Performance tests can not however, be regarded as valid indices of peak$\dot{V}O_2$

The debate about the predictive accuracy of 'alternative' tests still continues, despite extensive literature illustrating the limitations of field tests in the complex assessment of peak$\dot{V}O_2$ in children. In Hong Kong the Education Department still persists in encouraging the use of such predictive tests in schools. To date no field test exists which accurately predicts peak$\dot{V}O_2$ in children or adolescents and extensive laboratory determined values of peak$\dot{V}O_2$ for local children and adolescents need to be established. The small sample of data derived from this present study offer simply a pilot study of the peak$\dot{V}O_2$ of adolescents in Hong Kong and both large scale representative cross-sectional and longitudinal studies are needed.

4.2 Laboratory determined peak oxygen uptake.

During the direct determination of peak$\dot{V}O_2$ the cardiopulmonary system is placed under maximal stress. Children exercise until they are unable to continue despite strong encouragement, what is termed voluntary exhaustion. It is essential that test termination is based on the same criteria for every child and commonly the criterion used for a maximal effort has been a plateau in $\dot{V}O_2$ at maximal exercise as outlined by Hill and Lupton (1923).

Regardless of the definition of plateau, a common feature of the published data for children, like their adolescent counterparts, has been an inability for all the subjects to elicit a plateau in $\dot{V}O_2$ (Rowland & Cunningham, 1992; Rowland, 1993a).

Rowland & Cunningham (1992) state that the achievement of a plateau in children appears to be independent of subject effort, aerobic fitness or anaerobic fitness. Other criteria have been established to indicate maximum exertion when a plateau is not recorded.

Subjective fatigue is something which is quickly recognizable with experience of exercise-testing with child subjects. Profuse sweating, an inability to maintain the desired exercise intensity, dyspnoea and an unsteady gait are all indicators that the child is approaching or has reached his or her maximum

Ratings of perceived exertion have not been found to be consistent or valid amongst children and adolescents (Ward & Bar-Or, 1990), and do not appear to have the same physiological meaning as with adults. Many children and adolescents have no concept of what maximal exertion is, and the use of perceived exertion as an indicator for maximum is very precarious.

Peak heart rate has been the most commonly used alternative criterion for maximal performance. A peak heart rate within 10% of the age predicted maximum or a levelling off of the heart rate near peak$\dot{V}O_2$ have been used (Cumming and Langford, 1985; Sheehan *et al.,* 1987; Washington *et al.,* 1988). Rowland (1993b) argues that the traditional formula for calculating the age predicted maximum heart rate (220 minus age) is inappropriate with children since maximum heart rate decrements with age during the growth period are insignificant (Bar-Or, 1983. For practical reasons a target heart rate can serve as a useful marker when used in conjunction with other criteria, and for adolescents this value is normally 200 $b.min^{-1}$ (Rowland, 1993b).

A respiratory exchange ratio value near unity has generally been used for children and adolescents.

Pulmonary ventilation ($\dot{V}_E$) at peak$\dot{V}O_2$ corresponding to values over 50 $L.min^{-1}$, with the respiratory frequency (R_f) approaching 60 breaths per minute, have been reported for children (Mercier *et al.,* 1991; Girandola *et al.,* 1981). Exercise protocols which involve large incremental increases raise the blood lactate concentration, and the subsequent release of CO_2 as a result of the bicarbonate buffering of lactic acid drives the $\dot{V}_E$ (Wasserman *et al.,* 1973). Ventilation at peak$\dot{V}O_2$ is not 'maximal' $\dot{V}_E$ because of the dependence of this parameter on the protocol, and therefore results should be interpreted with care.

In view of the previous discussion, the following criteria are recommended as indicators of maximum when testing children and adolescents from the age of eight upwards. Peak$\dot{V}O_2$ can be regarded as a true maximum when the child shows evidence of maximal effort and satisfies the following criteria:

- Subjective fatigue: Profuse sweating, an unsteady gait, dyspnoea and an inability to keep up with the desired exercise intensity
- A peak heart rate of 200 $b.min^{-1}$
- A peak RER value above .98 during treadmill running and above 1.00 during cycle ergometry

If we look at the peak data for the boys and girls in the present study in table 4.1 below, it is evident that both the girls and boys reached maximum exertion.

Table 4.1 Peak exercise data for girls and boys

	RER	$\dot{V}_E$ $L.min^{-1}$	R_f (breaths/min)	HR (bpm)
Boys(n=30)	1.03 (.06)	89 (18)	58 (7)	200 (6)
Girls (n=21)	1.04 (.05)	69 (10)	56 (9)	202 (5)

4.3 Peak oxygen uptake during adolescence

The research of Armstrong *et al.* (1991) revealed that absolute peak$\dot{V}O_2$ in boys rose from 1.86 $L.min^{-1}$ at age 11.7 years, to 2.98 $L.min^{-1}$ at age 15.3 years. peak$\dot{V}O_2$ in girls showed a similar, though less marked increase from 1.75 $L.min^{-1}$ at age 11.8 years to 2.08 $L.min^{-1}$ at age 15.2 years.

Changes in peak$\dot{V}O_2$ $mL.kg.^{-1}min^{-1}$ with age have been documented both cross-sectionally and longitudinally in other countries. In boys, results have generally been consistent demonstrating that no significant change in peak$\dot{V}O_2$ $mL.kg.^{-1}min^{-1}$ is apparent between the years ten to sixteen. In agreement, Bar-Or (1983) found that in boys mass related peak$\dot{V}O_2$ remained fairly constant (50-55 $mL.kg.^{-1}min^{-1}$) across the range six to sixteen years of age. The results of Armstrong *et al.* (1991) are consistent with these findings, peak$\dot{V}O_2$ remaining between 48 and 50 $mL.kg.^{-1}min^{-1}$ from age eleven years through to fifteen years old.

In girls, mass related peak$\dot{V}O_2$ has been seen to decrease continuously from about ten years old through adolescence, levelling off in adulthood (Bar-Or, 1983; Åstrand, 1952; Rutenfranz *et al.* 1990). Armstrong and colleagues (1991), using a treadmill running protocol, found that the mean peak$\dot{V}O_2$ of the eleven year old girls was 43 $mL.kg.^{-1}min^{-1}$ dropping to 39 $mL.kg.^{-1}min^{-1}$ by fifteen years of age.

Armstrong & Welsman (1994) have generated linear regression equations to predict peak$\dot{V}O_2$ at various ages for boys and girls. These equations were based on data from over 11,000 subjects and were calculated separately for treadmill and cycle ergometer exercise.

Ergometer	Boys	Girls
Treadmill	y = -0.623+0.231x	y = 0.253+0.124x

y = peak$\dot{V}O_2$ $L.min^{-1}$ x = age in years

The available data for Hong Kong male adolescents (Barnett et al., 1995) report a mean peak$\dot{V}O_2$ of 2.7 (±0.44) $L.min^{-1}$ for boys with a mean age of 15.0 years. The value obtained from the above regression equation for 15 year old boys is 2.84 $L.min^{-1}$, supporting Barnett et al.'s conclusion that the peak$\dot{V}O_2$ of Hong Kong schoolboys is very similar to that found in other populations of similarly aged boys.

These data provide a similar picture, that peak$\dot{V}O_2$ values are homogenous across many ethnicities. Using the above equations the predicted peak$\dot{V}O_2$ of the 13.67 y old boys was 2.53 $L.min^{-1}$ whilst their actual peak$\dot{V}O_2$ was 2.66 $L.min^{-1}$. The 13.57 y old girls predicted peak$\dot{V}O_2$ was 1.94 $L.min^{-1}$ whilst their actual peak$\dot{V}O_2$ was 1.96 $L.min^{-1}$.

The European Work Physiology Group provide health and fitness cut-offs for this age-group (Bell et al., 1986). They proposed that a mass-related peak$\dot{V}O_2$ of 45 $mL.kg.^{-1}min^{-1}$ for boys and 40 $mL.kg.^{-1}min^{-1}$ for girls was sufficient for fitness. It can be seen that the mean values for both the girls and boys fall within both these cut-off values.

Contrary to much of the previous data for adolescents in Hong Kong, derived from field assessments of peak$\dot{V}O_2$, these adoelscents have very acceptable levels of cardiopulmonary fitness.

Koutedakis and Sharp (1989) state that "knowing the magnitude of parameters such as percent body fat and aerobic power .... identification of the best rowers might be possible" (pp 39-41).

When the two percentile groups were compared, peak$\dot{V}O_2$ was significantly greater in those students above the 50th percentile for distance compared to those below the 50th percentile. This was true of both the girls and boys, but it should be noted that when the conventional ratio standard was used to remove the effect of body mass, no significant difference between the two groups existed, however when ANCOVA was used to partial out body mass a significant difference was apparent. This highlights the inappropriateness of ratio standards for removing the effect of body dimensions.

Correlation coefficients were computed between distance rowed and peak$\dot{V}O_2$ to ascertain any relationship between these two variables A significant correlation was apparent for both sexes, with r values of r = .61 for boys and r = .70 for girls.

Although it would appear that the indoor rowing test was signifcantly related to peak$\dot{V}O_2$ these r values only explain 37% of the variance in the boys and 49% in the girls. This age group are still somewhere in the adolescent growth spurt, a very individual time of growth and development which may be accompanied by changes in athletic performance. Future in-depth talent identification studies should take account of maturational status as well as chronological age.

4.4 Anthropometric Profiles.

There exist many structural variables which have been identified as potentially limiting or improving performance in rowing.

Adult male heavy weight rowers are tall with body fat somewhere in the region of 8-12% and $\dot{V}O_2$ max values of 4.3-6.6 $L.min^{-1}$. Hahn et al. (1995) found his younger rowers to be tall with enhanced peak$\dot{V}O_2$ also. When a range of anthropometric variables were examined, arm length was found to be significantly longer in elite rowers, who also tend to have narrower hips.

When we look at these data, both the girls and boys in the upper percentiles were significantly taller than those in the lower percentiles. However, the upper percentile groups did not have lower body fat (estimated by sum of four skinfolds) which has been apparent in other child athletes. Of course, these students are untrained, and what these data would suggest is those children who are taller, have a correspondingly greater muscle mass, therefore perform better on the given indoor rowing task.

The fatness of the girls was a serious problem for programme adherence. Although no conversion to % body fat is made, it is easy to identify the large difference between the boys and girls in body fatness. This difference is expected with the increase in body fat accompanying pubertal development in adolescent girls. Some of the girls however, had sum of skinfolds of up to 180 mm, well above the average, or that associated with health. The initial indoor rowing test appeared to identify not only the taller, stronger girls, but a large group of fatter girls. Consequently many of those girls who fell into the upper percentiles had no interest in participating further in an exercise programme, giving an attrition rate of over 50% for the original group of girls.

There was no difference in the biacromial width or bitrochantirc width for either groups of boys or girls when those above the 50th percentile were compared with those below the 50th percentile. Therefore our group of adolescent potential rowers do not have wider shoulders or narrower hips compared to their less fit counterparts.

The two groups of girls showed no difference in arm length either. However, the boys above the 50th percentile had significantly longer upper and lower arms than those boys below the 50th percentile. Hahn (1990) note that the ratio of arm length to height was above average for elite oarsmen (45% for men and 44% for women). When the same ratio was calculated for this group of boys the difference was small: those above the 50th percentile had a ratio of 35% whilst those below had a ratio of 33%. There could still be potential growth in arm length for these boys, and therefore arm length is not an ideal identifier of rowing talent.

It would seem that the 3 minute indoor rowing test highlighted different anthropometric characteristics in the girls and boys. Again it is difficult to explain these results without any assessment of maturational status, and it is not thought that any of these variables other than height are stronger predictors of athletic potential for rowing.

5.0 Conclusions

Talent identification programmes are best suited to those sports which have specific and easily measurable physical and physiological requirements. With youth populations such attributes are particularly difficult to identify because of growth changes in bioenergetic and anthropometric characteristics. Success of talent identification programmes in youth are often more related to subsequent coaching and acquisition of skill.

These data confer with those produced by Hahn et al. (1995) for open competition rowers: that those children who perform better have a larger peak$\dot{V}O_2$ and are taller. This difference remained once the effects of body size had been partialled out using analysis of covariance.

The use of a three minute indoor rowing test may need to be modified for girls, since it is not necessarily identifying the potentially more talented students, but also the fatter students. Hahn et al. (1995) choose a 1 minute test, but perhaps a 2 minute test would better suit potential lightweight rowers. A comparison of the relationship of a 1 minute, 2 minute and 3 minute ergometer test with peak$\dot{V}O_2$ in this age group is needed to identify the best field performance task.

Adolescents in Hong Kong are as aerobically fit and therefore are as capable of sustaining training programmes which children from other countries undergo. It should be noted though that the maximal running speeds of these children, that is the treadmill speed at which they reached peak$\dot{V}O_2$ was approximately 2 $km.h^{-1}$ slower compared to similarly aged children from the UK. Maximal running speed is a performance variable and thought to reflect peak$\dot{V}O_2$ and running economy. Since peak$\dot{V}O_2$ is not different between the Hong Kong and UK students, it would seem that the Hong Kong students have poorer running economy. This could be simply a result of less access to running activities, and may also reflect low habitual physical activity patterns. This needs further exploration, however, from a coaching perspective distance covered when running or time taken to cover a certain distance may not be an appropriate method of monitoring training, particularly if norms from other populations are used. Heart rates corresponding to 75-80% maximum (200-205 bpm) are a much more appropriate monitoring device.

The use of an indoor rowing task is supported by these present data in identifying those more aerobically fit students, and may well prove to be a valuable tool in the identification of potential young rowers. Anthropometric variables are precarious since these students may be at differing stages in pubertal development, and therefore it would be easy to miss a child if he were yet to reach his peak height velocity.

Once a group of better performers has been identified, we recommend that laboratory testing of peak$\dot{V}O_2$ is essential.. Those interested students should then be involved in a training and coaching programme as soon as possible.

6.0 Recommendations

1. Further cross-sectional and longitudinal research should be conducted to generate a data base of peak$\dot{V}O_2$ norms for Hong Kong Chinese children and adolescents.

2. Development of talent identification programmes should concentrate on finding the most appropriate field performance measure, and upon peak$\dot{V}O_2$ rather than anthropometric variables.

3. The use of a 3 minute indoor rowing test is appropriate for adolescent boys and is a identifier of the more aerobically fit. This protocol may need some modification with adolescent girls, however, it still provides a godd identifier of the more aerobically fit girls.

4. Running speed norms from other countries are not appropriate for comparison with this population, heart rates should be used to monitor training.

5. The use of field estimates of peak$\dot{V}O_2$ may provide conflicting and confusing data and are not supported.

6. Differing anthropometric variables were related to distance traveled during the 3 minute indoor rowing task for boys and girls. However, only height can be recommended an identifier of potential rowers.

7. The following boys and girls were identified as youngsters with potential:

Name	School	Sex
Wong Lap Wah	Buddisht Kok Kwong	Male
Lorraine Lam	Buddisht Kok Kwong	Female
Chow Kin Ho	Buddisht Kok Kwong	Male
Tai Hoi Yan	Tsang Pik Shan	Female
Law Wing Fung	Pui Ying College	Male
Chan Ka Kin	Pui Ying College	Male
Cheung Ka Wo	Kwok Tak Seng	Male
Ho Shun Shing	Kwok Tak Seng	Male

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