METABOLIC DEMAND OF HONG KONG NATIONAL TEAM FLATWATER KAYAK ATHLETES

BY

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We hereby recommend that the Honours Project by Mr. Chui Ngo Yin entitled “Metabolic demand of Hong Kong national team flatwater kayak athletes” be accepted in partial fulfillment of the requirement for the Bachelor of Art Honours Degree in Physical Education and Recreation Management.

Dr. Louie Hung Tak
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Declaration

I hereby declare that this honours projects “Metabolic demand of Hong Kong national team flatwater kayak athletes” represents my own work and had not been previously submitted to this or other institution for a degree, diploma or other qualification. Citations from the other authors were listed in the references.

__________________________
Chui Ngo Yin

30th April, 2013
ACKNOELEDGEMENTS

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______________________________________________

Chui Ngo Yin

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Date: __________________________
ABSTRACT

Metabolic demand is one of the major contributing factors on athletes’ performance in many sports. However, the metabolic profiles amount Hong Kong athletes were seldom reported. In this study, the metabolic demand of Hong Kong national team kayak athletes was examined. Ten male Hong Kong team kayakers were participated in the study (age, 21.6±5.78; height, 174.7±7.25; weight, 71.1±11.22). The maximal oxygen uptake (VO$_{2\text{max}}$) of individuals was test measured during a Maximum Incremental Treadmill Running Test. The group mean of VO$_{2\text{max}}$ was 49.16±6.99 ml. kg$^{-1}$.min$^{-1}$. The VO$_{2\text{max}}$ during kayaking of individuals was tested during a 7X4 Min Incremental test. The group mean of the VO$_{2\text{max}}$ during kayaking was 4.15±0.72 L. sec$^{-1}$. In this study, the FVC test was chosen to assess individuals’ pulmonary ventilation. The group mean of FVC test was 4.71±0.6L, which is having a group mean of 104±15.12% of the predicted value. It suggests that all subjects were in a healthy condition for their training and competition. This study further found that the correlation between VO$_{2\text{max}}$ on treadmill and kayak egrometer was not significant($r=0.462$, $p<0.05$). This finding suggests that, the VO$_{2\text{max}}$ obtained on the treadmill is not a valid predictor for the VO$_{2\text{max}}$ on the kayak egrometer as well as the performance of kayaking. The VO$_{2\text{max}}$ and the aerobic power is an important element contributing to the performance, however the athletes should also work on the muscle endurance, muscular strength as well as increase their training intensity and frequency.
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CHAPTER 1
INTRODUCTION

According to the International Canoe Federation, Kayak is categorized as one of the canoe sprint events ("International canoe federation,""). It is a racing event where athletes use a double-bladed paddle while sitting. It was a demonstration sport at the 1924 Olympic Games and become a full-medal sport in 1936. (Kearney and McKenzie, 2000)

In order to understand an individual’s metabolic demand, cardiorespiratory fitness should be put into consideration. Cardiovascular fitness appears to be an important component to our health. A longitudinal study shows that there is a strong and inverse relationship between the level of aerobic or cardiorespiratory fitness and the mortality rate from heart disease. (Blair, Kohl & Paffenbarger, 1989) In other words, an individual who has a higher level of aerobic or cardiorespiratory fitness will obtain a lower mortality rate of heart disease. In addition, cardiovascular endurance is remarkably vital to athletes. Hoffman and Collingwood (1995) point out that, apart from benefiting to athletes’ health, it affects their performance significantly. It is especially essential for performing activities that required continuous effort.

On the other hand, pulmonary ventilation is also an indispensable factor. In an exercise physiology book, Powers & Howley, 2012, suggested that the testing of components of pulmonary ventilation can reflect an individual’s pulmonary disease. Therefore, a normal pulmonary functionality facilitates a healthy metabolic system. It can provide athletes an effective cardiorespiritory system to support their training and
competition. Components of pulmonary ventilations are vital capacity, residual volume and total lung capacity.

Maximal oxygen uptake (VO2 max) is an indicator of people’s aerobic power. It can show the functional capacity and is often considered as the benchmark indicator of cardiorespiratory fitness. (Loftin, Sothern, Warren and Udall, 2004) Moreover, the research suggests that it can be used to prescribe endurance exercise and monitor physical training adaptations.

Kayak races performance is having a strong relationship with aerobic power. Researchers point out that both 500m and 1000m K1 events are aerobic in nature. (Bullock, Woolford, Peeling & Bonetti, 2000) Even in the 200m K1 events, performance is highly affected by athletes’ aerobic power.

**STATEMENT OF PROBLEM**

The purpose of this study is to examine the metabolic demand of Hong Kong national team flatwater kayak athletes during exercise.

**HYPOTHESIS**

The following hypothesis were tested in this study:

Research Hypothesis
1. There will be a significant positive correlation between the VO$_{2max}$ result obtained on the treadmill and that of the kayak ergometer among Hong Kong national team kayak athletes.

2. The correlation between the FVC of the subjects and their VO$_{2max}$ on treadmill will be not significant.

3. The correlation between the FVC of the subjects and their VO$_{2max}$ on kayak ergometer will be not significant.

**Null Hypothesis**

1. The correlation between the VO$_{2max}$ result obtained on the treadmill and that of the kayak ergometer among Hong Kong national team kayak athletes was not significant.

2. There was a significant correlation between the FVC of the subjects and their VO$_{2max}$ on treadmill.

3. There was a significant correlation between the FVC of the subjects and their VO$_{2max}$ on kayak ergometer.

**DEFINITION OF TERMS**

The following terms were defined operationally:

**Hong Kong Kayak Athletes**

The athletes who are representing Hong Kong in international kayak race events.

**Elite Kayak athletes**

Athletes who can go to the final in the Olympic Game in kayak race events.
Percentage of VO_{2\text{max}} during kayaking

The comparison between athletes’ VO_{2\text{max}} measured on the treadmill and the VO_{2\text{peak}} measured on the kayak ergometer.

DELIMITATION

The following delimitations were included as part of the study:

1. The subjects of the study were including all Hong Kong kayak team athletes.
2. Total of 10 subjects were involved in this study.
3. The direct laboratory assessment for aerobic capacity was delimited by the Maximum Incremental Treadmill Running Test.
4. The Maximum Incremental Treadmill Running Test was carried at the Dr. Stephen Hui Research Center for Physical Recreation and Wellness in the Hong Kong Baptist University.
5. The 7 X 4 Min Incremental Test was carried at the Dr. Stephen Hui Research Center for Physical Recreation and Wellness in the Hong Kong Baptist University.
6. The FVC test was carried at the Dr. Stephen Hui Research Center for Physical Recreation and Wellness in the Hong Kong Baptist University.
7. The Maximum Incremental Treadmill Running Test and the 7 X 4 Min Incremental Test were tested on separate days within two weeks.
8. The 7 X 4 Min Incremental Test and the FVC test were tested on the same day.
LIMITATION:

The following limitations were included as part of the study:

1. The performance of the subjects might be affected by their daily life, training date and physical activity level.
2. The performance of the subjects might vary because of their focused training target.
3. The motivation and the effort of the subjects in performing the Maximum Incremental Treadmill Running Test, the 7 X 4 Min Incremental Test and the FVC test were not controllable which might affect their performance and the result of the study.
4. The findings in this study are only applicable to the subjects involved in this study.

SIGNIFICANCE OF THE STUDY

Metabolic demand is a major factor affecting exercise performance. Both pulmonary function and aerobic power are components of metabolic demand. In order to ensure athletes are in a healthy condition in terms of their respiratory system, FVC is vital information to predict this health status. On the other hand, performance in all events in flatwater kayak races are highly relay on the athletes’ aerobic power. (Bullock, Woolford, Peeling & Bonetti, 2000) However, due to one of the training principles--- specificity, training is one of the major factors that influencing the performance. (Hoffman and Collingwood, 1995) In other words, an athlete who has a relatively high VO$_2$ peak measured during running does not guarantee a relatively high VO$_2$ peak measure during kayaking. Therefore, measuring athletes’ VO$_2$peak 7 X 4 Min Incremental Test appears to be a comparatively precise measurement. It is because
their VO$_{2peak}$ are measured in an environment that closes to the real game situation. Athletes are using the same muscle groups during the test that they use in kayaking. As a result, data obtained from this study can accurately reflecting the aerobic power of the athletes. Also, it can provide reliable scientific data for their coach to set up the training goals. It could facilitate the development and improvement of the Hong Kong Kayak team.
CHAPTER 2

REVIEW OF LITERATURE

A strong aerobic power and pulmonary ventilation is a very important factor for kayak athletes in order to ensure their performance. As mentioned before, kayak race events are aerobic in nature. Therefore, a high cardiovascular endurance is required to contribute in sustaining their power output during the race. In addition, healthy pulmonary ventilation is an important factor to ensure athletes can fully utilize and further develop their aerobic power. The present study was aimed as examining the metabolic demand of Hong Kong national team flatwater kayak athletes during exercise. The review of literature for the present study focused on eight aspects: (a) Background of VO$_{2\text{max}}$ and VO$_{2\text{peak}}$; (b) factors affecting VO$_{2\text{max}}$; (c) test assessing VO$_{2\text{max}}$; (d) Background of pulmonary ventilation; (e) flat water kayaking; (f) metabolic demand in flat water kayaking; (g) VO$_{2\text{peak}}$ in flat water kayaking and (h) summary.

Background of VO$_{2\text{max}}$ and VO$_{2\text{peak}}$

Maximum Oxygen Uptake (VO$_{2\text{max}}$) was defined as a reproducible measure of the capacity of the cardiovascular system to deliver oxygenated blood to a large muscle mass involved in dynamic work (Power & Howley, 2012). Power and Howley also suggested that VO$_{2\text{max}}$ is the maximal capacity to transport and utilize oxygen during exercise. Therefore, VO$_{2\text{max}}$ or VO$_{2\text{peak}}$ is considered by many exercise scientists to be the most valid measurement of cardiovascular fitness. It is commonly used in studies that aim at measuring the aerobic power difference of individual or groups of athletes (Cooke, 2001).
VO$_{2\text{max}}$ can be expressed in both absolute value and relative value. Hoeger and Hoeger (2005) suggested that:

“This value can be expressed in liter per minute (L/min) or milliliter per minute (ml/kg/min). The relative value in ml/kg/min is used most often because it considers total body mass (weight) in kilograms. When comparing two individuals with the same absolute value, the one with the lesser body mass will have a higher relative value, indicating that more oxygen is available to each kilogram (2.2 pounds) of body weight. Because all tissues and organs of the body need oxygen to function, higher oxygen consumption indicates a more efficient cardiorespiratory system.

For individuals concerned about weight management, oxygen uptake expressed in L/min is valuable in determining the caloric expenditure of physical activity. The human body burns about 5 calories for each liter of oxygen consumed. During aerobic exercise the average person trains between 60 and 75 percent of maximal oxygen uptake” (p.151)

Furthermore, Power & Howley (2012) pointed out that VO$_{2\text{max}}$ was important to prolonged exercise. They found that VO$_{2\text{max}}$ could be trained up by dynamic exercise using a large muscle mass such as running, cycling and swimming. The training should be 20-60 minutes each session, three to five times a week at 50%-85% of the individual’s VO$_{2\text{max}}$.

**Factors Affecting VO$_{2\text{max}}$**

As mentioned above, VO$_{2\text{max}}$ is the best data to reflect an individual’s ability to sustain exercise in a prolonged period of time. However, there are several factors
affecting people’s aerobic performance as well as the VO$_{2\text{max}}$. Those factors are heredity, training state, gender, body composition and age (Mcardle, F. I. Katch, & V. L. Katch, 2006)

**Heredity.** Mcardle et al. (2006) stated that, although there is not enough evident proving how much can heredity affect VO$_{2\text{max}}$, researchers have focused on how genetic variability account for differences among individuals in physiologic and metabolic capacity. There were a longitudinal research on 15 pairs of identical twins and 15 pairs of fraternal twins. The research concluded that heredity alone accounted for up to 93% of the observed differences in VO$_{2\text{max}}$. Both identical twins and fraternal twins indicate a significant but small effect on aerobic capacity and endurance performance.

**Training State.** The individual’s training state must be considered at the moment of measuring the VO$_{2\text{max}}$ (Mcardle et al, 2006). A 15%-20% improvement in VO$_{2\text{max}}$ can be obtained after a 2-3 month training (Powers & Howley, 2012). It is because endurance exercise can increase the stroke volume, arteriovenous O2 difference, change in muscle fiber type, increase the supply of capillary to skeletal muscle, increase mitochondrial content in skeletal muscle, improve biochemical adaptations, increase plasma glucose concentration, improves muscle antioxidant capacity as well as improve acid-base balance during exercise. All the effects help individuals improving their aerobic power after endurance training. Therefore it increases their VO$_{2\text{max}}$. 
**Gender.** Mcardle et al. (2006) suggested that, VO$_{2\text{max}}$ of women generally are 15% to 30% lower than men in average. In well-trained athletes, female athletes’ VO$_{2\text{max}}$ are still 10% to 20% lower than male. The main reason is that males appear to have less fat and larger muscle mass comparatively in terms of body composition. Another possible reason is that male own 10%-14% greater concentration of hemoglobin than female. It provides a better oxygen-carrying environment for male. Hence, gender becomes a significant factor affecting VO$_{2\text{max}}$.

**Body Composition.** Mcardle et al. (2006) stated that, body mass can influence VO$_{2\text{max}}$ up to 70% in L.min$^{-1}$. Therefore, relative value is commonly used when expressing oxygen uptake. Moreover, as mentioned before, individual who has denser muscle mass and less fat could obtain a relatively higher VO$_{2\text{max}}$.

**Age.** Change in VO$_{2\text{max}}$ is correlated to change in chronological age (Mcardle et al, 2006). Cooke (2001) also found out that a research on 1700 men and women shows that, VO$_{2\text{max}}$ among children shows a steady increase. After that, there is a peak value obtained around 18-20 years old. Finally, VO$_{2\text{max}}$ decrease steadily as age increase.

**Test assessing VO$_{2\text{max}}$**

VO$_{2\text{max}}$ can be assessed by both laboratory test and field test. Generally, laboratory tests are considered to be more precise while field tests are less expensive and less time consuming.

**Laboratory test.** Test can be done either in maximal or sub-maximal level (Coulson & Archer, 2009). Treadmill, cycling ergometer, rowing and kayak ergometer are
commonly used in laboratory test. However, a research shows that the majority of people obtain a higher VO$_{2\text{max}}$ on treadmill than other ergometers (Harrison, Brown & Cochrane, 1980). For instance, the research shows that there is a 20% VO$_{2\text{max}}$ lower obtained on the bicycle than the treadmill.

Incremental tests are usually used in maximal test. It increases the intensity of the exercises to the subject until it reaches the maximum effort of the subject. The VO$_{2\text{max}}$ is then obtained at that time (Cooke, 2001).

Since maximal test is time consuming, sub-maximal tests are developed. Those treadmill and ergometers can be capable in those tests (Cooke, 2001). These tests are mainly using the relationship between heart rate and work rate to predict the VO$_{2\text{max}}$. Although error would be increased by using sub-maximal tests, they are less costly and time consuming.

**Field test.** Apart from the expensiveness and time-consuming, laboratory tests are not practical enough. Therefore, field test is developed to compensate this deficiency. Cooke (2001) states that:

“Submaximal filed test is base on measuring the heart rate response to a quantitative form of external work for which the mechanical efficiency is know. Thus, the oxygen uptake elicited by the external work can be estimated.” (p.167)

Cooke also suggested that the Astrand-Ryhming (1954) nomogram is the most widely used submaximal field test. In addition, Castagna, Impellizzeri, Chamari, Carломagno and Rampinini (2006) point out that, the 20-m shuttle run test, the multi-stage fitness test and the yo-yo endurance test were the most popular field tests for testing aerobic power.
Background of Pulmonary Ventilation

Pulmonary ventilation is defined as the amount of gas moved into and out of the lung. (Powers & Howley, 2012) It is important to human since it is regulated to provide the gaseous exchange necessary for aerobic energy metabolism. (Eston, 2001) There are several factors that affecting the pulmonary ventilation which are body size, age and sex. Therefore, every individual would have their own predicted value of pulmonary ventilation data. A basic measurement of pulmonary ventilation is forced vital capacity (FVC). It can measure an individual’s vital capacity which means the total volume that an individual can breathe in and out. A book focus on pulmonary disease mention that an individual who has a vital capacity that is lower than his or her 80% of the predicted value would classified as restrictive lung diseases (Bellamy & Booker, 2004). Furthermore, an exercise physiology book focusing on exercise performance reflects that, FVC only cause a small relationship with exercise performance. (Mcardle, 2007)

Flat-Water Kayaking

In the early history, kayak are used for transportation, finish and hunting (Jacob & Kenneth). As mentioned before, Kayak is classified as one of the canoe sports. According to Kearney & McKenzie (2000), the American Canoe Association, including Canada as one division, was founded in 1880. It started to become popular among the Europeans in the 1920s. It became a demonstration sport at the 1924 Olympic Games. It becomes a full-medal sport in 1936. There were 500m and 1000m races in the past. Recently, the 500m race is replaced by 200m race which is more enjoyable in the spectator side. Kayak events contain individual (K1), pair (K2) and four (K4).
**Metabolic Demand in Flat-Water Kayaking**

In kayaking, both 500m and 1000m events are aerobic in nature (Bullock, Woolford, Peeling & Bonetti, 2000). Even in the 200m event, it is significantly dependent by athletes’ aerobic power to 37%. In addition, an outstanding anaerobic power is also critical in 200m event.

**VO2 Peak in Flat-Water Kayaking**

In a research from Michael, Rooney and Smith (2008), world-class kayak athletes achieved a range of VO$_{2\text{peak}}$ from 53.8 ml.kg$^{-1}$.min$^{-1}$ to 58.5 ml.kg$^{-1}$.min$^{-1}$. The VO$_{2\text{peak}}$ was having 73% and 85% contribution towards 500m and 1000m events respectively.

**Summary**

Aerobic power plays a vital role in kayak races (Bullock, Woolford, Peeling & Bonetti, 2000). VO$_{2\text{max}}$ is the best indicator of aerobic power (Cooke, 2001). Therefore, measuring the VO$_{2\text{max}}$ for the athletes during kayaking is the most accurate way to predict their performance as well as help them in setting training goal. Laboratory test in maximal level is the most precise test measuring the athletes’ VO$_{2\text{max}}$. Apart from that, pulmonary ventilation is a vital factor supporting kayak athletes’ training and competitions (Bellamy & Booker, 2004). In addition, FVC is one of the comment ways to measure pulmonary ventilation. Therefore, this study was to examine the metabolic demand of Hong Kong national team flatwater kayak athletes during exercise.
Chapter 3

METHOD

The purpose of this study was to examine the metabolic demand of Hong Kong national team flatwater kayak athletes during exercise. This chapter was divided into the following parts: (a) subjects; (b) procedures; and (c) method of analysis.

Subject

Ten male Hong Kong National Team Kayak athletes age between 15-33 years old are involved in this study. They had to participate in the Maximum Incremental Treadmill Running Test, the 7 X 4 Min Incremental Test and the FVC test. Before the test, all participants were informed about the purpose, benefits and risks of the study. Written informed consent is also provided.

Procedures

Maximum Incremental Treadmill Running Test, the 7 X 4 Min Incremental Test and the FVC test were performed on the same athlete on separate days within two weeks. The Maximum Incremental Treadmill Running Test was conducted to all subjects first. It was conducted in the laboratory of Dr. Stephen Hui Research Center of Physical Recreation and Wellness. It was an air-conditioned laboratory that with a temperature at 22 degree and a relative humidity at 70%. After conducted the Maximum Incremental Treadmill Running Test to all subjects, the 7 X 4 Min Incremental Test and FVC test would be conducted. Both tests will be conducted in
the same laboratory under the same condition in the same day.

**Maximum Incremental Treadmill Running Test**

In the Maximum Incremental Treadmill Running Test, subjects were required to run on a treadmill. Therefore they were advised not to have a heavy meal 3 hours before the test. First of all, the body weight and height were measured. Their body weights were measured by the TANITA body composition analyzer (TBF410, Japan) and heights were measured by a wall-mounted stadiometer. The heart rate monitor (Sport Tester TM PE4000, Polar Electro, Finland) and the facemask for the test will be put on the subject after the stretching section. After that, the Maximum Incremental Treadmill Running Test will start. In this study, the Maximum Incremental Treadmill Running Test was following the Modified Astrand protocol. The protocol was progressive and incremental run to exhaustion on a motorized treadmill. It started with a 5-min warm-up section. It started with 0% gradient and at a speed elicited approximately 70% of the subject’s predicted maximum heart rate (220-age). After that, a 5 minutes stretching time was provided. The subject then had to run on the treadmill again in a workload of 5-8 mph and 0% gradient for 3min as the first section. After that, the treadmill gradient will increase by 2.5% every 2 minutes until the subject is exhausted. Thus, the VO2max is obtained. This study was following the criteria provided by The British Association of Sports and Exercise Sciences (BASES) (1997), in order to determine the acquisition of the VO2max, which are: (a) a plateau in the oxygen uptake-exercise intensity relationship, (b) a final respiratory exchange ratio of 1.15 or above, (c) a final heart rate of within 10 beat.min-1 of the predicted age-related maximum, (d) subjective fatigue and
volitional exhaustion and (e) a rating of perceived exertion (RPE) of 19 or 20 on the Borg 6 to 20 rating of perceived exertion scale (Cooper, Baker, Tong, Roberts & Hanford, 2005). Therefore, the RPE scale should be clearly explained to the subject before the test. Verbal encouragement was given during the test.

**The 7 X 4 Incremental Test**

In the 7 X 4 Incremental Test, subjects were required to perform kayaking exercises on a kayak ergometer. Therefore, they were advised not to have a heavy meal 3 hours before the test. First of all, the body weight and height were measured. Their body weights were measured by the TANITA body composition analyzer (TBF410, Japan) and heights were measured by a wall-mounted stadiometer. The heart rate monitor (Sport Tester TM PE4000, Polar Electro, Finland) and the facemask for the test will be put on the subject after the stretching section. After that, the 7 X 4 Incremental Test will start. This test involved 7 stages. According to Bullock et al. (2003), the first 6 stages are submaximal and should be performed at fixed intensities depending on the gender, age and performance ability of the athlete. All subjects in this study were considered as junior athletes. Thus, they will start at a 100W workload while the drag resistance of the kayak ergometer was set as 35. Each stage was last for 4 minutes and followed by a 60s rest. After that, a new stage start with a requirement of a 20W increases of workload. Subjects were instructed to perform at a maximum effort at the final (seventh) stage. However, if the criteria of the determination of acquisition of VO₂max provided by BASES appear in the earlier stages, the tester should stop the test and go straight to the maximal effort. The VO₂max was reported as the highest value attained over a period of one full minute or sum of the two highest consecutive 30s.
**FVC Test**

In the FVC test, the age, body weight and height of the subjects were measured and input to the computer. The predicted FVC value will be calculated. The subject will then need to put on a mask with a sensor connected to the computer. Therefore, their respiratory flow could be measured. After that, the test will start. The subjects were required to breathe following the tester’s instruction. They need to start with a few couples of normal breath. After that, the subjects would be informed to conduct a maximum inhalation slowly. The subjects then needed to carry out an exhalation by their maximum effort. The subjects should exhale all the air out as fast as possible for six second. Finally, the subjects would be informed to breathe in again with their maximum effort and the test will end. The same process would be repeated five times in order to eliminate the learning effect. The best score would be accepted as their FVC result.

**Method of Analysis**

Three sets of data obtained above were presented as mean, standard deviation, minimum and maximum. All data was analyzed by the Statistical Package for Social Science (SPSS). Pearson Product Moment Coefficient of Correlation (r) was used to examine the relationship between three sets of data. An alpha level of p<0.05 indicated statistical significance.
Chapter 4

ANALYSIS OF DATA

Result

Ten male Hong Kong national team kayak athletes were invited to participate in this study. Since one of them had injury on his right ankle, he did not participate in the Maximum Incremental Treadmill Running Test. Therefore, part of his data has been excluded. The purpose of the study was to examine the metabolic demand of the Hong Kong national team kayak athletes during exercise. All the participants engaged in three tests, which are the Maximum Incremental Treadmill Running Test, the 7 X 4 Min Incremental Test and the FVC Test. All participants finish the tests within two weeks.

The physical characteristics of the participants were presented in Table 1.

Table 1

Physical Characteristics of the participants (N=10)

<table>
<thead>
<tr>
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<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>±SD</th>
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<td>Age</td>
<td>15</td>
<td>33</td>
<td>21.6</td>
<td>5.78</td>
</tr>
<tr>
<td>Height (cm)</td>
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<td>186</td>
<td>174.7</td>
<td>7.25</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>53</td>
<td>85.3</td>
<td>71.1</td>
<td>11.22</td>
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The descriptive statistics of the Maximum Incremental Treadmill Running Test was shown in Table 2.

Table 2
Descriptive statistics of the Maximum Incremental Treadmill Running Test (N=9)

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
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<tr>
<td>$V_E$ at $VO_{2\text{max}}$</td>
<td>114.5</td>
<td>159.3</td>
<td>137.33</td>
<td>14.69</td>
</tr>
<tr>
<td>(L/min)</td>
<td></td>
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<td></td>
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</tr>
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<td>RR (bpm)</td>
<td>50</td>
<td>77</td>
<td>62.67</td>
<td>7.62</td>
</tr>
<tr>
<td>VT (L)</td>
<td>1.88</td>
<td>2.406</td>
<td>2.22</td>
<td>0.18</td>
</tr>
<tr>
<td>$VO_{2\text{max}}$</td>
<td>43.7</td>
<td>63.9</td>
<td>49.16</td>
<td>6.99</td>
</tr>
<tr>
<td>(ml/kg/min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$VO_{2\text{max}}$</td>
<td>3.9</td>
<td>5.35</td>
<td>4.496</td>
<td>0.47</td>
</tr>
<tr>
<td>(L/sec)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ at $VO_{2\text{max}}$</td>
<td>1</td>
<td>1.16</td>
<td>1.1</td>
<td>0.05</td>
</tr>
<tr>
<td>VEO$<em>2$ at $VO</em>{2\text{max}}$</td>
<td>32</td>
<td>41</td>
<td>36.44</td>
<td>2.70</td>
</tr>
</tbody>
</table>

$V_E$: pulmonary ventilation

RR: respiratory rate

VT: tidal volume

$VO_{2\text{max}}$: maximum oxygen uptake

RQ: respiratory ratio

VEO$_2$: ventilatory equivalent for oxygen consumption
The descriptive statistic of the 7 X 4 Min Incremental Test was shown in Table 3.

Table 3

Descriptive statistic of the 7 X 4 Min Incremental Test (N=10)

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_E$ at $VO_{2\text{max}}$ (L/min)</td>
<td>84.3</td>
<td>156.2</td>
<td>119.53</td>
<td>20.59</td>
</tr>
<tr>
<td>RR (bpm)</td>
<td>46</td>
<td>90</td>
<td>70.1</td>
<td>15.8</td>
</tr>
<tr>
<td>VT (L)</td>
<td>0.964</td>
<td>2.251</td>
<td>1.77</td>
<td>0.35</td>
</tr>
<tr>
<td>$VO_{2\text{max}}$ (ml/kg/min)</td>
<td>27.1</td>
<td>60.1</td>
<td>47.68</td>
<td>8.84</td>
</tr>
<tr>
<td>$VO_{2\text{max}}$ (L/sec)</td>
<td>2.86</td>
<td>5.58</td>
<td>4.15</td>
<td>0.72</td>
</tr>
<tr>
<td>RQ at $VO_{2\text{max}}$</td>
<td>0.93</td>
<td>1.1</td>
<td>0.98</td>
<td>0.05</td>
</tr>
<tr>
<td>VEO$<em>2$ at $VO</em>{2\text{max}}$</td>
<td>32</td>
<td>43</td>
<td>36.1</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Ve: pulmonary ventilation
RR: respiratory rate
VT: tidal volume
$VO_{2\text{max}}$: maximum oxygen uptake
RQ: respiratory ratio
VEO$_2$: ventilatory equivalent for oxygen consumption
The descriptive statistic of the Lung Capacity Test was shown in Table 4.

Table 4

Descriptive statistic of the Lung Capacity Test (N=10)

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (L)</td>
<td>4.08</td>
<td>6.15</td>
<td>4.71</td>
<td>0.60</td>
</tr>
<tr>
<td>%FVC</td>
<td>81</td>
<td>136</td>
<td>104</td>
<td>15.12</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>3.09</td>
<td>6.05</td>
<td>4.11</td>
<td>0.78</td>
</tr>
<tr>
<td>%FEV1</td>
<td>74</td>
<td>151</td>
<td>106</td>
<td>20.90</td>
</tr>
</tbody>
</table>

FVC: Forced Vital Capacity

%FVC: The percentage of the value of the Forced Vital Capacity of a subject compare with the norm

FEV1: Forced expiratory volume in one second

%FEV1: The percentage of the value of the Forced expiratory volume in one second compare with the norm
The descriptive statistic of the percentage different about the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test was shown in table 5.

Table 5  
Descriptive statistic of the percentage different about the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test (N=9)  

<table>
<thead>
<tr>
<th></th>
<th>Mean of the MITRT</th>
<th>Mean of the 7 X 4 MIT</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative value</td>
<td>49.68</td>
<td>47.68</td>
<td>97%</td>
</tr>
<tr>
<td>(ml/kg/min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute value</td>
<td>4.496</td>
<td>4.15</td>
<td>92.3%</td>
</tr>
<tr>
<td>(L/sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MITRT: Maximum Incremental Treadmill Running Test  
7 X 4 MIT: 7 X 4 Min Incremental Test  
Percentage: Mean of the MITRT/ Mean of the 7 X 4 MIT
Using the Pearson product-moment correlation coefficient, the finding showed that the correlation between the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test was not significant ($r=0.462$, $p<0.05$). Hence the null hypothesis that there was no significant correlation between the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test was accepted. Furthermore, the correlation between the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the result of the FVC was not significant ($r=0.039$, $p<0.05$). Hence the research hypothesis that there was no significant correlation between the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the result of the FVC is accepted. Last but not least, the correlation between the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test and the result of the FVC was not significant ($r=-0.211$, $p<0.05$). Hence, the research hypothesis that there was no significant correlation between the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test and the result of the FVC is accepted.

**Discussion**

The purpose of the study was to examine the metabolic demand of the Hong Kong national team kayak athletes during exercise. The following discussion will be divided into three parts: (a) The utilization of the aerobic power during kayaking amount Hong Kong national team kayak athletes, (b) The comparison of the data of VO$_{2\text{max}}$ between Hong Kong kayak national team athlete and the world class kayak athlete around the world, and (c) Factors affecting the result of the kayak competition.
The Utilization of the Aerobic Power during Kayaking Amount Hong Kong National Team Kayak Athletes

In the data obtained from the Hong Kong national team kayak athletes, the relationship between the Maximum Incremental Treadmill Running Test and the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test was not significant ($r= 0.462$, $p<0.05$). It reflected that the VO$_{2\text{max}}$ obtained on the treadmill is not a valid indicator to predict the result of VO$_{2\text{max}}$ on kayak ergometer as well as the real kayak performance among the subjects in this study. Although aerobic power appears to be a major factor influencing an individual’s kayak performance, there are other important factors that should not be ignored. Those factors will be discussed below which can explain the findings in this study and the difference of the performance between the elite kayakers and the subjects in this study. On the other hand, their VO$_{2\text{max}}$ results on the ergometer were over 90% of their VO$_{2\text{max}}$ result on the treadmill. It is a relatively high result. As mentioned before, the majority of people obtain a higher VO$_{2\text{max}}$ on treadmill than other ergometers (Harrison, Brown & Cochrane, 1980). Therefore, this result shows that most of the subjects could fully utilize their aerobic power during kayaking. Some of them even showed a higher result during the 7 X 4 Min Incremental test than the Maximum Incremental Treadmill Running Test. This finding can be explained by the following reasons. First, it is the skills specificity. Although research shows that people usually obtain a higher VO$_{2\text{max}}$ on treadmill, it may not happen on high-level athletes. For those kayak athletes, their skills level towards kayaking are high and muscles are familiar to the kayaking skills. Therefore, they can perform kayaking skills smoothly. Thus, a higher percentage of the aerobic power can be involved during kayaking amount the subjects. The second reason is the skill
nature. A research book suggested that the more active muscle involvement means the more oxygen use, hence a higher VO$_{2\text{max}}$. (Tucker & Dugas, 2009) In kayaking, arms, legs and trunk are involved during the exercise. According to those subjects, they needed to execute a high intensity of trunk rotation during kayaking which was not required on running. As a result, a high muscle involvement in kayaking than running obtained in this experiment. Thus, a similar result of VO$_{2\text{max}}$ obtained on both tests.

The third reason is the training program. According to the coach of those subjects, all of them started having running as part of their training for only half a year. Since they did not have a long training period on running compare with kayaking, it is not surprise to have a similar result of VO$_{2\text{max}}$ obtained on both tests although the result on the Maximum Incremental Treadmill Running Test should be higher theoretically. It is an excellent result reflecting that those subjects are having high skills level in order to support them to fully utilize their aerobic power. However, those subjects still could not get good results amount international competitions. The reason of this situation will be explained below.

On the other hand, when considering the FVC, all data obtained from the subjects were fallen into the normal range. Hence, all of them were in a healthy condition in terms of respiratory system.

**The Comparison of the Data of VO$_{2\text{max}}$ between Hong Kong Kayak National Team Athlete and the World-Class Kayak Athlete around the World**

According to a research of the metabolic demand about Chinese national team kayak player (尚文元、常芸丶劉愛杰丶張濤丶繆素, 2006), the descriptive statistic of the metabolic profile about Chinese national team kayak athletes was shown in table 6.
Table 6

Descriptive statistic of the metabolic profile about Chinese national team kayak athletes (N=6)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>VO$_{2\text{max}}$ (L/sec)</th>
<th>VO$_{2\text{max}}$ (ml/kg/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.2±2.86</td>
<td>188±1.55</td>
<td>86.1±4.25</td>
<td>5.30±0.37</td>
<td>60.8±1.43</td>
</tr>
</tbody>
</table>

VO$_{2\text{max}}$: maximum oxygen uptake

Compare with the Chinese kayak athletes, the mean of the VO$_{2\text{max}}$ on treadmill was much lower (China: 60.8±1.43, Hong Kong: 49.16±6.99). According to the comparison, there is almost 20% difference of the ability of the maximum oxygen uptake between Chinese national team kayak athletes and the subjects in this test. Therefore, although most of the subjects could utilize over 90% of their aerobic power during kayaking, their aerobic power was not high enough compare with the others.

A review article done by Michael, Rooney and Smith, 2008, reported several VO$_{2\text{max}}$ results obtained on the kayak ergometer done by different elite kayak athletes around the world. Those results were shown below in table 7.
Table 7
Descriptive statistic of the VO$_{2\text{max}}$ on kayak ergometer about different elite kayak athletes around the world

<table>
<thead>
<tr>
<th>Research author</th>
<th>Subjects (male)</th>
<th>Mean VO$_{2\text{max}}$ on kayak ergometer (L/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesch (1983)</td>
<td>6 elite kayakers</td>
<td>4.67</td>
</tr>
<tr>
<td>Hahn et al. (1988)</td>
<td>5 elite kayakers</td>
<td>4.62</td>
</tr>
<tr>
<td>Fry and Morton (1991)</td>
<td>38 well trained kayakers</td>
<td>4.78</td>
</tr>
<tr>
<td>This study</td>
<td>10 Hong Kong national team kayakers</td>
<td>4.15</td>
</tr>
</tbody>
</table>

As showed on table 7, there is a more than 10% different of the mean VO$_{2\text{max}}$ on kayak ergometer between the elite kayakers and the subjects in this study. As mentioned before, there is 73% and 85% aerobic contribution on the result of 500m kayaking events and 1000m kayaking events respectively. Therefore, a 10% difference in aerobic power may be appeared to be significant. It can explain the reason of the difference in performance between the Hong Kong national team kayak athletes and the elite athletes in the world.

**Factors Affecting the Result of the Kayak Competition**

When comparing the results between our subjects and those elite athletes, there are also great differences. For example, in 200m male K1 events, the world record now is 33.8s. In the Olympic, athletes who could get the medals in this events finished the race within 36s. However, amount the subjects in this study, the result of the best athlete in this event was 39s. This 10% more in time cost them could not go
to the Olympic. The different in other events are even greater. Apart from the
difference in aerobic power, there are also some reasons that affecting their results.

First of all, it is the muscle endurance. In this study, athletes needed to
participant in the 7 X 4 Min Incremental Test. Therefore, they need to exercise on the
kayak ergometer for seven stages. In each stage, the subjects should kayak ergometer
for four minutes in a particular intensity. The intensity keeps increasing by stage in a
given rate. Most of the subjects could not keep the intensity for four minutes starting
from the third stage. Their exercise intensity tended to drop at the third minutes.
Moreover, most of them ended the test at the third stage. There were only two
subjects that could finish the fourth stage. None of them could go to the fifth stage. It
may affect their performance especially on 1000m and longer events. This may cause
by they are having a lower lactate threshold (LT). According to a reference book, LT
means that an individual exercise with an increase of intensity to a point that lactic
acid start to accumulate in the blood more rapidly than it can be removed (Sharkey,
2002). Therefore individual who exercise in this intensity or above cannot sustain for
long. It also suggested that people who are having similar VO\textsubscript{2max} can have different
LT. Furthermore, LT appears to be more possible to train up than VO\textsubscript{2max} especially
for adults.

Another possibility is the training intensity and frequency. As most of the
subjects were part time athletes, they could only have training after work or after
school. They may be tired before training. Also the time available for them to receive
training was affected. As a result, the efficiency and effectiveness were affected.
Their fitness level and LT will then be lower than those full-time elite athletes which
influenced their performance and competition results.
Thirdly, it is the muscular strength. Under observation, during the 7 X 4 Min Incremental Test, some of the subjects wanted to try a higher stage before drop out. However, they could not work to that intensity for more than half a minutes. In this study, even half of the subjects were senior kayakers, but the junior level test was conducted. In other words, they were working on a lower level than they were expected during testing. However, they still could not reach the intensity in the end stages. It reflected that, apart from muscular endurance, subjects in this study are having a relatively low muscular strength compare with the western kayakers.

As those reasons above, there are several variables affecting the performance of kayaking for an individual. Although aerobic power is a major element contributing to a kayaker’s performance, it is suggested that people should not consider it as the only indicator reflecting the result. It can also explain that there was an insignificance of the correction between the results of VO2max of the Maximum Incremental Treadmill Running Test and the VO2max of the 7 X 4 Min Incremental Test in this study. It may cause by the difference of the skills level, physical fitness and training targets among those subjects. In addition, the FVC results in this study appear not to be one of the factors that should be considered in order to determine a kayaker’s ability. It is because the FVC showed insignificance between the two scores of the VO2max and those subjects’ performance.

As the discussion above, several recommendations on the future training for the subjects are suggested. Since most of the athletes were part-time athletes, it is not feasible for them to have a great increase in training frequency. Therefore, an increase of training intensity becomes an appropriate approach. It is suggested that the subject should work more on building muscle endurance and strength. Therefore, it can support them to have a higher intensity of training.
CHAPTER 5

SUMMARY AND CONCLUSION

Summary of Results

This study was designed to examine the metabolic demand of the Hong Kong national team kayak athletes during exercise. It also attempted to explain the reason about the difference about the performance between the Hong Kong national team kayak athletes and the elite kayakers around the world by comparing their difference of their aerobic power.

Ten male Hong Kong national team kayak athletes were invited to participate in this study. To measure their maximum oxygen uptake, the Maximum Incremental Treadmill Running Test and the 7 X 4 Min Incremental Test were conducted. Apart from that, to measure their dynamic pulmonary function, the FVC test was conducted. All tests were conducted at the laboratory of Dr. Stephen Hui Research Center of Physical Recreation and Wellness. All data collected was analyzed by the Statistical Package for Social Science (SPSS). Moreover, the Pearson Product Moment Coefficient of Correlation ($r$) was used with the 0.05 level of significance.

The results of this study were summarized as follows:

1. The correction between the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test was not significant ($r=0.462, p<0.05$)

2. The correction between the VO$_{2\text{max}}$ of the Maximum Incremental Treadmill Running Test and the result of the FVC was not significant ($r=0.039, p<0.05$)

3. The correction between the VO$_{2\text{max}}$ of the 7 X 4 Min Incremental Test and the result of the FVC was not significant ($r=-0.211, p<0.05$)
4. The maximum oxygen uptake on treadmill of Chinese national team kayak athletes was 19.14% higher than subjects in this study.

5. The mean VO$_{2\max}$ on kayak ergometer from the elite kayakers in different researches was 10% higher than the subjects in this study.

**Conclusion**

The finding showed that the relationship between the Maximum Incremental Treadmill Running Test and the VO$_{2\max}$ of the 7 X 4 Min Incremental Test was not significant ($r=0.462$, $p<0.05$). It reflected that the VO$_{2\max}$ obtained on the treadmill is not a valid indicator to predict the result of VO$_{2\max}$ on kayak ergometer as well as the real kayak performance among the subjects in this study. By comparing the VO$_{2\max}$ obtained on treadmill, the Chinese national team kayak athletes were 19.14% higher than subjects in this study. In addition, the mean VO$_{2\max}$ on kayak ergometer from the elite kayakers in different researches was 10% higher than the subjects in this study. Those comparisons provided the reason of a lower performance in Hong Kong national team kayak athletes. The study also suggested that, apart from the VO$_{2\max}$, the muscle endurance, training intensity and frequency and the muscular strength of the kayak athletes should put into consideration during training and predicting the performance. Those factors are believed to be part of the factors that influencing the performance.

**Recommendation for Further Study**

1. Similar study should be made in other similar sports for Hong Kong Team athletes such as rolling, windsurfing and dragon boat.

2. Lactate concentration should also be monitored during both incremental tests in order to find out the athletes’ LT.

3. The anaerobic power of the athletes should also be measured and compared.
REFERENCES


*International canoe fedreation*. (n.d.). Retrieved from


Dear Sir or Madam,

THE COMPARISON OF THE METABOLIC DEMANDS BETWEEN HONG KONG KAYAK ATHLETES AND WORLD-CLASS KAYAK ATHLETES DURING KAYAKING

I am Chui Ngo Yin, a year 3 student in the Hong Kong Baptist University majoring in Physical Education and Recreation Management, is now going to complete my Honour Project on the able mentioned topic.

A series of testing is set for collecting data including VO2max and the energy expenditure during tests of my project. The tests consist two parts: 1) The Maximum Incremental Treadmill Running Test and 2) The 7 X 4 Incremental Test. The time needed to complete these tests is about 1 hour each on discrete day. Please feel free to ask questions about the test. The procedures and protocols are shown below.

Should there be any queries or if you want to get a copy of this research report, please contact Chui Ngo Yin, telephone: 61358101.

Thank you.

Yours sincerely,

__________________
Chui Ngo Yin
Date: 5th March, 2013

I, _________________ understand my involvement of doing these tests is voluntary, and I have been told that my name will be kept confidential. I have the right to ask for the completed report.

__________________
Signature    Date
APPENDIX B

運動感覺測量表

6

7

非常輕鬆

8

非常輕鬆

9

非常輕鬆

10

尚算輕鬆

11

少許辛苦

12

辛苦

13

非常辛苦

14

非常辛苦

15

非常辛苦

16

非常辛苦

17

非常辛苦

18

非常辛苦

19

非常辛苦

20
APPENDIX C

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 to 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES NO

1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?

2. Do you feel pain in your chest when you do physical activity?

3. In the past month, have you had chest pain when you were not doing physical activity?

4. Do you lose your balance because of dizziness or do you ever lose consciousness?

5. Do you have a bone or joint problem (for example, back, knee, or hip) that could be made worse by a change in your physical activity?

6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

7. Do you know of any other reason why you should not do physical activity?

If you answered one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

• You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about kinds of activities you wish to participate in and follow his/her advice.

• Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

• Start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.

• Take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

Information on the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity and it is in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participated in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

“I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.”

NAME ____________________________

SIGNATURE ____________________________

DATE ____________________________

WITNESS ____________________________

Myth: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.
PAR-Q & YOU

Physical Activity Guide to Healthy Active Living

Physical activity improves health.

Every little bit counts. Even if you only manage a few minutes a day, you can make progress toward meeting the physical activity recommendations with these tips:

1. Start slowly.
2. Add minutes each week.
3. Choose activities you enjoy.
4. Make physical activity a part of your daily routine.

Get active your way—every day! For Life!

The following activities are shown to help improve your health:

• Walking
• Swimming
• Cycling
• Dancing
• Gardening
• Playing golf

You can do it—setting realistic goals is the key. Make physical activity a part of your daily routine.

Time needed depends on effort:

- Very Light Intensity
- Light Intensity
- Moderate Intensity
- Vigorous Intensity

Benefits of regular activity:

- Improved mood
- Reduced risk of chronic diseases
- Better sleep
- Increased energy

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FITNESS AND HEALTH PROFESSIONALS MAY BE INTERESTED IN THE INFORMATION BELOW:

The following exercise forms are available for doctors’ use by contacting the Canadian Society for Exercise Physiology (address below):

• The Physical Activity Readiness Medical Examination (PARmedic-X) — to be used by doctors with patients who answer YES to one or more questions on the PAR-Q.

• The Physical Activity Readiness Medical Examination for Pregnancy (PARmedic-X for Pregnancy) — to be used by doctors with pregnant patients who wish to become more active.

For more information, please contact the
Canadian Society for Exercise Physiology
202-185 Somerset Street West
Ottawa, ON K1P 0Z2
Tel. 1-877-451-3759 • Fax (613) 236-3585
Online: www.csep.ca

© Canadian Society for Exercise Physiology

The original PAR-Q was developed by the British Columbia Ministry of Health. It has been revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology chaired by Dr. K. Goodhill (2002).

En español. "El original PAR-Q fue desarrollado por la British Columbia Ministry of Health. Ha sido revisado por un Grupo de Asesoría de Expertos de la Canadian Society for Exercise Physiology, dirigido por Dr. K. Goodhill (2002)."
APPENDIX D

Dear Sir or Madam,

METABOLIC DEMAND OF HONG KONG NATIONAL TEAM FLATWATER KAYAK ATHLETES

I am Chui Ngo Yin, a year 3 student in the Hong Kong Baptist University majoring in Physical Education and Recreation Management, is now going to complete my Honour Project on the able mentioned topic.

A series of testing is set for collecting data including FVC, VO2max and the energy expenditure during tests of my project. The tests consist three parts: 1) The Maximum Incremental Treadmill Running Test, 2) The 7 X 4 Incremental Test and 3) FVC test. The time needed to complete these tests is about 1 hour each on discrete day. Please feel free to ask questions about the test. The procedures and protocols are shown below.

Should there be any queries or if you want to get a copy of this research report, please contact Chui Ngo Yin, telephone: 61358101.

Thank you.

Yours sincerely,

__________________
Chui Ngo Yin
Date: 5th March, 2013

__________________
I, ___________________ understand my involvement of doing these tests is voluntary, and I have been told that my name will be kept confidential. I have the right to ask for the completed report.

_____________ __________
Signature     Date
Procedures

Maximum Incremental Treadmill Running Test, the 7 X 4 Min Incremental Test and the FVC test were performed on the same athlete on separate days within two weeks. The Maximum Incremental Treadmill Running Test was conducted to all subjects first. It was conducted in the laboratory of Dr. Stephen Hui Research Center of Physical Recreation and Wellness. It was an air-conditioned laboratory that with a temperature at 22 degree and a relative humidity at 70%. After conducted the Maximum Incremental Treadmill Running Test to all subjects, the 7 X 4 Min Incremental Test and FVC test would be conducted. It will be conducted in the same laboratory under the same condition.

Maximum Incremental Treadmill Running Test

In the Maximum Incremental Treadmill Running Test, subjects were required to run on a treadmill. Therefore they were advised not to have a heavy meal 3 hours before the test. First of all, the body weight and height were measured. Their body weights were measured by the TANITA body composition analyzer (TBF410, Japan) and heights were measured by a wall-mounted stadiometer. The heart rate monitor (Sport Tester TM PE4000, Polar Electro, Finland) and the facemask for the test will be put on the subject after the stretching section. After that, the Maximum Incremental Treadmill Running Test will start. In this study, the Maximum Incremental Treadmill Running Test was following the Modified Astrand protocol. The protocol was progressive and incremental run to exhaustion on a motorized treadmill. It started with a 5-min warm-up section. It started with 0% gradient and at a speed elicited approximately 70% of the subject’s predicted maximum heart rate.
(220-age). After that, a 5 minutes stretching time was provided. After that, the subject had to run again on the treadmill again in a workload of 5-8 mph and 0% gradient for 3min as the first section. After that, the treadmill gradient will increase by 2.5% every 2 minutes until the subject is exhausted. Thus, the VO\textsubscript{2max} is obtained. This study was following the criteria provided by The British Association of Sports and Exercise Sciences (BASES) (1997), in order to determine the acquisition of the VO\textsubscript{2max}, which are: (a) a plateau in the oxygen uptake-exercise intensity relationship, (b) a final respiratory exchange ratio of 1.15 or above, (c) a final heart rate of within 10 beat.min\textsuperscript{-1} of the predicted age-related maximum, (d) subjective fatigue and volitional exhaustion and (e) a rating of perceived exertion (RPE) of 19 or 20 on the Borg 6 to 20 rating of perceived exertion scale (Cooper, Baker, Tong, Roberts & Hanford, 2005). Therefore, the RPE scale should be clearly explained to the subject before the test. Verbal encouragement was given during the test.

The 7 X 4 Incremental Test

In the 7 X 4 Incremental Test, subjects were required to perform kayaking exercises on a kayak ergometer. Therefore, they were advised not to have a heavy meal 3 hours before the test. First of all, the body weight and height were measured. Their body weights were measured by the TANITA body composition analyzer (TBF410, Japan) and heights were measured by a wall-mounted stadiometer. The heart rate monitor (Sport Tester TM PE4000, Polar Electro, Finland) and the facemask for the test will be put on the subject after the stretching section. After that, the 7 X 4 Incremental Test will start. This test involved 7 stages. According to Bullock et al. (2003), the first 6 stages are submaximal and should be performed at fixed intensities depending on the gender, age and performance ability of the athlete.
Therefore, subject in this study were considered as junior athletes. Thus, they will start at a 100W workload while the drag resistance of the kayak ergometer was set as 35. Each stage was last for 4 minutes and followed by a 60s rest. After that, a new stage start with a requirement of a 20W increases of workload. Subjects were instructed to perform at a maximum effort at the final (seventh) stage. However, if the criteria of the determination of acquisition of VO₂max provided by BASES appear in the earlier stages, the tester should stop the test and go straight to the maximal effort. The VO₂max was reported as the highest value attained over a period of one full minute or sum of the two highest consecutive 30s.

**FVC Test**

In the FVC test, the age, body weight and height of the subjects were measured and input to the computer. The predicted FVC value will be calculated. The subject will then need to put on a mask with a sensor connected to the computer. Therefore, their respiratory flow could be measured. After that, the test will start. The subjects were required to breathe following the tester’s instruction. They need to start with a few couples of normal breath. After that, the subjects would be informed to conduct a maximum inhalation slowly. After that, the subjects needed to carry out an exhalation by their maximum effort. The subjects should exhale all the air out as fast as possible for six second. Finally, the subjects would be informed to breathe in again with their maximum effort and the test will end. The same process would be repeated five times in order to eliminate the learning effect. The best score would be accepted as their FVC result.

**Method of Analysis**
Three sets of data obtained above were presented as mean, standard deviation, minimum and maximum. All data was analyzed by the Statistical Package for Social Science (SPSS). Pearson Product Moment Coefficient of Correlation (r) was used to examine the relationship between three sets of data. An alpha level of \( p<0.05 \) indicated statistical significance.