The PHYSICAL FITNESS PROFILE OF HONG KONG ELITE FEMALE SOCCER PLAYERS

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We hereby recommend that the Honors Project by Miss Sin Ho Yan entitled "The physical fitness profile of Hong Kong Elite Female Soccer players" be accepted in partial fulfillment of the requirements for the Bachelor of Arts Honors Degree in Physical Education and Recreation Management.

Dr. Tom Tong	Dr. Patrick La
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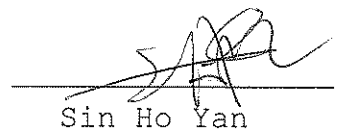

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ABSTRACT

From the pervious studies, most are the studies focus on the physical fitness profile on male soccer players who are originated from Western Europe and North America. Similar studies on female Hong Kong soccer players are definitely lacking or even none. Therefore, this study was designed to evaluate the physical fitness profiles of the elite female soccer players in Hong Kong. Eighteen players from the Hong Kong Hong Kong woman soccer team and Kwai Tsing Kappa Ladies Football Team, aged 16-32, were invited to participate in the study.

The following means and standard deviations were obtained: height 159.1±6.6cm; weight 52.0±6.6kg; shoulder width 29.6 ± 2.2cm; circumference of chest 80.5±3.6cm; waist 66.8±3.8cm; hip, 90.8±5.92cm; thigh50.5±4.6cm; calf, 35.4 ±1.8cm; percent body fat, 18.7 ±4.6%; leg strength 130.2 ± 27.5 kg, Hip flexibility: Hip flexion 91.9± 10.9degrees; Hip extension 39.5± 10.6 degrees; leg power (vertical jump) 45.03± 4.5 cm; FVC 3.28 ±0.27L; FEV_1 2.82 ±0.29L; VO2max 43.26±4.42ml/kg/min. The data were comparing to different female soccer or other

sports players from other countries, the Hong Kong elite female soccer players in a normal level of other sports athletes, in percent body fat, lower body muscular power and hip flexibility. However, they did a little poor on the cardiorespiration fitness. It was suggested to have more cardio training programs and also training include physical, technical and tactical to improve their overall performance.

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Chapter 1

INTRODUCTION

Soccer is one of the most widely played games in the world, certainly among males, and the women's game is also increasing in popularity.(Tumilty, 2000) A recorded number of girls and women are playing soccer worldwide. In the United States the number of female participants has risen from 7.5 million in 1998 to almost 9 million in 2002. (Hounsome, 2005) In Hong Kong, similar trend of women's soccer also happened. More and more females participated in soccer sport. In 1975, Hong Kong women's soccer team was first represented Hong Kong to the Asia Championship. They have been represented Hong Kong to compete in many national competitions for over 32 years until now.

In the past, many coaches may felt fitness played a minor role in soccer compared to skill, however, Tumilty (2000) claims that there is now no disagreement that soccer players need a wide range of fitness attributes to achieve success.

Although the number of female soccer players is increasing in recent years, research dealing with this trend is still lacking, especially in Asia. Studies of physiological characteristics of Hong Kong female soccer players are definitely very scarce. Therefore, in this study, we would like to evaluate the physical fitness profiles of Hong Kong elite female soccer players.

Statement of the Problem

Nowadays, most of the studies are focus on the profiles of physiological characteristic of male soccer players from Western Europe, North America and also Asia. From the previous study of Chin, Lo & So, (1992) and Aziz, Tan, Yeo & Teh (2005), the general sub-components, which are anthropometry, anaerobic power, aerobic fitness, flexibility and pulmonary functions, were investigated in the physiological profile studies of soccer players. Moreover, the differences of the anaerobic power between players, regardless of their

positions were also studied in English soccer athletes previously. (Davis,Brewer & Atkin, 1992) In Hong Kong, the physiological profiles of male soccer players, who would take part in the 2008 Beijing Olympic Games, have been evaluated in recent years as well.

However, there are not much similar studies designed for female soccer players exclusively. Tumilty(2000) pointed out that there is evidence indicated that the demands of the female game are similar to those of the men's game in terms of the stress placed on both the aerobic and the anaerobic energy system. The study of the physiological assessment is also important to female soccer players.

Purpose of study

The main purpose of this study is to evaluate the physical fitness profiles of Hong Kong elite female soccer players.

The physical fitness profile includes the characteristics of the players in Anthropometry, Body composition, Muscular fitness, and Cardiorespiratory Fitness.

Significance of Study

Based on the physical fitness characteristics of the elite female soccer players, an individual's strengths and weaknesses can be identified. According to Pyke, a testing program can provide coaches and athletes with a better understanding of the demands of the sport and the attributes that are required to be successful (2000). By knowing the physical fitness profile of the elite female soccer players, which provides scientific information to the coaches, they can have an enhanced training program and plan for their athletes regarding to the players' physiological characteristics, therefore can help to achieve a better performance and improvement in soccer.

Chapter 2

Review of literature

The present study was to determine physical fitness profiles of Hong Kong elite female soccer players. The review of literature for the present study focused on six aspects: (a) anthropometry, (b) body composition, (c) muscular fitness, (d) cardiorespiratory fitness, (e) gender difference in soccer and (f) a summary was included in the last section.

Anthropometry

Anthropometric measurement such as age, weight, height, body composition, limb circumferences measurements would be investigated in the study. Measurements should be selected according to the purposes of studies. (Malina, 1988).

Age

Reilly(1996) claimed that world top soccer players tend to have an average age of 25-27 years with a standard deviation of about 2 years. Moreover, in 1994, both Bangsbo and Reilly

discovered that the average age of goalkeepers seemed to be higher than other positions in the team. Goalkeepers generally aged 27.4 while players in other positions were 23 to 25 years old. Reilly (1994 & 1996) indicated that the age difference might be because goalkeepers had relatively lower possibility of chronic injuries and degenerative trauma.

Height

Reilly (1994 & 1996) and Bangsbo (1993) claimed there was no optimal height for a soccer player and it is not an indicator to assess the performance of players. However, they both agreed that height of the players would be helpful in deciding the playing position of the player. In the study of Bangsbo (1993), it showed that the mean height of male goalkeepers and central defenders was ranged from 188 to 190 cm, while full backs, midfield players and forwards was 178 to 179cm. Similarly, Tumilty (2000) also believed that goalkeeper is invariably the tallest player of the team, followed by the defenders, especially the center backs. Midfielders and

forwards tended to be smaller. In a study on the positional characteristics of physical performance in Division I college female soccer player, Vescovi, Brown and Murray (2006) stated that keepers and defenders are oftentimes taller and heavier compared to midfielders and forwards.

Body composition

Reilly and Secher (1990) addressed that body composition played an important role in fitness for a soccer player. Tumilty(2000) also stated that soccer is a collision sport that required significant muscle mass to produce power to accelerate, and to contest possession, so players should loss fat carefully to ensure that weight loss is mostly fat. Besides, Chin, So, Yuan, Li and Wong (1994) declared that low percent body fat would generate higher forces for jumping, kicking and tackling. The mean percent body fat for aged 18-34 years old male adults and female adults were 13% and 28% respectively (Heyward, 2002).Different playing positions might have

different mean percent body fat, in a study of Franks et al. in 2002, in which goalkeepers had the highest values in both the mean percent body fat and body weight among different playing positions. Bangsbo (1993) also recorded goalkeeper weighed heaviest.

Muscular fitness

Leg power

Studies usually indicated that soccer players of both sexes have only moderate vertical jump heights in comparison with other group of athletes (Tumilty, 2000). However, in recent study, vertical jump height was shown to be significantly related to short sprint performance in well-trained elite soccer players. (Chamari,K., Chaouachi,A., Hambli,M., Kaouech,F., Wisloff,U. & Castagna,C. 2008). Hugg(1994) also indicated that players who were successful in being selected for a variety of Australian squads attained better vertical jump scores than unsuccessful players. Besides, in the study

of the 5-jump test as a field test to assess lower limb explosive power, the result indicated that the 5JT would be an appropriated field test for measuring stride power in soccer players. (Chamari, et al. 2008) Thus, it is valuable to use the vertical jump test to test the lower limb horizontal explosive power of soccer players as a performance variable. Moreover, for the position characteristic in female soccer, it has also been reported that vertical jumping ability is greater in forwards and defensemen compared to midfielders, which may be the result of these positions are being involved in more frequent bursts of acceleration. (Vescovi, Brown & Murray, 2006)

Flexibility

Flexibility was important to protect soccer players against injury (Reilly & Howe, 1996). The statistical results from Rahnama and Manning (2005) supported that flexibility exercises reduced the chance of injury. Both Ekstrand (1982)

and Chin, Lo, Li and So (1992) had similar findings, they found that soccer players in general are less flexible than non-athletes with the exception of goalkeepers. The poor flexibility of soccer players indicated tight hamstrings, which may be due to the design of soccer training, and also the need for specific stretching to increase the range of motion in order to reduce the incidence of soccer injuries. (Chin, Lo, Li and So, 1992) Ekblom (2005) found that stretching after a training session could increase the flexibility on the next day. Thus, flexibility could not be neglected to soccer players and to reduce injuries.

Cardiorespiratory fitness

Cardiorespiratory fitness was a measure of maximum aerobic performance (Jones & Helms, 1993) .Besides, Heyward (2006) stated that direct VO2 max measurement was the most valid measure of functional capacity of the cardiorespiratory system. He also pointed out that “The VO2 max, or rate of oxygen

uptake during maximal aerobic exercise, reflects the capacity of the heart, lungs, and blood to transport oxygen to the working muscles and the utilization of oxygen by the muscles during exercise.” (Heyward, 2006)

Good cardiorespiratory fitness is important to support soccer players to play as long as possible in the game as a football match is officially lasted for 90 minutes. In 1991, Bangsbo, Nooregard and Thorsoe indicated that soccer involved intermittent anaerobic bursts throughout the game, but about 90% of activities were aerobic in nature.

Bangsbo (1994) implied that the average Vo2 max for elite female soccer athletes ranged bwtween 47 to 58 $ml/kg^{-1}/min^{-1}$. From a study to assess the effect of training in maximum oxygen consumption of college female soccer players, division I of the NCAA, USA (Ricardo, 2000), players had a mean VO2 max relative to 49.64±5.26$ml/kg^{-1}/min^{-1}$.

Yo-Yo Intermittent Recovery test

The Yo-Yo Intermittent Recovery Test was one of the Yo-Yo tests which proposed by Bangsbo (Bangsbo, 1996). It was an important tool in determining the individual's fitness level. It focused on the ability to recovery after intense exercise. The individual kept shuttle running for and back between the 20 meters markers at given speeds, controlled by a cassette tape. The test lasted for between 5 and 20 minutes, there was a 10 seconds pause between each exercise period (5-15 seconds). "The Yo-Yo Intermittent recovery test is particularly suitable for sports in which the ability to perform intensive exercise after short recovery periods can be decisive for the outcome of a competition such as badminton, soccer and basketball. The last speed and the number of performed 20 meters distances at this speed are recorded."(Bangsbo, 1996).

Gender difference in soccer players

Nowadays, with changing attitudes and ever growing media

coverage of women's sports on television, women are encouraged to participate in athletic competition, and consequently many of the differences in athletic accomplishments between males and females are fading away (Hounsome, 2005). In other words, physiological difference between males and females would be one of the factors that affect the performance in soccer.

According to Reilly (2003), the relative intensity of exercise of elite female soccer player was at an average about 70% of $\dot{V}O_{2\,max}$, which was similar to male player. However, when comparing the overall energy expenditure between females and males, males with 60 kg, was about 4600 KJ and the females who weight 75 kg, was about 5700 KJ (Ekblom and Williams, 1994). Besides, in the study of Miles, MacLaren, Reilly, & Yamanaka, it reported that the variables of heart rate and distances covered, female players exceeded 85% of maximal heart rates for 60 minutes, two-third of the games but overall covered less distance than do the male players. (2003)

Summary

From the literature review above, we understand that there are many physiological characteristics concurrently determined the success in soccer. Anthropometry, body composition, muscular fitness and cardiorespiratory fitness are the four main physical fitness components to be assessed on the elite female soccer players. At least, different physiological characteristics between males and females contributed to difference performance in soccer.

Chapter 3

Research design

Subjects

Eighteen elite female soccer players, aged 16-32, were invited to participate in the study. They are the top female soccer players in Hong Kong who represent the Hong Kong woman soccer team and Kwai Tsing Kappa Ladies Football Team to participate in both national and local female Grade-A competitions, and they were volunteered for the study. Participants were informed of the details such as the purpose and benefits of the study and they all provided written informed consent before the test.

Procedures

In this study, there were totally four physical fitness components assessed to the elite female soccer players. In each component, there were tests and measurements provided to the participants, the tests and measurements were simply

dividing into lab test and field tests. Measurement on anthropometry, body composition, muscular fitness and also maximum oxygen uptake (VO2 max) test were the lab testes while Yo-Yo intermittent Recovery Test was the field test. The lab tests and field tests were performed on separate days. The lab test was conducted in an air-conditioned laboratory of Dr. Stephen Hui Research Center of Physical Recreation and Wellness, with a temperature and relative humidity at around 22 degree and 70% respectively. For the lab test, body compositions measurements would be taken first, then the anthropometry of the subjects would be measurement, after that, vertical jump test, hip flexibility and then leg strength measurement would be performed. At last, pulmonary functions test and Vo2 max test would be taken.

On the other hand, The Yo-Yo Intermittent Recovery Test (field test) was conducted in an outdoor athlete track of the Joint Sports Centre which located in Baptist University.

Table 1. The Content of the physical fitness components

Anthropometry	Body composition	Muscular fitness	Cardiorespiratory fitness
Height and Weight (lab)	Percentage body Fat (lab)	Leg strength (lab)	Lung function (FVC and FEV1) (lab)
Shoulder width (lab)	Fat mass (lab)	Hip flexibility (lab)	Vo2max (lab)
Circumference measurements of chest, waist, hip, thigh and calf (lab)	Fat Free mass (lab)	Leg power test (vertical jump) (lab)	Yo-Yo Intermittent Recovery Test (field)

Anthropometry

Body height and weight

The body height of the soccer players was measured by a wall that mounted by a stadiometer(novel products inc. Rockton, lllinois), to the nearest 0.5 cm. Body weight was obtained by TANITA TBF410 BIA scale (TANITA Corp., Tokyo, Japan), to the nearest 0.1kg. All of the participants were

instructed to stand in an erect posture with eye looking front horizontally, heels should be hold together at the center of the horizontal platform. The weight of 0.3kg of the clothes was deducted from the body weight.

Shoulder width and circumference of chest, waist, thigh and calf

Shoulder Width

Subjects were required to stand in an upright position with tight clothes in the upper body, looking forward and arms placed by the sides. Anthropometer (LAFAYETTE Instrument company, Indiana) was used to measure the shoulder width of the subjects. The anthropometer was applied to the most lateral borders of the acromion processes. The width was read to the nearest 0.1cm (Wilmore et al., 1988).

Chest Circumference

Subjects stood upright with the feet at shoulder width. Chest Circumference was measured at the level of the fourth costosternal joints. The fourth costo-sternal joints were

located by a two-handed palpation method whereby the measurer placed both index fingers on the superior surfaces of the clavicles, while the thumbs located the first intercostals spaces. The index fingers then replaced the thumbs, which were lowered to the second intercostals spaces. This procedure was repeated until the fourth ribs were located. The fourth ribs and their costal cartilages were followed medially to their articulations with the sternum. The level of the fourth costo-sternal joints was marked. The measurement was made in horizontal plane. (Callaway et al., 1988).

Waist Circumference

Subjects were asked to stand upright and tape was placed around subjects' waist in horizontal plane at which was the narrowest part of the torso. (Callaway et al., 1988).

Hip Circumference

Subjects stood erect with arms at the side and feet together. The measurer stood at the side of the subject so that the level

of maximum extension of the hip could be seen. An inelastic tape was placed around the hip in a horizontal plane at this level without compressing the skin. The measurement was recorded to the nearest 0.1cm. (Callaway et al., 1988).

Thigh Circumference

It was measured at the same level of the thigh skinfold measurement, which was the midway between the midpoint of the inguinal crease and the proximal border of the patella. It was recorded to the nearest 0.1cm (Callaway et al., 1988).

Calf Circumference

Subjects were suggested to stand upright, and tape was placed horizontally around the calf and the circumference was obtained at the widest part. It was recorded to the nearest 0.1cm (Callaway et al., 1988).

Body composition

Percentage body fat measurement and Fat free mass

Both of the percentage body fat measurement and fat free

mass of the players were using the body composition analyzer device to measure. Subjects were required to stand in an upright position, looking forward and with feet on the footpad electrodes on the body composition analyzer device (TANITA TBF-410 ,TANITA Corp., Tokyo, Japan), followed with the instruction manuals. The mood of athletic female adult should be selected and the subject’s height and sex was entered. The weight of 0.3kg of the clothes was deducted from the body weight.

Muscular fitness

Leg strength

The back-leg dynamometer was used to measure the leg strength of the subject. The subject was instructing the purpose of the test. Then, the subject stood on the platform with the feet hold a comfortable distance apart for balance .After that, the subject was instructed to knees flexed to an angle of 130° to 140° .The players holds the hand

bar using pronated grip and positions it across the thighs by adjusting the length of the chain. Without using the back, the player slowly exerts as much force as possible while extending the knees. The maximum indicator needle remains at the peak force achieved. There would be three trials with a 1-min rest interval. Then, the maximum score would be recorded in kilograms. (Heyward, 2006)

Hip flexibility (Hip Flexion)

The hip flexibility was measured by using the universal goniometer. The goniometer measured the angle between two bone segments. When the maximal amplitude of a movement is reached, this maximal amplitude was then read and recorded. (Eston & Reilly, 1996) The subjects should perform 10 minutes stretching warm-up prior to the test. After that, subjects lay supine on a table. The goniometer was placed on the lateral midline of pelvis as the stationary arm, and then the moving arm should place on the lateral midline of femur. The landmarks

were the tip of the greater trochanter and the lateral femoral epicondyle. Knee was allowed to flex as rang of hip flexion completed. The goniometer was kept with the red scale left of the subject (the needle is then at zero degree at the start of the motion), in line with the longitudinal axis of the thigh oriented on both landmarks. Triple measurements were performed and the average of the two closest result as central value.

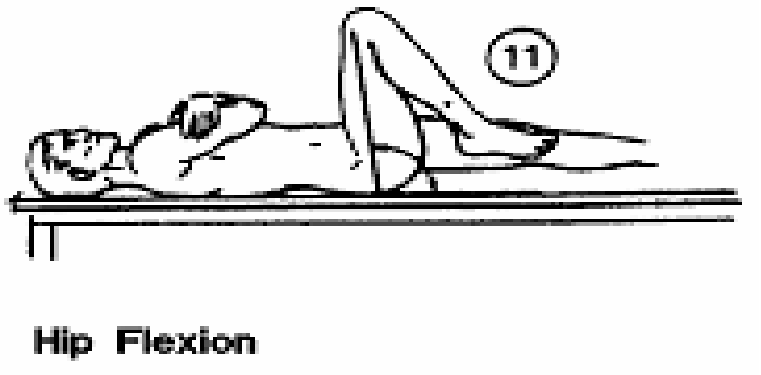

Figure 1. The angle measured of hip flexion

Hip flexibility (Hip Extension)

After measuring the hip flexion, the hip extension of the subjects was also measured by using the universal goniometer. Subjects lay prone on the table. The goniometer was placed

on the lateral midline of pelvis as the stationary arm, and then the moving arm placed on the lateral midline of femur. The landmarks were the tip of the greater trochanter and the lateral femoral condyle (Eston & Reilly, 1996). A maximal extension in the hip was performed while the opposite leg kept contact with the table by assistance of instructor. Knee was allowed to flex as rang of hip flexion completed. The goniometer was kept with the red scale left of the subject (the needle is then at zero degree at the start of the motion), in line with the longitudinal axis of the thigh oriented on both landmarks. Triple measurements were performed and the average of the two closest result as central value.

Vertical jump

The vertical jump ability of the players was measured by vertec, the most common apparatus for measuring vertical jump ability. The subjects should perform 10 minutes warm-up and stretching prior to testing, including a few vertical jumps

at one-half to three quarter effort, should be sufficient. The stretching exercises should include shoulder stretches because the arm reach requires a full range of motion. The subjects then stands with both feet together and flat on the ground and the dominant arm near the wall or the standard of the apparatus. The players then reach up as high as possible with the dominant arm so that the palm of hand is against the measurement scale and the point of reach is observed and recorded. This is called the standing reach. The subject will stand below the Vertec Device, without moving the feet, bends the knees, jumps as high as possible to displace the markers and attempt to touch or swat the vertec at the highest point of the jump. The jumping reach is indicated on the vectec by the highest displaced vane. The difference in distance between the standing reach height and the jump height is the score. Three jump trials are given with the best trial used. It was recorded in inches (in) to the closest 0.5 in, and then converts to centimeters to the closest 1cm. (Adams & Beam, 2008)

Cardiorespiratory fitness

Pulmonary function

FVC / FEV1%

Before the tests of FVC, FEV_1, the flow sensor calibration had to be done. O2 and CO2 analyzers of the metabolic cart were calibrated with standard gases (Gas 1: O2:25.89%, CO2:0%;Gas 2:O2:16.44%,C02:3.89%), and the flow-volume integration system was calibrated by applying standard volume (3L) of gas at various flow rates. (Tong, Fu, & Chow, 2001)

The mouthpiece and nose-clips were put on the subjects prior to the test. During the test, subjects inhaled as deeply as possible (maximal inspiration), and then forcefully exhales all the air from the lungs (maximal expiration) as quickly as possible. The players should be specifically told to concentrate on blowing as fast as possible for the first second and then to continue to exhale for as long as necessary to empty the lungs as much as possible. The procedure is typically done a minimum of three times in an attempt to get

three acceptable trials and to measure the highest value possible. The best result would be recorded. (Adams & Beam, 2008)

Maximum oxygen uptake (VO2max) test

The maximum oxygen uptake (VO2max) of each subject was measured directly by performing an incremental running test on a treadmill (h/p cosmos/ pulsar, Germany). All subjects were instructed and understand with the testing procedures before data collection. Before the test, warm-up exercise which included 5 minutes treadmill running at self-selected speed and followed by 10 minutes stretching exercises were given to the subjects. Then, the test started at 0% gradient and at a speed elicited approximately 70% of predicted maximum heart rate (220-age). As the test began, the treadmill gradient was increased by 2% every 2 minutes with constant speed until heart rate reached 180bpm or > 90% of predicted maximum value. The 2% gradient was then increased for every

minute until either the heart rate exceeded 180bpm or the respiratory exchange ratio (RER) > 1.15. Metabolic cart (Vmax 229d, SensorMedics, and U.S.A) was used to measure the metabolic data such as O2 uptake, CO2 output and RER were measured with a metabolic cart (2900, Sensor Medics, CA) breath-by-breath at 20-second sampling intervals. Each subject wear the facemask and mouthpiece breathed through the attached low-resistance valve connected to the mixing chamber of the metabolic cart during the test. O2 and CO2 analyzers of the metabolic cart were calibrated with standard gases and the flow sensor calibration was done before. Verbal encouragement was given to the subjects during the test. Exercise heart rate (HR) was recorded during the last five second of each stage using a heart rate monitors (Polar, Finland). (Tong, Fu, & Chow, 2001)

Yo-Yo Intermittent recovery Test

In the Yo-Yo Intermittent recovery Test, participants were given a detail instruction before the test in order to avoid

the learning effect. Prior the test, 5 minutes free running on ground at self-selected pace and then 10 minutes stretching warm-up exercise was needed. There were two levels in the Yo-Yo Intermittent test. In this study, Level 1 was used as it is the Yo-Yo Intermittent recovery Test. For the Level 1 test, the starting speed was 10 km/h. The test consisted of repeated 20 meters shuttle runs at progressively faster speeds by a tape-recorder. Each run separated by a 10-seconds active rest period. Two markers were placed 20 meters apart from each other, with a third marker placed 5 meters behind the side of the start marker. Seven lanes which were 2 meters apart to each other would be set up as seven participants were tested at the same time. The figure of the setting was as follow:

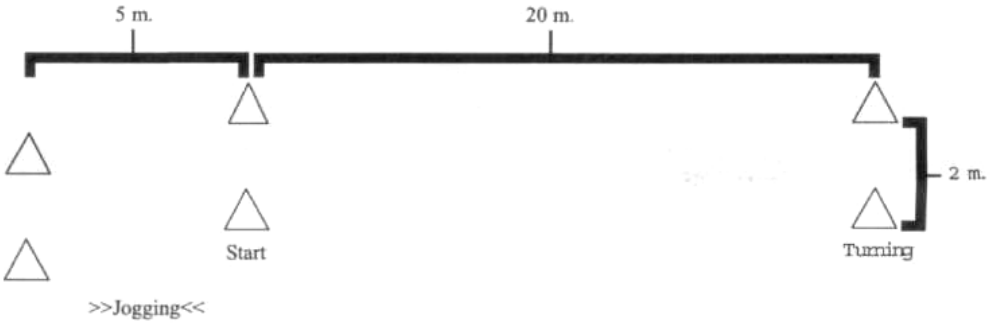

Figure 2. The setting of the Yo-Yo Intermittent Recovery Test

When the test started, the participants began to run forward 20 meters at the time of the first signal form the tape recording. Participants were expected to reach the marker exactly at the time of the next signal, which was the “beep” sounds from the tape. They supposed to jog to the third marker and jogged back to the start marker within the 10 seconds recovery period. At the start marker, participants stopped and waited for the signal for the start of the next shuttle. The speed was increased at intervals, and the time between the signals would be shortened. When the participants were unable to maintain the currently indicated speed, a warning would be given to the participant. If the participant still could not reach the marker at the time of the next signal, she had to stop, and the test was ended. The maximum performance of the Yo-Yo Intermittent Recovery Test is the maximal ability of the participants to continue the test. The last speed level and the number of repetitions were recorded on the test schemes. Participant's performance in the Yo-Yo test was defined as

the maximum distance covered (Bangsbo, 1996).

Definition of terms

The following terms were defined operationally:

Anthropometry

It is the measurement of body size and proportions. The measurements are body weight, height, circumferences, skinfold thickness and bony widths and lengths (Heyward, 2002).

Cardiorspiratory fitness

It represents the ability of the heart, blood vessels, blood, and respiratory system to supply fuel, especially oxygen, to the muscles and the ability of the muscle to utilize fuel to allow sustained exercise. (Corbin & Lindsey, 1990)

Body composition

Body composition is a component of physical fitness which refers to the absolute and relative amounts of muscle, bone and fat tissues composing body mass (Heyward, 2002).

Waist-to-Hip Ratio

The waist-to hip ratio (WHR) is as an indirect measure of lower-and upper-body fat distribution. (Heyward, 2006)

Muscular strength

It is defined as the ability of a muscle group to develop maximal contractile force against a resistance in a single contraction. (Heyward, 2006)

Vertical jump test

The vertical jump test was proposed to evaluate lower limb explosive power of athletes competing in various disciplines. (Chamari, et al. 2008)

Pulmonary Function

It refers to the effective ventilatory system that the body‘s needs for gas exchange. This system regulates the gaseous state of our “external” environment for aerating fluids of the “internal” environment during rest and exercise.

(McArdle, Katch. F.I., Katch V. L., 2006)

Forced vital capacity

It represents the total air volume moved in one breath from full inspiration to maximum expiration, or vice versa. (McArdle, Katch. F.I., Katch, V. L., 2006)

Force expiratory volume (FEV1)

It is the volume of gas expired in one second by a forced (maximal effort) expiration from a full inspiration (Powers et al., 2007).

Maximum Oxygen Uptake (VO2max)

Maximum Oxygen Uptake (VO_{2max}) is defined as the maximal amount of oxygen that can be consumed per minute during maximal exercise (Noble, 1986). The VO2 max, or rate of oxygen uptake during maximal aerobic exercise, reflects the capacity of the heart, lungs, and blood to transport oxygen to the working muscles and the utilization of oxygen by the muscles during

exercise. (Heyward, 2006)

Bioelectric Impedance Analysis (BIA)

BIA is a device used as determining body composition which included percentage body and fat free mass of the body. A specific amount of electrical current is transmitted through the body, and the device calculates the resistance (impedance) of the body. As fat is a poor conductor of electricity, so the resistance is directly related to the amount of fat in the body. The resistance is also related to the length (height) and cross-sectional area (weight) of the conductor (body). These data are required in predicting percentage body fat and fat free mass. (Anshel, Freedson, Hamill, Haywood,Horvat & Plowman 1991).

Delimitations

The followings are the delimitations included as part of the study:

1. The subjects of the study were delimited to the elite female soccer players from the Hong Kong woman soccer team and Kwai Tsing Kappa Ladies Football Team who participated in both national and local female grade-A competitions.
2. The subjects of the study were delimited to the female soccer team players aged between 16-32 years old.
3. There are totally 18 subjects were involved in this study.
4. The venue for the test was in the Dr. Stephen Hui Research Centre for Physical Recreation and Wellness located in Hong Kong Baptist University.
5. Each subjects had to finish all the lab tests and measurements within the same day, and the field test on another day, unless they were unable to take and finish the tests because of any illness or injury.

Limitations

The following limitations were included in the study:

1. The data of tests were collected in different dates and time.
2. The performance of the subjects might vary according to their different daily lifestyle, physical activity level and physical characteristics.
3. The study could not control other variables that might affect the VO_{2max} level of the athletes, such as recovery from sickness and injury.
4. The effort and motivation of the subjects in performing the maximum oxygen uptake test and the yo-yo intermittent recovery test were uncontrollable which might influence the results of the study.
5. Study findings were applicable only to the subjects included in this study.

Statistical analyses

The data collected in this study were entered to the “Statistic Package of Social Science 13.0 for windows” (SPSS 13.0) software. Means and standard deviations of each testing items were calculated.

Chapter 4
ANALYSIS OF DATA

This chapter was divided into two main sections, including the results and discussion. In each section, it was generally divided into four physical fitness aspects, they were (a) anthropometry, (b) body composition, (c) muscular fitness, (d) cardiorespiratory fitness.

Results

Eighteen female Hong Kong elite soccer players were invited to participate in the study. The purpose of the study was to evaluate the physical fitness profiles of Hong Kong elite female soccer players. All the participants engaged in several lab tests and the Yo-Yo Intermittent Recovery Test within about 3 weeks.

Anthropometry

The age of the subjects was ranged from 16 to 32 years old with a mean of 23 years old and a standard deviation of 4.4

years. The height of the subjects was ranged from 148.5 to 177 cm with a mean height of 159.2 cm and a standard deviation of 6.57 cm. The weight of the subjects was ranged from 39.7 to 65.6 kg with a mean weight of 52.1 kg and a standard deviation of 6.6 kg. The shoulder width of the subjects was ranged from 25 to 33 cm with a mean width of 29.7cm and a standard deviation of 2.2 cm. The chest circumference of the subjects was ranged from 73.5 to 88 cm with a mean of 80.6 cm and a standard deviation of 3.7 cm. The waist circumference of the subjects was ranged from 60.5 to 73 cm with a mean of 66.8 cm and a standard deviation of 3.8 cm. The hip circumference of the subjects was ranged from 83 to 102 cm with a mean of 90.9cm and a standard deviation of 5.9 cm. The thigh circumference of the subjects was ranged from 44 to 61 cm with a mean of 50.5 cm and a standard deviation of 4.6 cm. The calf circumference of the subjects was ranged from 32 to 40 cm with a mean of 35.5 cm and a standard deviation of 1.8 cm.

Table 2. *Physical Characteristics of* Hong Kong female elite soccer players *(N = 18)*

Variables	Minimum	Maximum	Mean	±SD
Age (yrs)	16	32	23.0	4.4
Height(cm)	148.5	177.0	159.1	6.6
Weight(kg)	39.7	65.6	52.1	6.6
Shoulder width (cm)	25.0	33.0	29.7	2.2
Circumference (cm)				
-Chest	73.5	88.0	80.6	3.6
-Waist	60.5	73.0	66.8	3.8
-Hip	83.0	102.0	90.9	5.9
-Thigh	44.0	61.0	50.5	4.6
-Calf	32.0	40.0	35.5	1.8

Body Composition

The mean and standard deviation of the subjects on the measurements of body composition by using the BIA device were presented in Table 3. The percent body fat of the subjects using BIA measurement was ranged from 13.6 to 27.4% .The mean and standard deviation of the percent body fat using BIA measurement were 18.7 and 4.6% respectively. The fat mass of

the subjects was ranged from 6.2 to 16.4 kg with a mean of 10.2 kg and a standard deviation of 3.3kg. The fat free mass of the subjects was ranged from 38.8 to 51.0 kg with a mean of 42.9 kg and a standard deviation of 3.7 kg.

Table 3. The body composition data of Hong Kong female elite soccer players *(N = 18)*

Variables	Minimum	Maximum	Mean	±SD
Body Fat (%)	13.6	27.4	18.7	4.6
Fat mass (kg)	6.2	16.4	10.2	3.3
Fat Free Mass(kg)	38.8	51.0	42.9	3.7

Muscular Fitness

The mean and standard deviation of the subjects in the measurements of leg strength, hip flexibility, which included hip flexion and hip extension, and leg power of the subjects were presented in Table 4. The mean and standard deviation

on leg strength were 130.2 kg and 27.5respectively. Besides, the range of hip flexibility on hip flexion was 78 to 113 degrees with mean 91.9 degrees and standard deviation was 10.9 degrees. For hip extension, the range was 19 to 56 degrees. The mean was 39.5 degrees and the standard deviation was 10.6 degrees. For the leg power test (vertical jump), the minimum jump height was 39.4 cm while the maximum was 55.9 cm. The mean was 45.0 cm and the standard deviation was 4.5 cm.

Table 4. The leg muscular strength of Hong Kong female elite soccer players *(N = 18)*

Variables	Minimum	Maximum	Mean	±SD
Leg Strength(kg)	80	190	130.2	27.5
Hip Flexion (degree)	78	113	91.9	10.9
Hip Extension (degree)	19	56	39.5	10.6
Vertical jump(cm)	39.37	55.88	45.0	4.5

Cardiorespiratory fitness

Pulmonary Functions

In the FVC test, the subjects performed 2.83 to 3.84L. The mean and standard deviation of the test was 3.28±0.27 L. In the FEV1 test, the minimum and maximum volumes measured were 2.49 L and 3.57 L respectively. Its mean was 2.84 L while the standard deviation was 0.29 L.

Table 5. Selected Pulmonary Function Measurements of Hong Kong elite female soccer players *(N = 18)*

Variables	Minimum	Maximum	Mean	±SD
FVC (L)	2.83	3.84	3.28	.27
FEV1(L)	2.49	3.57	2.84	.29

Cardiorespiratory Function

Maximum Oxygen Uptake (VO2max)

In Table 6, it showed that the soccer players had a minimum of 34.1ml/kg/min and a maximum of 50.2ml/kg/min in the VO2max

test. The mean and standard deviation was 43.27 ± 4.42 ml/kg/min.

Table 6. Cardiorespiratory Fitness of Hong Kong female elite soccer players *(N = 18)*

Variable	Minimum	Maximum	Mean	±SD
VO2max (ml/kg/min)	34.1	50.2	43.27	4.42

Yo-Yo Intermittent Recovery Test

The total distances of the participants covered in the Yo-Yo Intermittent Recovery Test were ranged from 400 m to 1000 m. The mean and standard deviation of the distances were 680 ± 184.4 m.

Table 7. The total distance covered in the Yo-Yo Intermittent Recovery Test of Hong Kong female elite soccer players *(N = 17)*

Variable	Minimum	Maximum	Mean	±SD
Yo-Yo Distance (meters)	400	1000	680.0	184.4

Discussion

In Hong Kong, there were limited researches about the physical fitness characteristics of female elite soccer players. Thus, this study was to evaluate the physical fitness profiles of Hong Kong elite female soccer players who aged 16-32. Accordingly, it aimed at helping the development in female soccer. The following discussion would divide into four parts: they are (a) anthropometry, (b) body composition, (c) muscular fitness, and (d) cardiorespiratory fitness.

(a) Anthropometry

Descriptive data about the anthropometric measurement of the Hong Kong elite female soccer players were included in Table 2. There were no significant differences in the age, weight and height of the Hong Kong female soccer players and

for those in other countries. In a study about the injuries in female soccer players in German national league, the mean age is 22.4 ± 5.0 years of those soccer players, and was similar to the Hong Kong female soccer players in our study. (Faude,Junge, Kindermann, & Dvorak, 2005) In a study on positional characteristics of physical performance in Division I college female soccer players, their mean height and weight are 168.4 ± 5.9 cm and 64.8 ± 5.9 kg respectively. (Vescovi, Brown & Murray, 2006)

In the present study, the mean heights (159.1 ± 6.6 cm) and weight (52.0 ± 6.6 kg) of the Hong Kong female soccer players were relatively shorter and lighter than the elite female soccer players in other countries. However, Bangsbo (1993) and Reilly (1996) stated that there was no optimal height for soccer players, but height might determine the choice of playing position.

Base on my findings, the morphological characteristic of the Hong Kong elite female soccer players were not significant

deference when compared to other female athletes on the measurement of shoulder width, circumference of chest, waist, thigh and calf. As they played contact sport, they should be bigger and stronger than ordinary people, However, from the measurement data, female soccer players in Hong Kong were comparatively smaller and weaker when compare to other contact sports athletes.

(b) Body composition

The measurements result of the body composition of the female elite soccer players in Hong Kong were presented in Table 3. Percent body fat was usually associated with body weight. The percent body fat of male soccer players ranged from 9% to 16% (Reilly, 1990). In the present study, the average percent body fat of the Hong Kong female soccer players was 18.7% ± 4.6%. One of the study on college female soccer players (division I of the NCAA, USA), the mean body fat percentage is 16.54 ± 3.07 % (Ricardo, 2000). Moreover, in other study

on a descriptive profile of elite U.S. women's collegiate field hockey players, (Wassmer & Mookerjee, 2002) the mean percent body fat was 17.29 % ±3.79% which were slightly lower than the female soccer players in Hong Kong. On the other hand, study about the anthropometric profiles of elite Asian female handball players (Hasan,Reilly, Cable, Ramadan, 2007), the average percent body fat was 23.4 % ± 2.8% ,which is higher than Hong Kong elite female soccer players. Collegiate athlete seemed to have lower body weight and in term of percent body fat. In the present study, fews of the subjects were secondary school students, physical growth might not be totally developed. Therefore, the weight of the subjects might be relatively lower when compared to other elite sports players, and the average percent body fat was also lower than them.

(c) Muscular fitness

Leg strength and Vertical jump

The component of muscular fitness was mainly focus on the

lower body muscular power, which included leg strentgth, hip flexibility and leg power. The data on musclue fitness of the Hong Kong elite female soccer players were presented in table 4. The mean leg strength and power of the Hong Kong female soccer players were 130 ± 27.5 kg and 45.03 ± 4.5 cm. Vertical jumping ability is approximately 20-36 cm for sedentary college females, 24-38 cm for college tennis players, 38-41 cm for select soccer players, and 51-52 cm for American U-20 and Australian national soccer players (Vescovi, Brown & Murray, 2006). In a study of college female soccer player (division I of the NCAA, USA).The mean ± SD vertical jump height was 49.38 ± 7.39 cm.(Ricardo, 2000) Our sample had a mean of 45 cm, which is slightly lower than the national level standards. However, they already performed well in the leg power test, sufficient parametric training were provided for the athletes. Research has shown that elite players who were faster (15 and 30 meters), could jump higher, had better agility, and were more aerobically fit compared to non-elite

players (Vescovi, Brown & Murray, 2006). In fact, a soccer game involved many activities that were forceful and explosive, e.g. tackling, jumping, kicking, turning and changing pace. Therefore, the power output during such activities was related to the strength of the muscles involved in the movements. (Bangsbo, 1993) Thus, high level of muscular strength might benefit soccer players and diminished the risk of injury, so leg strength and power training such as leg press and jumping exercise was highly recommended for soccer players and also the present subjects as well.

Hip Flexibility

In the present study, the mean hip flexion and extension were 91.9 ± 10.9 degrees and 39.5 ± 10.6 degrees which were presented in Table 4. In general, the hip flexibility of the Hong Kong Elite female soccer players was satisfatory. When compared the hip flexion and extension of the Hong Kong female soccer players to non-athlete adult women in other countries,

the present subjects had a higher range of motion on their hip joint. In a study on a adult women's flexibility, (Monteiro, Simao, Polito & Santhana, 2008)the hip flexion and extension of the contol group are 80.4 ± 14.7 degrees and 29 ± 6.1 degrees respectively before the strength training. Flexibility is an important variable for both health and athletic performance and is influenced by factors such as sex, age, and training (Monteiro, Simao, Polito & Santhana, 2008). In a study of lower extremity kinematics and kinetics in baseball and softball players, it indicated that females had significantly more maximum hip flexion than male (Wallacem, Kemozek, Bothwell, 2007). Therefore, in our study, the hip flexibility of the elite female soccer players was relatively well.

(d) Cardiorespiratory fitness

Pulmonary functions

The mean of FCV (L) and FVC1 (L) are represented the pulmonary function of the Hong Kong elite female soccer player

and are presented in Table 5. The mean FVC and FVC1 are 3.28 ± 0.27 L and 2.84 ± 0.29 L respectively. Athlough there were deficient data on the pulmonary function of female soccer players, the pulmonary function of the Hong Kong elite female soccer players was satisfactory when compared to the general population in Finland. A study which about the spirometric and anthropometric determinants of forced expiratory time in a general population (Kainu, Lindqvist, Sarna, Sovijarvi, Chaves, Bezerra, & Fleck, 2008). The descriptive statistic of mean FVC and FVC1 is 3.57 ± 0.64 L and 2.81 ± 0.58 L in women (n= 355). Both the results of FVC and FVC1 in the present subjects were similar to those in the general population in other countries, the subjects in the present study had normal lung function to cope with the soccer game.

Maximum Oxygen Uptake (VO2max)

The mean and standard deviation of the maximum oxygen uptake (VO2max) of the Hong Kong elite female soccer players was 43.26 ± 4.42 ml/kg/min. According to the Bangsbo (1994)

findings, the VO2max of female soccer athletes should range form 47 to 58 ml/kg/min. In a study on college female soccer players (division I of the NCAA, USA), the mean VO_2 max relative is 49.64 ± 5.26 ml/kg/min. (Ricardo, 2000). On the other hand, a study about the elite U.S. women's collegiate field hockey players, the predicted oxygen consumption is 42.87 ± 9.08 ml/kg/min only (Wassmer, Mookerjee, 2002)

In the present study, the mean value of VO_2 max of the subjects was satisfactory. The mean value was only slightly lower than the value in the internation soccer level, and somehow it was higher than other sports elite athletes. Hong Kong elite female soccer players had an appropriate amount of aerobic training on their practices. As we knew that a soccer game lasted at least one and a half hour, or sometimes even longer, players were required to have good aerobic capacity, so extra amount of aerobic training was recommended.

Yo-Yo Intermittent Recovery Test

The mean and standard deviation of the distances that the

Hong Kong elite female soccer players covered were 680 ± 184.4 m. The Yo-YO intermittent recovery tests have been extensively used for testing in a variety of sports, such as basketball, soccer, rugby and running. In a review article, which topic is “the Yo-YO intermittent recovery test, a useful tool for evaluation of physical performance in intermittent sports.” Data in Yo-Yo intermittent recovery test were obtained from female soccer players with the performance level of top-elite, moderate-elite and sub-elite players. The mean distances that they covered were 1600M, 1360m and 1160m respectively (Bangsbo, Iaia & Krustrup, 2008). The data on national sub-elite players were comparable to the Hong Kong elite female soccer players. It was almost 500m lower than female soccer players in national level. In the present study, subjects performed only one time for the test, they might not alert to the signals from the recorder tape and as a result affected their performance. However, it was no doubt that aerobic capacity played an important role in the performance of the Yo-Yo Intermittent

Recovery Test. As the data on VO2 max of the Hong Kong elite female soccer players were relatively lower than the national female soccer players, the performance in the Yo-Yo Intermittent Recovery Test were not well as the female soccer players in other countries.

Recommendation

According to my findings, the lower body muscular and cardiorespiration fitness of the Hong Kong elite female soccer players seemed to be relatively weaker among the physiological characteristics. Thus, squat jump and walking lunges exercise were suggested to be added in their training section in order to strengthen their lower body muscles. Beside, shuttle run training and 9 minutes run could be regular as a part of their training to enhance their cardiorespiration fitness.

For the development and selection of young female soccer players, the players who are relatively taller and stronger were more preferable, to improve their ability to be competing with others in the game.

Chapter 5

SUMMARY AND CONCLUSION

The present study attempted to evaluate the physiological profiles of the Hong Kong female elite soccer players who participated in grade-A level and international competition. In the investigation, four different physical components were involved, including (a) Anthropometry, (b) body composition, (c) muscular fitness, (d) cardiorespiratory fitness.

Summary of Results

This study showed that the Hong Kong elite female soccer team players were generally shorter and lighter than the other elite female soccer players in different countries. They had normal somatotype in the norm of Asia female predicted from the anthropometric measurements. Their average percent body fat measured by BIA was higher than collegiate elite female players but relatively lower than women' elite sport players. In other words, the Hong Kong elite female soccer players were relatively thinner when comparing with the elite players. The

muscular fitness in lower body part of the Hong Kong elite female soccer players was not bad. As the mean vertical jump height of the Hong Kong elite female soccer players was only slightly lower than national level, they had room for improvement. They were comparatively better in hip flexibility and pulmonary functions. However, their cardiorespiratory fitness was not as good as the female elite players in other countries. The mean maximum oxygen uptake (VO2max) and the mean distance in Yo-YO intermittent recovery test were not as good as other female elite athletes.

Conclusion

Although the female soccer in Hong Kong was not as popular as male, this physiological profile study of the Hong Kong female elite soccer players was helpful to the development of female soccer in Hong Kong and allowed more people to know about them. Moreover, it provided useful information and reference in the programs planning and evaluation of the female soccer development over years in Hong Kong.

Comparing with the previous study about the physical fitness of other sports athletes, the data of the present study showed that the Hong Kong elite female soccer players tended to be shorter and lighter than athletes in other countries, the appearance of Hong Kong players were comparatively small. The percent body fat was in a normal level of other sports athletes, as well as the lower body muscular power and their hip flexibility. Besides, the Hong Kong female soccer players were a bit poor in the cardiorespiration fitness, which were aerobic power and also the performance in Yo-Yo intermittent recovery test.

As the previous studies mentioned, cardiorespiratory fitness was important to soccer players, therefore, better cardiorespiratory fitness was necessary to improve all physiological aspects of the players. Most of the sport players in Hong Kong were amateur as female soccer players. Although the overall physiological fitness of the Hong Kong elite female players was comparable to national or Asia level,

there was still room for improvement. We should know that not only skill levels affect players' performance, but their physiological characteristics also contribute to performance. Therefore, if the team wanted to show obvious improvement in their performance and even to achieve a reasonable success in international competitions, physical fitness training should be addressed with technical and tactical training.

Recommendations of Further Study

Based on the study, the following recommendations were presented for further study:

1. The sample size should be enlarged in order to obtain more representatives.
2. The heart rates of the participants should be monitored during the Yo-Yo Intermittent Recovery Test, in order to ensure the participants were trying their best and achieved their maximum effort.
3. The leg strength measurement which used the leg dynamometer should be modified or replaced by another

measurement device. In this study, participants did not know well about the proper use of muscle in using the dynamometer, and they sometimes were not keeping the back straight and the hips raised vertically during the test.

4. The test should undergo in pre-season period, which can help to minimize the uncontrollable variable such as injury and competition that would be affected the testing schedule.

BIBLIOGRAPHY

Adams,G.M. & Beam,W. C. (2008). Exercise Physiology:Labortory Manual.(5th ed). New York: McGraw-Hill.

Al-Hazzaa, H. M., Almuzaini, K. S., Al-Refaee, S. A., Sulaiman, M. A., Dafterdar, M. Y., Al-Ghamedi, A. et al (2001). Aerobic and anaerobic power characteristics of Saudi elite soccer players. *Journal of Sports Medicine and Physical Fitness*, *41*, 54-61.

Anshel, M.H., Freedson, P., Hamill, J., Haywood, K., Horvat,M., & Plowman, S.A. (1991). *Dictionary of the sport and exercise sciences.* Champaign, IL: Human Kinetics.

Aziz, A. R., Tan, F., Yeo, A., & Teh, K.C. (2005). Physiological attributes of professional players in the Singapore soccer league. In T., Reilly, J.,Cabri, & D. Araujo (Eds.),*Science and football V* (pp. 139-143). NY: Routledge.

Bangsbo, J. (1993). *The physiology of soccer – with specialreference to intense intermittent exercise.* Copenhagen,Denmark: University of Copenhagen.

Bangsbo, J. (1994). Physiological demands. In B., Ekblom (Eds.), *Football (soccer)* (pp. 43-58). International Olympic Committee.

Bangsbo, J. (1996). *Yo-yo tests.* Denmark: August Krogh Institute.

Bangsbo, J. Iaia, F. M., Krustrup, P., (2008), The Yo-Yo Intermittent Recovery Test. A Useful Tool for Evaluation of Physical Performance in Intermittent Sports. *Sports Med.38*, 37-51

Bangsbo, J., Nooregard, L., & Thorsoe, F. (1991). Activity profile of competition soccer. *Canadian Journal of Sport Sciences*, 16, 110-116.

Borms, J. & Roy,P.V. (1996). Flexibility. R.,Eston & T.,Reilly .(Eds),Kinanthropometry and Exercise Physiology Laboratory Manual. Test, Procedures and Data (pp.115-145). UK:E. & F.N. Spon.

Callaway, C. W., Chumlea, W. C., Bouchard, C., Himes, J. H.,Lohman, T. G., Martin, A. D., Mitchell, C. D., Mueller,W. H., Roche, A. F., & Seefeldt, V. D.(1988). Circumferences. In T.G., Lohman, A.F., Roche, & R., Martorell (Eds), Anthropometric *Standardization Reference Manual* (pp. 39-54). Champaign, IL : Human Kinetics

Chamari,K.,Chaouachi,A.,Hambli,M.,Kaouech,F.,WisLOff,U., Castahna,C.(2008). The Five-jump test for distance as a field test to assess lower limb explosive power in soccer players. *Journal of strength and Conditioning Research.*

Chin, M., Lo, Y., Li, C., & So, C. (1992). Physiological profiles of Hong Kong elite soccer players. *British Journal of Sports Medicine*, *26*, 262-266.

Chin, M. K., So, R. C. H., Yuan, Y. W. Y., Li, R. C. T., &Wong, A. S. K. (1994). Cardiorepiratory fitness and isokinetic muscle strength of elite Asian junior soccer players. *Journal of Sports Medicine and Physical Fitness*,*34*, 250-257.

Davis, J.A.,Brewer, J. & Atkin, D. (1992) Pre-season Physiological characteristics of English first and second division soccer players. Journal of Sports Science,6,541-547

Ekstrand, J., & Gillquist, J. (1982). Frequency of muscle tightness and injuries in soccer players. *American Journal of Sports Medicine*, *10*, 75-78.

Faude, O., Junge, A., Kindermann, W. & Dvorak, J. (2005) Injuries in Female Soccer Players: A Prospective Study in the German National League. *The American Journal of Sports Medicine.33,* 1694.

Gabbett,T.J.(2007).Physiological and Anthropometric Characteristic of Elite Women Rugby League Players.*Journal of strength and Conditioning Research. Champaign.21,* 875-882

Hasan,A.A.,Reily,T.,Cable,N.T.,Ramadan,J.(2007). Anthropometric profiles of elite Asian female handball players. *Journal of Sports Medicine and Physical Fitness*. *47*,197-203

Heyward, V.H. (2002). *Advanced fitness assessment and exercise prescription.* (4th ed.). Champaign, IL: Human Kinetics.

Heyward, V.H. (2006). *Advanced fitness assessment and exercise prescription.* (5th ed.). Champaign, IL: Human Kinetics.

Hounsome,D.(2005). The baffled parent’s guide to coaching girl’s soccer. United States of America: Library of Congress Cataloging-in-Publication Data.

Hugg,P.J.(1994)The Selection of Australian Youth Soccer Players Based on Physical and Physiological Characteristics. A thesis for the Degree of Master of Applied Science (Sport Studies), University of Canberra.

Jones, A. D. G., & Helms, P.(1993). Cardiorespiratory fitnessin young british soccer players. In T., Reilly, J., Clarys,& A., Stibbe (Eds.), *Science and Football II* (pp. 298-303).London: E & FN Spon.

Kainu,A.,Lindqvist,A.,Sarna,S.,Sovijärvi.(2008).Spermatic and anthropometric determinants of forced expiratory time in general population. *Clin Physical Funct Imaging.28,* 38-42.

Malina, R. M.(1988).Physical anthropology. In T.G., Lohman, A.F., Roche, & R., Martorell (Eds), *Anthropometric Standardization Reference Manual* (pp. 99-102). Champaign, IL : Human Kinetics.

Malousaris,G.G.,Bergeles,N.K.,Barzouka,K.G.& Bayios,I.A.(2008). Somatotype, size and body composition of competitive female volleyball players. *Journal of Science and Medicine in Sport.11,* 337-345.

McArdle, W. D., Katch, F. I. & Katch, V. L. (2006). *Essential of exercise physiology.* Philadelphia: Lippincott William & Wilkins.

Melrose,D.R.,Spaniol,F.J.,Bohling,M.E.& Bonnette,R.A.(2007).Physiological and performance characteristic of adolescent club volleyball players. *Journal of Strength and conditioning Research. 21,* 481-487.

Miles,A., Maclaren, D.,Reilly and Yamanaka, K., (2003) In T., Reilly, J., Clarys,& A., Stibbe (Eds.), *Science and Football II* (pp. 140-147).London: E & FN Spon.

Monteriro,W.D.,Simao,R., Polito,M.D.,Santana,C.A.,Chaves,R. B., Bezerra,E. & Fleck,S.J.(2008) Influence of strength training on asult women's flexibility. *Journal of Strength and Conditioning Research.22,* 672-675.

Noble, B. J. (1986). *Physiology of exercise and sport*. USA: Time Mirror.

Powers, S. K., & Howley, E. T. (2007). *Exercise physiology theory and application to fitness and performance.*(6th ed.) New York: The McGraw – Hill.

Pyke, F. (2000). Introduction-Reason for testing. C.J.Gore(Ed.)*Physiological tests for elite athletes*.Champaign,IL: Human Kinetics.

Reilly, T. (1996). Fitness assessment. In T., Reilly (Eds.),*Science and soccer* (pp. 25-50). UK: E & FN Spon.

Reilly, T., & Secher, N. (1990). Physiology of sports: an overview. In T., Reilly, N., Secher, P., Snell, & C.,Williams. (Eds.), *Physiology of sport* (pp.464-485). UK: E. & F.N. Spon.

Ricardo,T. A.(2000).The effect of training in the maximum oxygen consumption (VO(2) max) and the physical conditioning of college female soccer players (division I of the NCAA, USA).Texas A&M University.

Tong, T. K., Fu, F.H. & Chow,B. C.(2001). Nostril dilatation increased capacity to sustain moderate exercise under nasal breathing condition. *The Journal of Sport Medicine and Physical Fitness.*

Tumilty,D.(2000).Protocols for the physiological assessment of male and female soccer players. C.J.Gore(Ed.)*Physiological tests for elite athletes*(pp.356-362).Champaign,IL: Human Kinetics.

Vescovi,J.D.,Brown,T.D.,Murray,T.M.,(2006).Positional characteristics of physical performance in Division I College female soccer player. *Journal of Sports Medicine and Physical Fitness. 46*,221-227.

Wassmer, D.J., Mookerjee, S.(2002). A descriptive profile of elite U.S. women's collegiate field hockey players. *Journal of Sports Medicine and Physical Fitness, 42,*165-172.

Wallace, B.J., Kernozek, T.W.& Bothwell, E.C.(2007)Lower extremity kinematics and kinetics of Division III collegiate baseball and softball players while performing a modified pro-agility task. *Journal of Sports Medicine and Physical Fitness. 47,* 377-381.

Wilmore, J. H., Frisancho, R. A., Gordon, C. C., Himes, J. H., Martin, A. D., Martorell, R., & Seefeldt, V. D. (1988). Body breadth equipment and measurement techniques. In T.G., Lohman, A.F., Roche, & R., Martorell (Eds), *Anthropometric Standardization Reference Manual* (pp. 27-38). Champaign, IL : Human Kinetics.

APPENDIX A

Informed Consent for physical Fitness Testing (English Version)

I understand that I am responsible for monitoring my own condition throughout the tests, and should any unusual symptoms occur, I will cease my participation and inform the instructor.

In signing this consent from, I: _____, (Name of Participant), affirm that I have read this form in its entirety and that I understand the description of the testing procedures and the risks and discomforts, and having had an opportunity to ask questions that have been answered to my satisfaction.

_____ _____

Signature of Participant Date

_____ _____

Tests Investigator Date

APPENDIX A
Informed Consent for Fitness Testing
(Chinese Version)

2008-2009 體能測試內容及家長同意書

確認回條及家長同意書

致：各受試者

本人是香港浸會大學體育系三年級學生。正就有關畢業論文進行體能測試，其體測內容包括：

1. 最大攝氧量的直接測驗法: 極限運動測試

受試者在跑台按漸增速度和斜度維持跑步，直到全身力竭。對心血管疾病的人而言，衰竭運動具有潛在危險的可能性。

2. 20 米來回跑測試

受試者進行20 米來回跑運動，直到全身力竭。對心血管疾病的人而言，衰竭運動具有潛在危險的可能性。

3. 肌肉力量及耐力量測試

測量受試者髖關節的柔韌度、以及大腿群肌的肌力。受試者可能會出現運動後延遲性肌肉酸痛。

4. 足球技能表現

測試受試者在球場上來回跑、運球及長傳的能力。當中包括全速跑20米、運球及長傳的足球技能。受試者可能會出現運動後延遲性肌肉酸痛。

5. 肺部肌肉測試

測試受試者的肺部肌肉的肌耐力，受試者需在十二秒內用力及快速的呼吸。受試者可能會出現面紅、頭暈的徵狀。

(1) 意向回覆：(*請在合適空格加上"X"／ 請刪除不適用者)

□ 本人 / 參加者已細閱以上內容詳情，確認接受邀請，參加此計劃的全部項目。本人清楚明白此計劃的高度要求，並承諾會竭盡全力，爭取進步。

□ 本人 / 參加者不接受邀請參加體能測試，其原因

是：_____

(2) 個人資料：

姓名：(中文)_____ (英文)_____

出生日期：_____ 性別：_____ 身份証號碼：_____

身高： _____cm 體重： _____kg

聯絡電話：(日)_____ (夜)_____

電郵：_____

就讀學校／工作機構：_____

(3) 參加者責任聲明：

本人_____身體健康狀況良好，適宜參加上述的測試，本人並未有任何疾病，而不適合參與此體能測試。

如有疑問，會向醫生尋求指示。在訓練或比賽期間發生意外而導致任何事故，本人願承擔全部責任，主辦或協機構並不需要負上任何法律責任。此外，本人亦明白必須遵守上述計劃的一切規則及教練 / 指導員之安排。

確認日期：_____ 參加者簽名：_____

※ 註：未滿十八的參加者必須由家長簽署同意參加有關測試

家長/監護人姓名：_____ 家長/監護人簽名：_____

與參加者之關係：_____ 日期：_____

- 本人聲明：申請人所提供之資料只會用作報名記錄及聯絡用途。所有個人資料，除獲測試員授權職員外，將不會提供予其他人士。若要求更改或索取已申報的個人資料，請與測試員聯絡。

APPENDIX B
Physical Activity Readiness Questionnaire (PAR-Q)
(English Version)

PAR-Q is designed to help you. For most people physical activity should not pose any problem or hazard. PAR-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of activity most suitable for them. Common sense is your best guide when you answer these questions. Please read the following questions carefully and answer each one honestly: check YES or NO.

YES	NO	Questions
		1. Has your doctor even 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 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?

I,_____ (Name of Participant), have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

_____ _____

(Signature of participant) (Date)

APPENDIX B

Physical Activity Readiness Questionnaire (PAR-Q)

(Chinese Version)

體能活動適應能力問卷與你

（一份適用於 15 至 69 歲人士的問卷）

經常進行體能活動不但有益身心，而且樂趣無窮，因此，愈來愈多人開始每天多做運動。對大部分人來說，多做運動是很安全的。不過，有些人則應在增加運動量前，先行徵詢醫生的意見。

如果你計劃增加運動量，請先回答下列 7 條問題。如果你介乎 15 至 69 歲之間，這份體能活動適應能力問卷會告訴你應否在開始前諮詢醫生。如果你超過 69 歲及沒有經常運動，請徵詢醫生的意見。

普通常識是回答這些問題的最佳指引。請仔細閱讀下列問題，然後誠實回答：

是	否	
☐	☐	1. 醫生曾否說過你的心臟有問題，以及只可進行醫生建議的體能活動？
☐	☐	2. 你進行體能活動時會否感到胸口痛？
☐	☐	3. 過去一個月內，你曾否在沒有進行體能活動時也感到胸口痛？
☐	☐	4. 你曾否因感到暈眩而失去平衡，或曾否失去知覺？
☐	☐	5. 你的骨骼或關節(例如脊骨、膝蓋或髖關節)是否有毛病，且會因改變體能活動而惡化？
☐	☐	6. 醫生現時是否有開血壓或心臟藥物（例如 water pills）給你服用？
☐	☐	7. 是否有其他理由令你不應進行體能活動？

請答「是」或「否」

如果在上述問卷中有一個或以上「是」的答案，即表示參加者的身體狀況可能不適合參加有關活動。故爲其安全起見，參加者請先行諮詢醫生的意見；並須在報名時出示醫生紙，證明其身體狀況適宜參加有關活動。

本人已閱悉、明白並填妥本問卷。本人的問題亦已得到圓滿解答。

姓名 _____

簽署 _____

日期 _____

APPENDIX C

Data Collection Form (1)

Name :_____(Chi) _____ (Eng)

Date of Birth: _____/_____/_____

Age: _____

Height: _____cm Weight: _____kg

Experience of soccer:

0-2 / 3-4 / 5-6 / 7-8 / 9-10 / 11 or above years

Position:_____

Times of training: _____days/ week _____minutes / day

Anthropometry

Shoulder width: _____

Circumference:

- Chest: _____
- Waist: _____
- Hip: _____
- Thigh: _____
- Calf: _____

Body Composition

Percentage body Fat: _____%

Fat mass: _____kg

Fat Free mass: _____kg

Muscular fitness

Leg strength: Trial1_____Trial2_____Trial 3_____

Hip flexibility: (Hip Flexion): Trial1_____Trial2_____Trial 3_____

(Hip Extension): Trial1_____Trial2_____Trial 3_____

Leg power test: (vertical jump) Trial1_____Trial2_____Trial 3_____

Cardiorespiratory fitness

-Lung Function

FVC: _____FEV$_1$: _____

Predicted maximum HR: _____

70% of Predicted maximum: _____

HR: _____

Speed: _____ mph VO_2 max:_____ml/kg $^{-1}$ /min^{-1}

Stage	RPE	HR
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

APPENDIX D

Data Collection Form (2)

TEST SCHEME: YO-YO INTERMITTENT RECOVERY TEST – LEVEL 1

Date: Name:

Speed level: Intervals:

5	1							
	(40)							
9	1							
	(80)							
11	1	2						
	(120)	(160)						
12	1	2	3					
	(200)	(240)	(280)					
13	1	2	3	4				
	(320)	(360)	(400)	(440)				
14	1	2	3	4	5	6	7	8
	(480)	(520)	(560)	(600)	(640)	(680)	(720)	(760)
15	1	2	3	4	5	6	7	8
	(800)	(840)	(880)	(920)	(960)	(1000)	(1040)	(1080)
16	1	2	3	4	5	6	7	8
	(1120)	(1160)	(1200)	(1240)	(1280)	(1320)	(1360)	(1400)
17	1	2	3	4	5	6	7	8
	(1440)	(1480)	(1520)	(1560)	(1600)	(1640)	(1680)	(1720)
18	1	2	3	4	5	6	7	8
	(1760)	(1800)	(1840)	(1880)	(1920)	(1960)	(2000)	(2040)
19	1	2	3	4	5	6	7	8
	(2080)	(2120)	(2160)	(2200)	(2240)	(2280)	(2320)	(2360)
20	1	2	3	4	5	6	7	8
	(2400)	(2440)	(2480)	(2520)	(2560)	(2600)	(2640)	(2680)
21	1	2	3	4	5	6	7	8
	(2720)	(2760)	(2800)	(2840)	(2880)	(2920)	(2960)	(3000)
22	1	2	3	4	5	6	7	8
	(3040)	(3080)	(3120)	(3160)	(3200)	(3240)	(3280)	(3320)
23	1	2	3	4	5	6	7	8
	(3360)	(3400)	(3440)	(3480)	(3520)	(3560)	(3600)	(3640)

APPENDIX D

Data Collection Form (3)

RESULT SCHEME: YO-YO INTERMITTENT RECOVERY TEST

Date: Level:

Surface condition: Weather:

No.	Name	Speed level Intervals	Total distance	Comments
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				