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DESIGNING SPECIFIC TESTS TO PROFILE SEPAK TAKRAW PLAYERS:

ANTHROPOMETRIC AND PHYSIOLOGICAL PROFILES OF SEPAKTAKRAW PLAYERS.

MN Jawis,
HJ Singh,*
R Singh,
M.N Yassin,

Sports Science Unit and *Department of Physiology
School of Medical Sciences
Universiti Sains Malaysia
16150 Kubang Kerian
Kelantan, Malaysia

Running Head: Physiological profiles of Sepaktakraw players

Address for correspondence:
Rabindarjeet Singh, Ph.D
Sports Science Unit,
School of Medical Sciences,
Universiti Sains Malaysia,
16150 Kubang Kerian,
Kelantan, Malaysia;
Tel: +609-766 4833
Fax: +609-764 1945
E-mail: rabindar@kck.usm.my

Abstract

Aim: This study determines anthropometric and physiological profiles of sepaktakraw players representing the state of Kelantan. ***Methods:*** A total of 39 sepaktakraw players, specialising in the three playing positions (tekong, feeder, and killer), was divided into under 15 years (U15), under 18 years (U18) and under 23 (U23) age categories. Height, weight, percent body fat [%bf], VO_2max and heart rates during matches, for the estimation of oxygen consumption during a game, were recorded. Statistical analysis was performed using one-way ANOVA for independent measurements and data are presented as mean ± SD. ***Results:*** The U23 and U18 players were significantly taller than the U15 players ($p<0.01$) but no significant difference was evident between the U18 and U23 groups. Similarly, U23 players were significantly heavier than the U15 players ($p<0.05$) but no significant difference in body weight was evident between U15 and U18 or between U18 and U23. No significant difference was found in %bf between the three groups. Mean maximal heart rate (MHR) during exercise was significantly higher in the U15 group when compared to the U18 and U23 groups ($p<0.05$). No significant difference was evident in mean MHR between the U18 and U23 groups. VO_2max was not different between the three groups. Nevertheless, oxygen pulse (O_2P_{max}) was significantly lower in the U15 ($p<0.001$) group when compared to the other two groups. Oxygen consumption during matches was 69.1, 68.5 and 56.4% of their VO_2max in the killer, tekong and the feeder respectively. ***Conclusion:*** Although the mean height and body weight of the players were within the Malaysian population norms, they were somewhat lower than those of players of other court games from other countries. The %

INTRODUCTION

Sepaktakraw (Kick Volleyball), or Takraw for short, is one of the fastest growing games in Asia. It has attained an impressive level of international popularity, particularly after its introduction in the 10th Asian Games in Beijing in 1990 and as a demonstration sport in the 1998 Commonwealth Games in Kuala Lumpur. It has now spread to over 20 countries including Argentina, Australia, Brazil, Canada, Korea, Germany, England, India, Japan, Puerto Rico, Spain, and USA (Takraw World, 2003). The game is played on an area the size of a doubles badminton court, with three players on each side of a 5-foot high net (Figure 1).

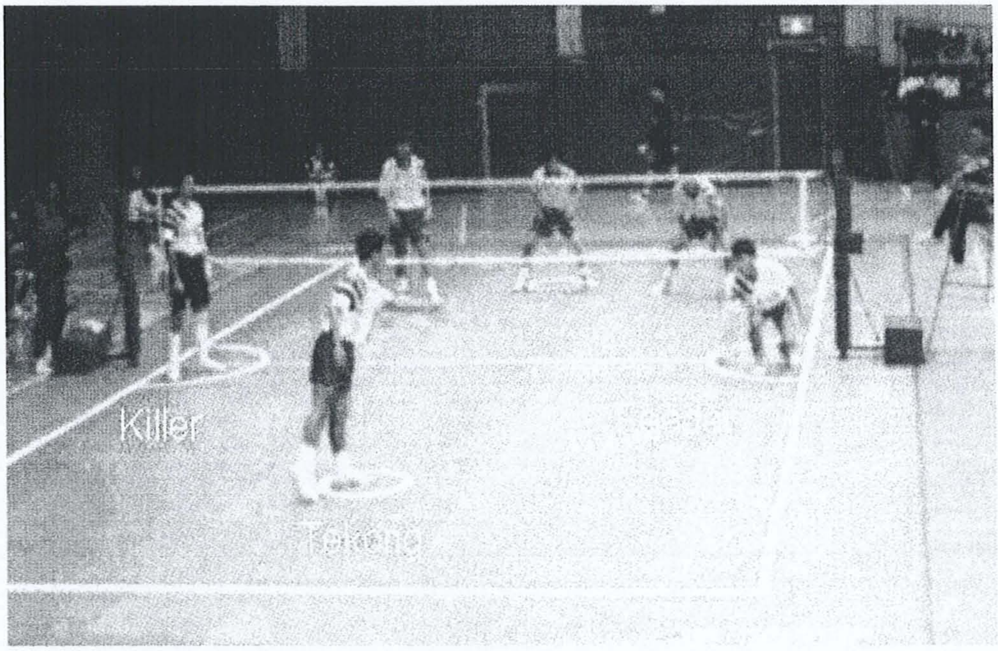

Figure 1. Positions in sepaktakraw game before the start of a rally.

Sepaktakraw combines ball skills (kicking & juggling), with the agility and acrobatic moves of gymnastics. It is also described as an acrobatic volleyball but in which the use of hands is prohibited. Like in volleyball, there are passes, sets and spikes but all without the use of hands or arms. The players are allowed the use of head, chest, feet and thighs to propel the ball over the net. Both setting and spiking is done with the feet and numerous forms of the spikes are used to kill a rally. The two most commonly used spikes are the "sun back" spike (Figure 2) and the "roll" spike (Figure 3). They are both performed aerially and their execution requires immense agility, precision, timing and skill.

Sepaktakraw is considered a game requiring precision, timing, accuracy and agility. The intensity of the game is intermittent, depending on the strategy employed by a team. The continuous flow of play, smooth transition from offence to defence and shared responsibilities by the players require all players in the team to perform almost similar movements on the sepaktakraw court during the actual play.

Despite its increasing popularity, little data exists in the literature on the physical and physiological profiles of sepaktakraw players that could help select players or help develop or adopt appropriate training modalities for the uplift of the game to standards not achieved before. Player profiling has become a very important process on the road to excellence in sports. This study therefore attempts to compile some information about the National Sepaktakraw GP 2002 champions, considered to represent the top sepaktakraw players in the country.

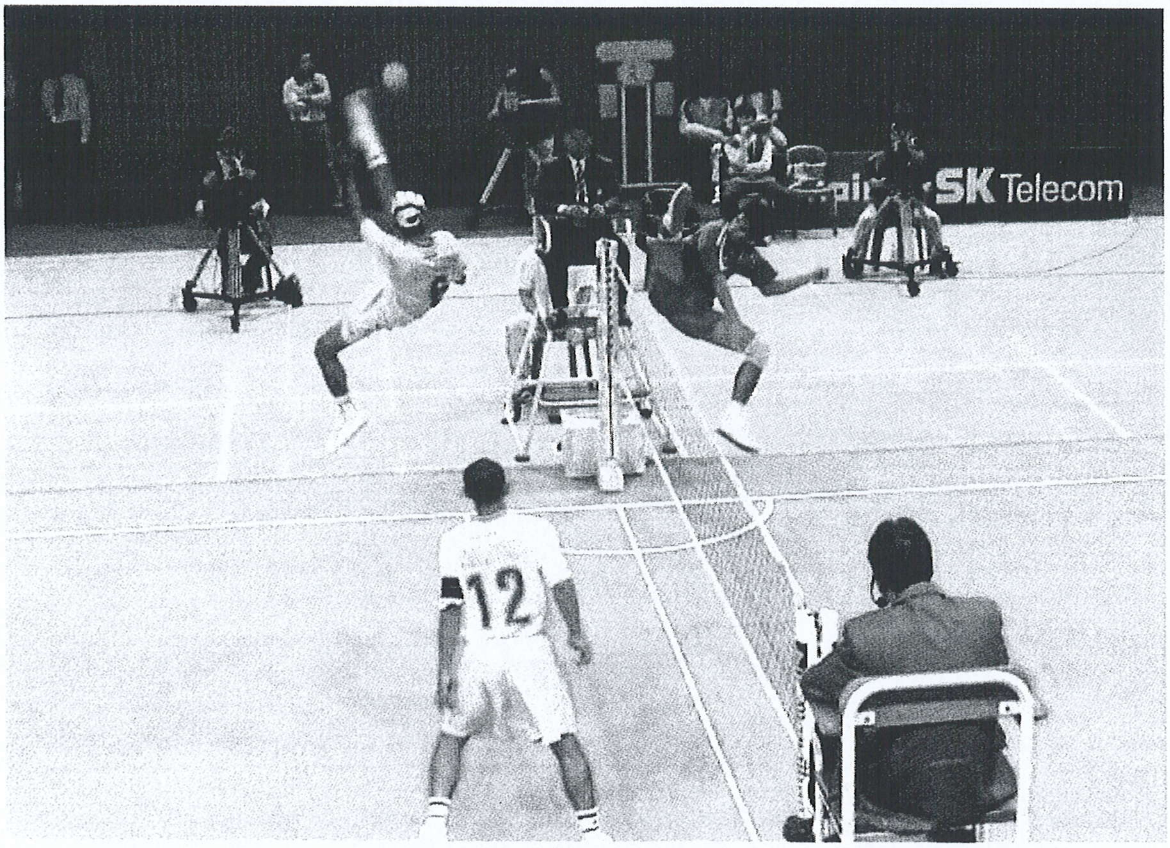

Figure 2. Execution of a Sun Back spike.

Figure 3. Positions of the spiker and the defender during execution of a "role" spike.

METHODS

A total of 39, male, sepaktakraw players representing the state of Kelantan participated in the study. They were divided into three age categories; under 15 years (U15; n=12), under 18 years (U18; n=15) and under 23 years (U23; n=12). Anthropometric and cardiopulmonary parameters were determined after receiving an informed consent from all the subjects. This study was approved by the University's Ethics Committee.

Anthropometric measurements

For the measurement of height and weight subjects stood on the weighing machine bare-footed and dressed in shorts or light clothing. Standing height was recorded to the nearest 0.5 cm using a standiometer ( ) and body weight was recorded to the nearest 0.5 kg using a digital weighing scale (model SECA). Skinfold thickness was measured with a Harpenden calliper at four sites; abdomen, thigh, triceps and suprailliac, as per the recommendations of the American College of Sports Medicine (ACSM, 1995). The mean of three measurements represented the value for each site. Percent body fat was calculated using the 4 site equation (Forsyth and Sinning, 1973).

Back and Leg Strength

The back and leg strength was measured using a leg dynamometer (Takei Kiki, Kogyo. Co. Ltd. Japan). The subject stood on the platform with the trunk straight and the knees flexed to an angle of 130° to 140°. The subject then held the hand bar by using a pronated grip and positioned it across the thighs by adjusting the length of the chain. The subject pulled the handle bar slowly but vigorously extending the knee without using the back. This test involved the maximum power, as three attempts were allowed with a minimum of 60-second rest interval between attempts. The maximum indicator needle remained at the peak force achieved. The score was recorded for all the three attempts with the best-pulled result being taken as a measure of strength (kg).

Standing Long Jump

A Standing Long Jump mat was used for this where the subject stood with feet comfortably apart behind a line. The subject was asked to jump maximally and was allowed to perform a countermovement jump (CMJ) prior to the take off. CMJ is a jump with the arm swing which has been shown to contribute approximately 10% to the jump height. (Luhtanen and Komi,1978). The best of the three jumps was recorded. The distance (cm) from the takeoff line to the back of the heel closest to the takeoff line was recorded. (Robertson and Fleming,1987). A 2 min rest was allowed between jumps to minimize the effect of fatigue. The following formula was than used to convert the distance recorded into power (kg.m) = $\frac{\text{Weight x distance}}{100}$

Range of Motion

The Leighton flexometer (1987) (Spokane, USA), a weighted 360° goniometer, was used to asses static range of motion (ROM) of the right side of the neck, trunk and ankle. For the neck ROM (flexion and extension), the subject lay supine on a bench with the head and neck projecting over the bench with the shoulders touching the edge of the bench and arms at the side. The flexometer was attached to the right side of head and over the ear. The subject was then instructed to raise the head and move to a position as near to the chest as possible and the dial was locked in this position. The subject was then instructed to lower the head as low as possible. This position was held for 3 sec and the pointer was locked. The ROM was recorded to the nearest degree.

For the assessment of the trunk ROM (rotation), the subject lay in supine position on a bench with the legs together, knees raised above hips and parallel to the bench and body. The flexometer was fastened around both legs at the middle rear of upper legs. With the shoulders being held down, the subject was asked to lower the knee to the left as far as possible. The knees were moved directly side wards at the height of the hips and the dial was locked in that position. The subject was then instructed to lower the knee to the right as far as possible. This position was held for 3 sec. and the pointer locked and the ROM was recorded to the nearest degree.

ROM of the ankle (flexion and extension) was obtained with the subject sitting on the bench with the right leg resting on and foot projecting over the end of the bench with knee straight. The left leg was extended downward with foot resting on the floor. The flexometer was than fastened to the inside of the right foot. The subject was instructed to turn the right foot downward as far as possible and the dial was than locked. After which the subject was asked to turn the right foot upward and towards the knee as far as possible and the pointer locked and the ROM was recorded to the nearest degree. For the inversion and eversion ROM of the ankle, the flexometer was fastened to the front of the shoe. The subject sat at the end of the bench with the knees projected over and the lower legs downwards. With lower legs secured in position by the assessor's free hand the subject was asked to turn the foot inward as far as possible and the dial locked. After which the subject was than instructed to turn the foot outwards as far as possible and the position was held for 3 sec and the pointer was locked and ROM was than recorded to the nearest degree.

Determination of maximal oxygen consumption (VO_{2max})

Maximal oxygen uptake was determined using an incremental running test to exhaustion performed on a motor-driven treadmill (Quinton, Model 18-60 USA). All subjects were familiarised with the testing procedures prior to data collection. Following a 5 min warm-up, subjects ran at a predetermined speed for VO_2max testing which was maintained throughout the test. The gradient was increased by 2.5%, from the initial 3.5% gradient, every 3 minutes until volitional exhaustion (Taylor, 1955). Metabolic and respiratory measurements were measured using a metabolic chart recorder (SensorMedic 2900, USA). Heart rates were obtained using telemetry heart rate monitor (Polar, Finland). Maximum oxygen pulse (O_2Pmax) was determined by dividing maximum oxygen uptake in ml/min with maximum heart rate obtained during the VO_2max test.

Determination of VO_2 during a match

Oxygen consumption during a game was estimated from the heart rates of the three players (feeder, killer and tekong) during four consecutive matches over a period of four days. For this, each player was fitted with a heart rate transmitter and receiver (Polar, Finland) during the game. The heart rates were recorded every minute until the end of the game in each individual. After each game, the receiver was interfaced with a personal computer and the data was downloaded for analysis. The length of the matches varied from between 60 – 70 minutes. The heart rates during each match were averaged and VO_2 was estimated from their respective heart rate *vs.* oxygen consumption curves that were obtained in the laboratory a few days earlier.

RESULTS

Table 1. Anthropometric measurements expressed as mean ± SD in the three age categories

Age Categories	U15 (n=12)	U18 (n=15)	U23 (n=12)
Variables			
Age (years)	13.8 ± 0.8***	16.7 ± 1.0†††	20.4 ± 1.3
Height (m)	1.61 ± 0.07**	1.69 ± 0.04	1.69 ± 0.07
Weight (kg)	49.7 ± 7.3†	58.7 ± 10.3	61.9 ± 10.6
Body fat (%)	7.6 ± 2.4	8.7 ± 5.1	10.2 ± 4.8

, * significantly different from the U18 and U23 at p<0.01, p<0.001 respectively
†, ††† significantly different from the U23 at p<0.05, p<0.001 respectively

Height, weight and % body fat

As expected, the U23 and U18 players were significantly taller than the U15 players (p<0.001) but no significant difference in height was evident between the U18 and U23 players. Similarly, U23 players were significantly heavier than the U15 players (p<0.05) but no significant difference in body weight was evident between U15 and U18 or between U18 and U23 players. No significant difference was evident between the three groups in % body fat.

Table 2. Range of motion (ROM) and strength characteristics (Mean ± SD) of the players in the three age categories.

Age Categories		U15 (n=12)	U18 (n=15)	U23 (n=12)
Variables				
Neck ROM (°)	Flex/Ext	129.0 ± 12.9	142.1 ± 12.3*	144.7 ± 9.7**
Trunk ROM (°)	Rotation	125.1 ± 17.1	142.0 ± 13.5**	142.4 ± 20.2*
Ankle ROM (°)	Flex/Ext	68.0 ± 7.2	74.9 ± 9.1	77.9 ± 10.9*
	Inv/Ever	58.7 ± 8.7	66.9 ± 4.2*	63.3 ± 8.3
Back & Leg strength (kg)		108.8 ± 18.8	131.4 ± 22.5*	149.0 ± 23.5***
Standing Long jump (cm)		201.5 ± 13.8	217.9 ± 17.8*	227.2 ± 17.9**
Standing Long jump power (kg.m)		100.2 ± 16.6	127.6 ± 23.8*	140.6 ± 26.6***

*, **, *** significantly different from U15 at $p<0.05$, $p<0.01$ and $p<0.001$ respectively

Table 2 describes mean rang of motion and strength result of the three age groups. Mean neck ROM of the U18 and U23 players was significantly greater than that of the U15 players ($p<0.05$ and $p<0.01$ respectively). However, there was no significant difference in the neck ROM between the U18 and the U23 players. Mean trunk rotation of the U18 and U23 players was significantly greater than that of the U15 players ($p<0.01$ and $p<0.05$ respectively). Again there was no significant difference in mean trunk rotation between the U18 and U23 players. Mean ankle flex/ext ROM of the U15 players was significantly smaller than that of the U23 players ($p<0.05$). However, there were no significant differences in ankle flex/ext ROM between the U18 players and the U15 and U23 players. However, the mean ankle inver/ever ROM of the U18 was significantly greater than those of the U15 players ($p<0.05$) but no significant difference was noted between the U15 and the U23 players.

The achievement in the back and leg strength test of the U18 and U23 players was significantly higher than that of the U15 players ($p<0.05$ and $p<0.001$ respectively) (Table 2). In the standing long jump test (distance in cm), the leg strength of the U18 and U23 players were significantly greater than those of the U15 players ($p<0.05$ and $p<0.01$ respectively). Similarly, the mean leg power (kg.m) in the U18 and U23 players was significantly greater than those of the U15 players ($p<0.05$ and $p<0.001$ respectively). However, there were no differences in mean leg strength and power between the U18 and U23 players.

Table 3: Cardiopulmonary parameters (Mean ± SD) during maximal test of the three age categories.

Age Categories	U15 (n=12)	U18 (n=15)	U23 (n=12)
Variables			
Max HR ($b.min^{-1}$)	195.9 ± 8.7	188.0 ± 5.1*	187.7± 7.2*
VO_{2max} ($ml.kg.min^{-1}$)	51.9 ± 3.9	53.5 ± 5.5	51.2 ± 4.5
$O_2 P_{max}$ ($ml.beat^{-1}$)	13.3 ± 1.7	16.9 ± 2.5***	17.2 ± 2.2***

*, *** significantly different from the U15 at $p<0.05$ and $p<0.001$ respectively.

Cardiopulmonary parameters

Maximal heart rate (Max HR) obtained during the maximal test was significantly higher in the U15 players when compared to the U18 and U23 players ($p<0.05$; Table 2). However, no significant difference was evident in Max HR between the U18 and U23 players. Maximum oxygen consumption was similar in all the three age categories.

However, maximal oxygen pulse (O_2P_{max}) was significantly lower ($p<0.001$) in the U15 players when compared to the other two age groups category players.

Table 4: Heart rates, oxygen consumption and % VO_2max (Mean ± SD) during matches in the three position players.

Players	Heart rate (beats.min^{-1})	VO_2 (ml.kg^{-1}.min^{-1})	%VO_2max
Feeder	139.8 ± 7.2	29.8 ± 2.8	56.4 ± 5.2
Tekong	142.9 ± 6.3	35.4 ± 2.2	68.5 ± 4.2
Killer	140.1 ± 12.0	36.7 ± 5.4	69.1 ± 10.0

No significant differences were evident between the mean heart rates of the three position players during the matches (Table 4). However, oxygen consumption was somewhat lower in the feeder when compared to the Tekong and the Killer players but the difference was not statistically significant. When expressed as % of VO_2max, average oxygen consumption ranged between 60 and 70% of the VO_2max in all the three position players. Again %VO_2max was lowest in the feeder when compared to the other two position players, but it was not statistically significant.

DISCUSSION

After soccer, sepaktakraw is probably the next most popular game played by those Malays living in suburban and rural areas in Malaysia. The level of affluence is somewhat lower than in the urban areas of the country. The life-style too is somewhat more active than that of urban Malay. This is also reflected in the anthropometric measurements, particularly in the body weight and % body fat of these players. Mean height of the U23 group was found to be within the Malaysian population norm for that age category (Singh et al., 1989). It was however lower than that reported in Indian (Majumdar *et al*, 1997) and Chinese badminton players (Chin *et al*., 1995). Similarly, whilst the height of the U18 and U15 groups were also within the national norm for their age category, the results indicate that these two groups of players were also shorter than age-matched Chinese badminton (Chin et al., 1995) and English squash players (Brown *et al*., 1998). They were also found to be shorter than Hong Kong and Chinese national junior soccer players (Chin *et al*., 1995). The exact significance of height to performance in sepaktakraw remains unclear. Little information correlating height with performance in sepaktakraw exists in the literature. Although the U23 players in the group were taller and probably better than the U15 and U18 players, it is however, unclear if the difference in the standard of play between these players was due to the height *per se,* as the U23 players have the advantage of having more experience in the game. Whilst there may be a minimum requirement for height in sepaktakraw, it is unlikely that a higher than the average height will bestow any extra advantage to a player. Furthermore, from personel and general observations, national players from the other leading sepaktakraw playing countries also appear to be of the same height as the Malaysians, suggesting that height above the required average may not provide any additional advantage.

The concept of ideal weight for the athlete includes not only the total body weight but also the body composition. An optimal body size and composition characteristics for a specific sport will vary depending on the physical tasks required (Boileau and Horswill, 2000). Once again the body weights of the sepaktakraw players were within the range of the Malaysian population norms (Singh *et al.*, 1989). When compared to body weights of players from other sports, mean weight of the U23 players was found to be lower than those of Italian (Faccini and Antonio 1996) and Indian badminton players (Majumdar *et al*, 1997). The difference in body weights between the sepaktakraw players and Italian badminton players is expected as Europeans generally have higher body weight for any given age category. But the reason for the difference in body weight between the sepaktakraw players and the Indian badminton players is uncertain. Like in the case of the Italians, it may also reflect the racial difference and genetic make-up of the individuals. It has also to be recognized that the physical requirements for sepaktakraw and badminton are not identical and comparison of the anthropometry between players of these two sports in this instance is just to provide us with a picture of where the sepaktakraw players rank in terms of anthropometry and physiological capabilities when compared to players of other court and field games. Although little anthropometric data exist of players from other relevant sports in Malaysia to which these profiles could be compared, there is nevertheless a general believe that the sepaktakraw players appear somewhat leaner and less muscular. This may be an important attribute for excellence in sepaktakraw. Agility is an important requirement of a sepaktakraw player, particularly flexibility of the lower limbs. Power generated during a serve and when spiking is dependant, more on the timing and velocity of movement of the limb rather than to the muscle mass itself. A high body weight and extra muscle mass will most certainly impede agility, flexibility, velocity of movement and will make the take-off during acrobatic kicks slow and difficult. It is therefore not surprising that top sepaktakraw players are leaner and less muscular. Although mean %bf increased with increasing age category, the differences however were not statistically significant (Table 1). The subjects who participated in the study were very lean with low %bf when compared to Malaysian dragon boat rowers whose average %bf was 11.8 % (Singh et al., 1989). The recommended %bf ranges from 10-15% for young athletes and 11-18% for teenage athletes (Lohman et al., 1997) and for adult males in their mid 20s it is 15-16% of the body weight (ref). The reason for the low %bf is unclear. The body weight of the sepaktakraw players in this study was however within the range of the Malaysian population norms. Under nutrition is no longer considered a problem in this part of the country. Whether the range of %bf evident in this study is ideal for a sepaktakraw player is uncertain. More studies are clearly needed to correlate %bf with performance. It nevertheless suggests that, like in numerous other court games, body fat of between 8-12 % of the body weight may be sufficient for top-level performance in sepaktakraw. The players in this study can be considered as elite sepaktakraw players as some of them were also currently representing the country. As selection to the state and national teams is based on performance, the Malaysian national players could be considered to have the ideal body weight and body composition. It may therefore be argued that the average body weight of between 60 to 70kg, recorded in the U23 players in this study could be considered as an ideal weight of a sepaktakraw player. Similarly, a height measurement of 1.68 to 1.75m could also represent as the ideal height for a sepaktakraw player. Nevertheless, more based studies correlating body weight, height and body composition to performance are required to confirm these assumption.

Flexibility performance

Players were tested mainly on parts of the body that are most involved in sepaktakraw game namely: neck, trunk and ankle. At the neck joint (flex/ext) of the U15 (129°) and the U18 (142.1°) groups are categorized as an Average whereas, for the U23 group (144.7°) is categorized as Moderate High. The trunk rotation, ankle flex/ext results of the U15, U18 and U23 were considered as Average too. However, the ankle inver/ever U15 was considered average, but the other two groups of players were considered as Moderate High. All categorizes result should refer to Leighton, 1987. As to compare with other sports, at the neck flex/ext, the U18 and U23 found to have low degree of flexibility when compared to those from the gymnast group but greater than the basketball players (150° and 140°; Leighton, 1987) respectively. Surprisingly, at the ankle flexion, all the three groups of the sepaktakraw players found to have good flexibility when compared to the similar group as the gymnast and the basketball groups (50° and 60°; Leighton, 1987) respectively. This result showed that as a sepaktakraw player; need a high level of flexibility at some particular joints.

Flexibility decreases with age (ACSM, 2000). However, observer had noticed that the ROM in the flexibility of sepaktakraw players had increased with age, which was absolutely differs from researchers that observed flexibility decreased with age. One of the reasons was the U23 players had involved in this game for more years compared to the other age group players, which emphasized the players to warm-up before exercise to avoid injuries. With adequate warm-up and specificity, the actual ROM at any particular joint will be increase within the potential for that particular joint (ACSM, 2000).

Secondly, the level of competition may increase the level of flexibility which made the players to performed more acrobatically action to get points. Flexibility performance is based upon activity performance. In this study, the U23 group has been involved at national level, which required a high intensity and flexibility whereas the U15 players performed only at school level with less than year experience. Although the U23 group is considered older than the other team mates and had larger muscles, they however could perform the flexibility test as well as the other younger team mates.

Exercise to improve flexibility involves stretching of ligaments and tendons. Stretching of a tendon to 108% of its original length alters the tendon qualities and the tendon remains at 104% of its original length when unloaded (Viru, 2000). Individuals with large hypertrophied muscles or excessive amounts of subcutaneous fat may score poorly on ROM test because adjacent body segments in these people contact each other sooner than in those with smaller limb and trunk girths. Inflexibility of an older individual increased muscle stiffness and lower stretch tolerance compared to younger individuals with normal flexibility (Magnusson, 1998) but with the 10 weeks of flexibility training can help to counteract age-related decreases in ROM (Girouard and Hurley, 1995).

In this study, sit-and-reach test were not use to measure the ROM of the sepaktakraw players. Some fitness researchers assume that the sit-and-reach to be a valid measure of low back and hamstring flexibility but with poorly related to low back flexibility ($r = 0.10$; Patterson, 1996) in children and adults (Hui and Yuen, 2000). Sit-and-reach test is not suitable to assessed the ROM of the sepaktakraw players which require a direct methods of measuring static flexibility at joint rotation (in degrees) using flexometer (r=0.96; Sell, 1994). No comparison with other sports can be made due to some limitation as most of the sports such as soccer, volleyball and badminton used sit-and-reach test as to measure flexibility.

In sepaktakraw game, optimal musculoskeletal function requires an adequate ROM to maintain all joints. Lack of flexibility in this area may be associated with an increased risk for the development of chronic lower back pain. Therefore preventive and rehabilitative exercise programs should include activities that promote the maintenance of flexibility. Lack of flexibility is prevalent in the elderly but based on the result obtained, the U23 players tend to have similar categories as the U15 and U18. Age per se does not appear to be a dominant factor in terms of reduced flexibility performance.

Isometric Testing

Isometric test requires the sepaktakraw players to produce a maximal force against an immovable resistance that is in series with a cable tensionmeter whose transducer measures the applied force. This test is performed to quantify the maximal force developed (Wilson, 2000). Within each group of Kelantan sepaktakraw players, a large range was observed for U23, (e.g. the strongest pull was 185kg and the lowest was 105kg). For the U15 and U18 group the range was quite similar. The range pulled was between 91–140kg and 95–162kg respectively. However, these results are within the norms of the static strength (Corbin, 1978).

Standing long jump is another type of isometric test. The U23 group however, had similar recorded strength performance when compared to the Malaysian rowers that had 140.0kg.m (Singh, 1995). However, it was lower when compared to those from the basketball (169.0kg.m) group (Hoffman and Maresh, 2000). Despite the popularity of isometric test of muscular function, numerous researchers reported that these test have a relative poor relationship to dynamic performance measures that would require a high level of strength (Wilson,2000). Many of the relationships were not significant ($r = \sim 0.5$; Baker, 1994).

No statistically significant difference in VO_{2max} was evident between the three groups. The aerobic capacities of these players however were somewhat lower than those reported in Italian (59.8ml.kg.min^{-1}; Faccini and Antonio 1996) and Chinese badminton players (63.4ml.kg. min^{-1}; Chin et al., 1995). They were also lower than those observed in English basketball (54.8ml.kg. min^{-1}), volleyball (56.9ml.kg. min^{-1}; Newton *et al.*, 1999), junior squash (57.2ml.kg. min^{-1}; Brown et al., 1998), Hong Kong junior soccer (58ml.kg. min^{-1}; Chin et al., 1995) and Italian tennis (56.3ml.kg. min^{-1}; Faccini and Antonio, 1996) players. The reason for this is not immediately apparent but it may have something to do with training and the requirements of the game. By its nature, sepaktakraw is a game of lower work intensity when compared to badminton, squash, tennis and soccer or for that matter even basketball. It is therefore not surprising to find a lower aerobic capacity in the sepaktakraw players. Interestingly, the VO_{2max} of sepaktakraw players was also found to be lower than that of volleyball players although one would assume that both these games might be of equal intensity.

Measurement of oxygen consumption during competitive games revealed demands of moderate intensity on the aerobic capacity of the players. In general estimation of VO_2 from heart rates throughout the matches, revealed workload intensities of about 70 % of maximum heart rates or between 50 and 72% of VO_2 max (Table 3). Oxygen consumption ranged from between 28 – 43 $ml.kg^{-1}min^{-1}$ during competitive matches (Table 3). These values are lower than those reported for some badminton (Faccini and Antonio 1996) and soccer (Chin et al, 1992; Chin *et al.*, 1995) players, where oxygen consumption rates of between 45 and 52 $ml.kg^{-1}min^{-1}$ or between 75 and 86% of VO_2max have been observed. The difference in the oxygen consumption during the game and the lower VO_2 max of the sepaktakraw players probably suggests the lower work intensity of this sport.

This data appears to be the first of its kind obtained from the sepaktakraw players in Malaysia. Little comparison is possible as there is no published data of sepaktakraw players from the other countries or even from other Malaysian court games. In conclusion, the anthropometric and physiological profile of the Kelantan sepaktakraw players provide a useful database against which talented groups may be compared and provide useful information for talent detection and identification and development programs.

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