Relationship Between Selected Fitness Components of Sarawak Tennis Players

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Abstract: In tennis, sport-specific technical skills are the elements of a successful performance. It also requires a complex interaction of several fitness components and metabolic pathways. A tennis match is characterized as intermittent whole body effort, alternating a few seconds intense activity and short recovery activity interrupted by several resting periods with a typical average match time of 1.5 hours up to more than 5 hours. The purpose of the study was to develop and measure the fitness components of Sarawak tennis players. Thirteen young trained players in the age bracket 15 to 21 years old with experience of at least 2 years in playing tennis and have participated in at least SUKMA level were tested for eight fitness tests. A Pearson correlation test was conducted to examine the relationships among the variables. Significant correlations were found between all the variables (p <.05) except for, flexibility and muscular strength, muscular endurance, muscular power, agility and speed endurance (p >.05). Muscular strength for the left hand was not significantly correlated with speed and aerobic capacity (p >.05). There was no significant relationship between speed and muscular power, agility and speed, muscular endurance and aerobic capacity (p >.05). Additionally, speed and speed endurance showed no significant relationship with muscular endurance (p >.05). This study quantifies physical fitness profile using the tennis-specific tests that can help to upgrade Sarawak tennis players’ performance by examining the relationships among all the fitness components. The findings would be beneficial for coaches to assess their trainees in tennis sports as well as be used as the guidelines for selection purposes.

Key words: Component • Tennis • Fitness • Young players

INTRODUCTION

In tennis, the specific technical skill is the main element of good tennis players as an example in racket and ball handling skill and stroke techniques [1]. In a match, tennis has been characterized by intermittent whole body effort, alternating a short 2-10 second intense activity of high intensity exercise and short 10-20 second recovery activity interrupted by several resting periods of longer duration for about 60-90 second with a typical average match time of 1.5 hour to some rare cases to more than 5 hours [2]. After serving, a tennis player runs an average of 3 meters per shot and a total of 8 to 15 meters [2] with a change of direction 3 to 6 times during a typical rally in pursuit of one point. A tennis player might hit the ball an average of 4-5 times and complete 1300 to 3600 meter per hour of play, depending on the level of the player whether amateur or advanced and the surfaces of the court whether it is slow or fast respectively [2].

Physical fitness is defined as the capacity to perform an activity in a full range of physiological and psychological qualities [3]. The key that makes a difference between victory and failure are the player fitness [4]. Typical tennis players must react quickly and be excellent in a linear movement and multidirectional move in short agility [2]. Strength is also required in muscle and flexibility in the joint for performance and to reduce injuries, while adequate Range of Motion (ROM) in the main joints is an essential for strokes and on court movement [2]. Therefore in order to determine the outcome of one tennis match coaches or physical trainer must build up or plan the athletes training programs so that they will have all the attribute of one tennis player needs [3].

In physiological perspective, an average physiological response to a tennis match have been reported to be rather moderate, with a mean of exercise intensity less than 60-70% of VO2 max and mean heart rate
of 60-80% of maximal values [5]. Meanwhile, in blood lactate concentration also usually remain low that is 1.8-2.8 mmol/l during a single tennis match [6]. However, following long and intense match, lactate concentration might increase up to 7 mmol/l, suggesting that a single tennis match involves in aerobic and anaerobic glycolytic processes also taking part in the muscle energy support during a match [7]. Therefore, a tennis player must have a good physical demand that able to tolerate with high intensive training which a mixture of speed, agility and power combined with medium to high aerobic and anaerobic capability which related to the whole body [2].

In the diverse activity pattern and mixed energy requirement tennis, it is suggested that fitness demand like flexibility, strength, endurance, power, agility, speed, body composition and aerobic and anaerobic fitness of a player will determine the victory and failure [8]. Thus, successful performance cannot be defined by only on the physical attribute but also need mutual interest with the coach to obtain information of the player physical fitness to clarify the objective of the training program of short or long term [4].

In Malaysia one of the major events that most athletes waited is Sukan Malaysia (SUKMA) where there is a total of 1238 medals being offered during this major event. Tennis alone has 28 medals offered to the athlete. In 2014, according to official result of Sukma Perlis, Sarawak tennis team alone has contributed 9 medals that consist of 4 gold, 2 silver and 3 bronze for both man and female categories, but in 2016 in Sukma Sarawak tennis contributed only 5 medal that consist of 2 gold and 3 bronze that most medals were contributed in female categories. Despite it, a home advantage in men categories only contributed 2 bronze in men single and mix double.

In order to obtain unremitting achievement in future, the junior team or the backup squad need to be trained and well developed. Therefore, it is important for the athletes and coaches to know the athletes’ level of performances in order to improve the achievement of Sarawak tennis. Therefore, this study aimed to measure the anthropometry and selected fitness components to establish a data for the Sarawak tennis association on Sarawak Tennis athletes that have potential in competing at higher level competition.

**MATERIALS AND METHODS**

**Subjects:** The subjects of this study comprises of N=15 Sarawak tennis players who were four in the Sukma Sarawak team while the others were the top 10 in the state level, aged from 15 to 21 years old and had two or more years of competition experience at the state and national level.

**Anthropometry:** Height: Subject were instructed to remove their shoes and socks before measuring the height and to stand properly with assistance from the measurement before the height value was taken. Height was recorded to the nearest 0.5 cm. The measurements were obtained twice and the mean value was calculated as the final score.

**Weight:** TANITA (BC 541) weighting scale was used in this test to measure weight of the subject with the capacity of 440lb and readability of 0.2 lb(1kg). Subjects were asked to remove their shoes and socks before measuring and took out anything that can influence the weight reading from the pocket. The subjects were asked to stand properly on the scale. Weight was recorded to the nearest 0.1kg.

**Flexibility (Sit & Reach Test):** Subject were instructed to do gentle stretching before the test to prevent injury. After a light warm up, two trials were carried out in the continuous slow movement without jerking and knees bending with maximum value of reach by two arms recorded to the nearest 0.5 cm mean value after two trials.

**Muscular Endurance (1 –Minute Push-ups):** Subject were asked to perform as many push-ups as possible; with a place hands approximately wider than shoulder width and maintain a horizontal spinal position by maintaining a straight leg position, with their knees off the mat for men. For women, a modified push-ups was apply by placing hands approximately wider then shoulder with and mainting a horizontal spinal position same as men by placing their knees on the mat. All subject were required to bend their elbows to lower their extremities until the chest was approximately 12 cm from the mat (touch the sponges provided) while mainting the prescribe position with their backs. The subjects extended the elbows and return to original position. The speed of movement was control with a audio pacer set to 3 second each position. The maximum number of repetition performed in 1 minute with appropriate technique were recorded.

**Muscular Strength (Handgrip Test):** Handgrip strength was measured using a Jamar Hydraulic Hand Dynamometer. The subjects were asked to perform a
maximal voluntary contraction, standing with the dynamometer at one side and gripping the dynamometer as hard as they could for 5 second. Three trials were performed for each hand considered to be the maximum voluntary handgrip strength. Both dominant and non-dominant hand were tested.

**Speed (20-Meter run):** The 20-meter speed test was employed to evaluate the subjects’ speed and acceleration ability. Three runs were completed and the best time was recorded as final score. Subject were given five minutes rest between each runs. Each subjects were tested individually.

**Power (Overhead Medicine Ball Test):** This test required the subject to throw the medicine ball (2 kg) by using both hand behind their head as far as possible with the proper technique. Subjects were instructed to hold the medicine ball behind their head as starting position and throw similar to a serving technique. Subjects were allowed three attempts to toss the medicine ball in the highest throw value was recorded to the nearest feet.

**Speed Endurance (Spider Run):** The spider run test involved quick run to collect five balls that were located on the court at the back corners of the service boxes located at the back corners of the court. The subjects started from the middle of the baseline and run to collect each of the balls and bring them one by one to the starting point. Even though traditionally spider test is considered an agility test due to its relatively long duration; it can also be used to evaluate specific speed endurance in tennis [9]. The subject were allowed three attempts, the best time was recorded in seconds.

**Agility (T-Test):** The agility test required the subject to run from point A to point B then by using side step move toward point C back to point B then move toward point D back to B then by running reversed to point A in shortest period of time [10]. Subject were given three times to perform the test and best time was recorded as final score. Subjects were instructed to rest five minutes between each runs and were tested individually.

**Cardiovascular Fitness (Yo-Yo Intermittent Recovery Test-Level 1):** Before the test conducted, subjects were given an instructions and explanations on the test protocol. This test required the subject to run 20 meter continuously with turning in the opposite direction after each straight 20 meter run with a 5 meter resting interval before the next beep; the running will be instructed by the audio playback. The flat surface with 5 meter distance cone A to B and 20 meter from cone B to cone C with a total of 25 meter in total distance was used in this test. The subjects were asked to run from the starting line that is cone B to cone C and run back toward cone B before the second beep, then jog to cone A back to cone C while waiting for the next beep. The test was stopped when the subject failed to reach the line for two consecutive ends.

**RESULT**

This study involved thirteenth male and female Sarawak Tennis athlete consist of 8 male and 5 female respectively from Sarawak Lawn Tennis Association (SLTA) and Persatuan Tennis Bumiputera Sarawak (PTBS), Kuching, Sarawak. They were all ranged from 15 to 21 years old, with mean age 18.08 ± 2.1, weight 59.35 ± 10.12kg and height 171.08 ± 5.25 cm.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean±SD</th>
</tr>
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<tbody>
<tr>
<td>Flexibility (inches)</td>
<td>20.54±7.763</td>
</tr>
<tr>
<td>Muscular Strength (Right) (kg)</td>
<td>42.38±13.257</td>
</tr>
<tr>
<td>Muscular Strength Left (kg)</td>
<td>34.07±9.647</td>
</tr>
<tr>
<td>Power (meter)</td>
<td>26.65±6.647</td>
</tr>
<tr>
<td>Agility (sec)</td>
<td>12.03±1.003</td>
</tr>
<tr>
<td>Speed Endurance (sec)</td>
<td>20.15±1.880</td>
</tr>
<tr>
<td>Speed (sec)</td>
<td>3.45±0.236</td>
</tr>
<tr>
<td>Muscular Endurance (Reps per min)</td>
<td>45.00±8.051</td>
</tr>
<tr>
<td>Aerobic &amp; Anaerobic Endurance (Distance - m)</td>
<td>1243.07±369.670</td>
</tr>
</tbody>
</table>

Table 1 shows the subjects fitness components’ descriptive statistics. Pearson correlations test was conducted to measure the relationship among the fitness components of the tennis players (Table 2). Significant and positive correlation were found between flexibility and cardiovascular fitness (r = 0.753), while there is a significant negative correlation with speed (r = -0.625). Muscular strength for right hand was significant correlated with all the other fitness components (p <.05). Agility (r = -0.653), speed endurance (r = -0.582) and speed (r = 0.572) were significant negative correlated with muscular strength for the right hand, while the others appear positive relationships, muscular strength for the left hand (r = 0.824), power (r = 0.835), muscular endurance (r = 0.729) and cardiovascular fitness (r = 0.839). On the other hand, muscular strength for the left hand was also has significant relationship with leg power (r = 0.840), agility (r = -0.697), speed endurance (r = -0.676) and
Table 2: Correlation Between Health Related Component and Skill Related Component

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flex</td>
<td>1.000</td>
<td>0.378</td>
<td>0.093</td>
<td>0.126</td>
<td>-0.125</td>
<td>-0.215</td>
<td>-0.625*</td>
<td>0.475</td>
<td>0.753*</td>
</tr>
<tr>
<td>2. Str (R)</td>
<td>1.000</td>
<td>0.824*</td>
<td>0.835*</td>
<td>-0.653*</td>
<td>-0.582*</td>
<td>-0.572*</td>
<td>0.729*</td>
<td>0.839*</td>
<td></td>
</tr>
<tr>
<td>3. Str (L)</td>
<td>1.000</td>
<td>0.840*</td>
<td>-0.697*</td>
<td>-0.676*</td>
<td>-0.416</td>
<td>-0.572*</td>
<td>0.557*</td>
<td>0.526</td>
<td></td>
</tr>
<tr>
<td>4. Power</td>
<td>1.000</td>
<td>-0.823*</td>
<td>-0.807*</td>
<td>-0.296</td>
<td>0.710*</td>
<td>0.569*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Agility</td>
<td>1.000</td>
<td>0.746*</td>
<td>0.178</td>
<td>-0.351</td>
<td>-0.235</td>
<td></td>
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<tr>
<td>6. Sp. End</td>
<td>1.000</td>
<td>0.178</td>
<td>-0.351</td>
<td>-0.235</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>7. Speed</td>
<td>1.000</td>
<td>0.746*</td>
<td>0.178</td>
<td>-0.351</td>
<td>-0.235</td>
<td></td>
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<tr>
<td>8. M. End</td>
<td>1.000</td>
<td>0.746*</td>
<td>0.178</td>
<td>-0.351</td>
<td>-0.235</td>
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<td>9. Cardio</td>
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muscular endurance \((r = 0.557)\). Both leg power and muscular endurance were appear significant positive correlated with muscular strength for the left hand, while speed endurance and muscular endurance were significant negative correlated. Agility and speed endurance exhibits a significant positive correlation \((r = 0.746)\), similar to muscular endurance and cardiovascular endurance \((r = 0.756)\). Speed and cardiovascular endurance has a significant negative correlation \((r = 0.704)\). The significant level is at.05 \((p <.05)\).

**DISCUSSIONS**

The purpose of this study was to develop a fitness profile of the Sarawak tennis players on selected fitness components. The findings revealed some of the fitness components were related to each other.

A factor that is able determine one tennis match outcomes is the player’s fitness and physical capabilities [1]. Thus, physiological profiling may become essential for designing an optimal physical conditioning program for tennis players. Plus, the player’s fitness capability and anthropometry characteristics also make an important contribution to a match result [11]. The findings of this study highlights significant correlations between the selected fitness components. Hence, the result of the present study emphasize the importance of sport-specific fitness test and demonstrate their value and contribution to a tennis player’s performance. However, one should take into account that this present study result related only to fitness capability on selected fitness components variable and that no tactical or technical variable were measured. Therefore, a reliable prediction of a player’s future success is not possible based on the present study findings.

It was found that there were significant correlations between the fitness components. For the health-related components, flexibility and speed suggests an inverse relationship. This means the lower body flexibility indicates a greater speed. In previous study also stated that the greater the range of motion (ROM) the greater the sprint performance [12]. The present study applied sit and reach test and 20-m run test for these components. However, flexibility and cardiovascular endurance has a positive relationship which indicates the greater the lower body flexibility, specifically the hamstring muscles, the greater the cardiovascular endurance. This gives an interesting information. Flexible hamstring muscles means that the muscles are able to perform at their maximal range of motion which also give advantage to the running performance in cardiovascular endurance thus the running could sustain longer and the distance covered is greater. This suggests that, a flexible lower body could contribute to a greater cardiovascular endurance. This relationship might indicate a link between flexibility and cardiovascular endurance as agreed by Institute Of Medicine (2012) [13].

Cardiovascular endurance replicates the functioning of the pulmonary and cardiovascular systems to deliver oxygen and the capacity of tissues to extract oxygen from the blood for a better delivery of human performance. A tennis match which known as endurance sport [2] could benefit to this advantage. This positive relationship was between muscular endurance and cardiovascular endurance. This leads to the information that, the greater the muscular endurance of the upper body of the players, the greater their cardiovascular endurance. This explains that the ability to sustain running over a period of time is associated with the upper body endurance, which involves repetitive arm swings. Again, this gives information that, an endurance upper limb could benefit the endurance performance. Additionally, muscular strength (right hand) is associated with all of the fitness components. Most of the tennis players in the present study were right-handed, thus this could explain positive relationships with upper body power, muscular endurance
and also cardiovascular endurance. On the other hand, regarding the negative relationships with agility, speed endurance and speed explain that the greater the upper body strength, the lower the performance of these skill-related components. However, this relationship may not affect the performance of the tennis players as their muscular strength was at good indicator.

For upper body power, it shows inverse relationships with agility and speed endurance. This indicates that, the greater the upper body power, the lower the agility and speed endurance. The indirect relationships indicate the upper body and lower body ability. In tennis, creatine phosphate re-synthesis occurs primarily by oxidative processes [14]. This shows the importance of aerobic metabolism to tennis, as it is an agent which enhance the recovery from intense activities and maintains the power outcome, especially throughout a long-lasting game.

Agility and speed endurance show a positive relationship, where it can be interpreted as the greater the agility, the greater the speed endurance. The other skill-related component measure, speed, is inversely related to cardiovascular endurance. Even though these two components are from different category, in the present study, it shows that the greater the players’ speed ability, the lower the cardiovascular endurance. In accordance with this, a greater aerobic capacity may also decrease the reliance on anaerobic energy sources and the accumulation of lactate and fatigue levels in the exercising muscles [12]. However, both anaerobic and aerobic capacity of the players in this study were in good level. In relation to the present findings, the significance of anaerobic-type or power and speed related variables to tennis performance has been demonstrated previously. In past studies, female college tennis players produced significantly higher strength during the internal rotation of the dominant arm and non-dominant arm shown and this difference was attributed by the stretch-shortened muscle action required in tennis serve [16]. It has been reported that female regional tennis players had 40% and 15% greater back and leg strength than club players [17]. The importance of strength is also demonstrated by studies showing that external, internal and diagonal peak torques of the shoulder contribute substantially to service ball velocity [18]. It is recommended, therefore that strength training to be included in the training program of tennis in order to improve performance [6].

Besides agility, speed endurance is also related with muscular strength and power. This shows that a relatively greater muscular strength and power which reflects that in order to have near maximal speed for prolonged amount of time the players will have a good muscular strength and power. This also reflects that when the players have a good speed endurance, they can perform the action with maximal power and strength repetitively. This is supported by studies which examine the relationship between physical characteristic among young tennis players had found the similar findings [9,7].

On the other hand, agility and cardiovascular endurance do not have a significant relationship. This is contradicted to a study [4] in which the intervention of aerobic training observed an improvement in agility. Whilst agility has significant relationships with muscular strength and power, the endurance tennis game might contribute to the association with this skill-related fitness. A high level of fatigue was found to reduce skill and hitting accuracy by as much as 80% [19]. It is therefore not surprising that world-class tennis players were found to demonstrate higher aerobic fitness and lower lactate levels at comparable intensities then lower-ranking player [7].

**CONCLUSIONS**

Not many study were conducted with an objective to determine fitness profile or to create norms and standards for physical fitness component in tennis and specifically for tennis specific games. Based on this study, the findings presented shows the relationships between the specific fitness components of tennis players. Muscular strength is related to the other fitness components of the players either positively or inversely. To cardiovascular endurance, the relationships with most of the fitness components should be highlighted. Speed endurance was greatly shows relationships with two skill-related fitness; agility and power. In addition, the ability to move from point to point in the shortest period of time; speed is not as importance as the relationships of speed endurance and the other fitness components.

With this findings, the norms and physical fitness standards could be establish. The junior and senior tennis players could have a chance to be fairly graded based on their ability and will not be overated and underated. Moreover, this could open the eyes to the coaches that the importance of needing to know the fitness level of each of his or her athletes. Conversion of the normative data to relationship made the results of this study practically usable to the coaches in order to grade their tennis player’s physical fitness appropriately. Additionally, creating local athletes based norms is
important. Since quite often we obliged to use norm imported from the different countries, which usually related to different ethnic group [20], leading to improper and sometimes biased judgement and result. This study quantifies physical fitness profile and provide norms for testing that can help accurately grading Sarawak Tennis playes according to their assessment and selection purpose.

REFERENCES