

COMPARISON OF FITNESS COMPONENTS BETWEEN STATE AND
NATIONAL VOLLEYBALL PLAYERS
IN MALAYSIA

by

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ABSTRAK

Penentu komponen kecergasan atlit telah popular dalam beberapa dekad kebelakangan ini. Sebagai pemain bola tampar, mereka hendaklah mempunyai kecergasan yang bagus supaya dapat bertanding di perlawanan bertaraf tinggi. Walau bagaimanapun, di Malaysia, data berkaitan komponen kecergasan dalam kalangan pemain bola tampar amatlah terhad, oleh itu tujuan kajian ini dijalankan adalah untuk menentukan perbezaan dalam komponen kecergasan di antara pemain bola tampar peringkat negeri dan peringkat kebangsaan (lelaki dan wanita). Dua puluh lapan pemain negeri (jantina: 14 lelaki dan 14 wanita ; umur: 19.4 ± 1.2 tahun , 18.3 ± 1.2 tahun) dan 24 pemain kebangsaan (jantina: 12 lelaki dan 12 wanita ; umur: 22.8 ± 1.4 tahun , 21.3 ± 1.1 tahun) telah mengikuti kajian ini. Komponen kecergasan berkaitan kesihatan (kardiovaskular, fleksibiliti, komposisi badan dan kekuatan dan ketahanan otot badan) dan kemahiran (ketangkasan, kelajuan dan kekuatan) telah dikaji. Independent Sample T-test telah digunakan untuk membandingkan semua komponen antara kategori pemain negeri dan pemain kebangsaan. Hasil analisis menunjukkan bagi pasukan lelaki, perbezaan yang signifikan hanya terdapat pada berat, BMI dan kelajuan sahaja antara kedua-dua kategori. Keputusan ini dipengaruhi dengan faktor umur, di mana berat dan BMI meningkat mengikut umur dan bagi komponen kelajuan pemain negeri menunjukkan mereka lebih pantas daripada pemain kebangsaan. Manakala bagi pasukan wanita, perbezaan yang signifikan hanya terdapat pada tinggi, berat dan ketangkasan sahaja ($p < 0.05$) bagi kedua-dua kategori di mana tinggi dan berat juga dipengaruhi oleh faktor umur dan bagi komponen ketangkasan, pemain kebangsaan menunjukkan mereka lebih tangkas berbanding pemain negeri yang membuktikan hal ini berkait rapat dengan latihan dan pengalaman bermain. Kesimpulannya, banyak faktor lain yang dapat mempengaruhi tahap permainan seseorang selain dari komponen kecergasan. Walau

bagaimanapun, maklumat daripada kajian ini dapat memberi menjadi penanda aras komponen kecergasan untuk pasukan lain agar dapat sentiasa mengekalkan prestasi yang terbaik.

ABSTRACT

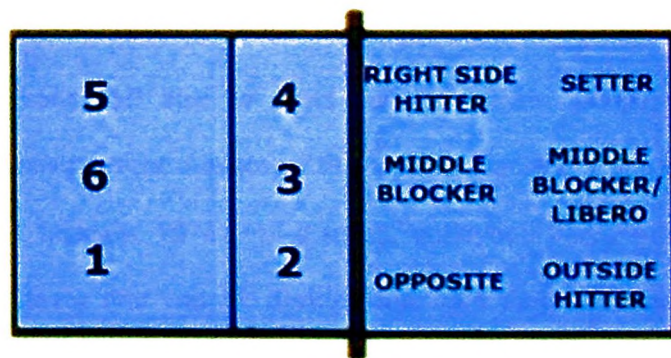
The determination of fitness components of athletes has been popular over last few decades. As a volleyball player, they need to have a well developed physical fitness to enable successful performance at the competitive level. However, in Malaysia, there is limited information regarding the fitness components among volleyball players. Therefore the objective of the study was to determine the difference of fitness component between state and national volleyball players (men's and women's). Twenty eight state players (gender: 14 males and 14 females ; age: 19.4 ± 1.2 years respectively , 18.3 ± 1.2 years respectively) and 24 national players (gender: 12 males and 12 females ; age: 22.8 ± 1.4 years respectively , 21.3 ± 1.1 years respectively) participated in this research. Health and skill related fitness components were assessed. The health-related fitness includes cardiovascular fitness, flexibility, body composition and muscle strength and muscle endurance. Meanwhile, the skill-related fitness component are agility, speed and power. Independent Sample T-test was used to analyses the differences of all physical fitness components between the state and the national players. Results showed that, the men's national team, heavier compared to state players, while state players revealed that they are faster compared to the national players. While for women's national team, the players are taller, heavier and agile compared to the state players. The result showed that training and playing experienced influenced the agility in the court. In conclusion, there are a lot of other factors that may contribute to an individual performance apart from their fitness component. However, information gained from this study can be a benchmark for future team fitness component in order to maintain well establishes fitness level to optimize performance.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Volleyball is among the most popular games played all over the world (Govind, 2013). The sport was first played as an official Olympic sport in the 1964 Olympic (Volleyball, 2007). It is a game in which two teams of six players are separated by a net. The game is played on a 18 m (59 ft) long and 9 m (29.5 ft) wide court, divided into 9 m × 9 m halves by a one-meter (40-inch) wide net. Each team tries to score points by grounding a ball on the other team's court under organized rules. There are five positions in each volleyball team; the setter, outside hitter/left side hitter, middle hitter, opposite hitter/right side hitter and libero/defensive specialist (Figure 1.1). Each of these positions plays a specific, key role in winning a volleyball match.



www.VolleyballAdvisors.com

Figure 1.1 Position in Volleyball

As a volleyball player, they should master six basic skills; serve, pass, set, attack, block and dig. Volleyball is essentially a game of transition from one of the above skills to the next, with expected team movement between plays on the ball. The game is played, with the first team to score 25 points by a two-point margin is awarded the set. Matches are best-of-five sets and the fifth set, if necessary, is usually played to 15 points. (Scoring differs between leagues, tournaments, and levels; high schools sometimes play best-of-three to 25); in the NCAA matches are played best-of-five to 25.

Tsunawake (2003) explained that physical fitness characteristics of the volleyball players are more important as these have marked effects on the skill of players and the tactics of the teams. This is because volleyball games require repeated maximum exertion such as dashing and jumping. Beside that, Smith *et al.* (1992) reported that volleyball is a game of explosive strength, agility, skill and concentration as there are a lot of combines skill with many rallies, therefore players are feel necessity for have a good physical fitness that will enable successful performance during competition.

Furthermore, volleyball also involves various sprints, jumps (blocking and spiking), and high-intensity court movement that occurs repeatedly during competition (Hosler, Morrow, and Jackson, 1978). As a result, volleyball players depend on well developed physical fitness that can be divided into two major components; health-related fitness and skill-related fitness. Health-related physical fitness consists of those components of physical fitness that have a relationship with good health. The components are commonly defined as body composition, cardiovascular fitness,

flexibility, muscular endurance, and strength. While skill-related physical fitness consists of those components of physical fitness that have a relationship with enhanced performance in sports and motor skills. The components are commonly defined as agility, balance, coordination, power, speed and reaction time. Most of the components are necessary for volleyball players because the game places a large number of demands on the technical and physical skills of a player. During the course of play, players are required to serve, pass, set, attack, block and dig the ball. Therefore, playing volleyball requires flexibility, good agility, upper and lower body strength and speed in order to be played effectively.

On the other hand, selected physiological and anthropometric characteristics could successfully discriminate level competition among volleyball players (Thissen and Mayhew, 1991). Thus, the present study has been conducted on state and national volleyball players in Malaysia to evaluate their selected physical characteristics that are crucial as volleyball players.

1.2 Nature of the Game

1.2.1 Position in Volleyball

Like in other sports, volleyball also has its own position identity. As mentioned earlier, there are five positions in volleyball. Each position play different role and thus makes this game interesting. As there are different position with differ role in the team, they also require different physical demands according to the position.

Firstly, the role of the setter. In volleyball, setter (Figure 1.2) is the one who have the task for orchestrating the offense of the team. They aim for second touch and their main responsibility is to place the ball in the air where the attackers can place the ball into the opponent's' court for a point. Setters need to have upper limb muscle strength to push the ball where he/she wants and must be quick at moving around the court. Besides, setter also need to block, therefore a setter requires to have good jumping abilites to block the spiking/attack from the opponents.



Figure 1.2 The setter

Next, liberos are defensive players who are responsible for receiving the attack or serve. They are usually the players on the court with the quickest reaction time and best passing skills. They do not necessarily need to be tall, as they never play at the net, which allows shorter players with strong passing and defensive skills to excel in the position and play an important role in the team's success. A libero also feel necessity for a great agility to move quickly and change direction in a match.



Figure 1.3 The libero

Then, middle hitters, opposite hitters and outside hitters are players that mostly performing jumps because their job is to spick and block. Therefore, a spiker or hitter requires well developed power and muscle strength of lower limb. Besides that, they also need to play defense while at the back court, thus others components are also important for them like agility, speed. Hitter also need to play in rallies, therefore spiker or hitter also needs to have well-developed cardiovascular fitness.



Figure 1.4 Hitter/Spiker

1.3 Game Requirement

Volleyball is an intermittent sport that requires players to participate in frequent short bouts of high-intensity activity, followed by periods of low-intensity activity (Kunstlinger, Ludwig, and Syegemann, 1987; Viitasalo *et al.*, 1987). The high- intensity bouts of exercise, coupled with the total duration of the match about 90 minutes, requires players to have well-developed aerobic and anaerobic lactic (ATP-CP) energy systems (Polglaze and Dawson, 1992; Viitasalo *et al.*, 1987).

However, the length of time varies depends on the level of competition and scoring. The game can generally be played at high low intensity based on the opponents game play or the circumstances of the game. The volleyball skills and condition of the players affect the strategy of the game, the more flexible the player the more the strategies that a coach can make by doing substitutions, different rotation and variety of tactical executions.

1.4 Research Objective

The general objective of this study is to compare the differences in fitness component between state and national volleyball players in Malaysia. While the specific objectives of this study are to compare differences of health related fitness and skill related fitness between state and national volleyball players in Malaysia.

1.5 Research Hypothesis

Ho1 : There is no significant difference in health related fitness
between state and national volleyball players in
Malaysia.

HA1 : There is significant difference in health related fitness
between state and national volleyball players in Malaysia.

Ho2 : There is no significant difference in skill related fitness
between state and national volleyball players in Malaysia.

HA2 : There is significant difference in skill related fitness
between state and national volleyball players in Malaysia.

1.6 Significance of Study

The present study is about fitness component between state and national volleyball players in Malaysia. The study was used physical fitness test to evaluate the fitness components among the volleyball players. According to Claenssens *et al.* (1999), an appropriate and wise use of physical fitness test can enhance the performance level of the elite sportsperson. The identification of health related fitness on the other hand can help not only with the health maintenance of the sportsperson, but at the same time plan and undertake proper measures for the continuous improvement of the physical fitness, performance and physiological profile both at individual and group/team level.

Besides that, based on the present study, it would allow coaches and athletes to identify and assess the physical and performance characteristics specific to the age groups for purposes of professional evaluation, selection, monitoring and continuous development at both individual and team level (Bozo *et al.*, 2012). This also can help in development and selection of the players.

Furthermore, the athlete itself can identify their strength and weakness in their own fitness component. Physical fitness tests can determine the level of fitness and from it, they can compete with other athletes in a good way. Last but not least, the evaluation can be a benchmark of the fitness level for other volleyball players.

CHAPTER 2

LITERATURE REVIEW

2.1 Component of Physical Fitness

According to World Health Organization in 1971 physical fitness has defined it simply as "the ability to perform muscular work satisfactorily". However, The President's Council on Physical Fitness and Sports in 1971 offered one of the more widely used definitions, describing physical fitness as the "ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies." While, The Centers for Disease Control and Prevention sponsored a workshop in 1985, bringing together a group of experts who concluded that physical fitness "is a set of attributes that people have or achieve that relates to the ability to perform physical activity". Besides that, the American College of Sports Medicine in 1990 proposed that "fitness is the ability to perform moderate to vigorous levels of physical activity without undue fatigue and the capability of maintaining such ability throughout life." All of these definitions place an emphasis on having vigor and energy to perform work and exercise. Vigor and energy are not easily measured, however, and physical fitness experts have debated for more than a century on the important measurable components of physical fitness. The most frequently cited components fall into two groups, one related to athletic skills and the other one related to health.

Skill related fitness refers to the components of fitness that are necessary for optimal work or sports performance (Bouchard, 1994). According to US Department of Health and Human Services (2008), this is defined in terms of the individual's ability during athletic competition, a performance test or occupational work. Skill related fitness depends heavily on aerobic and/or anaerobic capacity, power, reaction time, agility, balance, speed and coordination. While health-related physical fitness consists of those components of physical fitness that have a relationship with health. These components are favorably or unfavorably affected by physical activity habits and are related to the health status. Health-related fitness has been characterized by an ability to perform daily activities with vigor, and by traits and capacities that are associated with a low risk for the development of chronic diseases and premature death. It includes cardiovascular fitness, flexibility, muscular strength & endurance and body composition.

In volleyball, selected physical fitness components could successfully discriminate among the players (Gabbet, 2007). Thissen-Milder and Mayhew (1991) also showed that physical fitness could distinguish among different competition. Besides, we could use certain physical fitness values to select an ideal athlete (Faria and Farida, 1989) or to evaluate the effects of training (Forbes 1991).

2.2 Skill-related Fitness

2.2.1 Speed

Speed is a skill-related component of physical fitness that relates to the ability to perform a movement within a short period of time (Surgeon General's Report on Physical Activity and Health, 1996). A well developed speed can be determined by body movement that can rapidly move from one point to another (Mannan *et al.*, 2012).

Volleyball is a game that demands speed, as it requires players to have rapid acceleration and deceleration (Govind *et al.*, 2013). This game constitutes movements like sprinting for short distance for example to run after the touch out ball done by teammates or run after the ball farther from the own position (Mannan *et al.*, 2012). Besides that, Gabbet (2007) showed that, in volleyball, the players are required to have speed since it is a fast game and needs to have various sprints to jump and block that occurs repeatedly during the competition.

In many team sports, players rarely run more than 20 m in a straight line during a game or match. Thus, testing speed over distances greater than 20 m is often irrelevant as players do not have opportunity to achieve such stride. Furthermore, in volleyball the game is played on a 18 m (59 ft) long and 9 m (29.5 ft) wide court, divided into 9 m × 9 m halves by a one-meter (40-inch) wide net, therefore the required space played in this game is not big as the other game like football or hockey (Volleyball, 2007), thus the testing speed, a 20-m sprint is the suitable for volleyball players.

2.2.2 Agility

Agility refer to the ability to rapidly change the position of the entire body in space with speed and accuracy (Surgeon General's Report on Physical Activity and Health, 1994). It can also be defined as the quickness and readiness of movement. It is the ability to change the position of the body with skill and control when faced with some sort of stimulus or opposing movement (Mishra and Das, 2008)

Agility constitutes as an important fitness component required for a volleyball player since this game needs the player to change their direction quickly and efficiently to dig the ball, set the ball, blocking and others court movement (Mannan, 2012). De Almeida and Soarres (2003) also highlighted that volleyball includes fast movements and sudden shifts which need high agility for optimized performance. The agility of players can be assessing by using the 'T-test', which includes forward, backward and lateral movements that are required and important in volleyball (Hoffman, Maresh, Armstrong, and Kraemer, 1991).

2.2.3 Power

Power relates to the ability to perform work within a certain period of time (Surgeon General's Report on Physical Activity and Health, 1996). Besides, it also can be defined as ability to produce maximum force in the shortest time. There are two components of power are muscle speed and strength. An effective combination of these two components allows a person to produce explosive movements such as required in jumping (spiking) (Mannan, 2012).

Muscle strength in the lower limbs is crucial in volleyball. The performance in the vertical jump is directly related to the performance of the players. As the jump is one of the components of service and defense movement of volleyball, being used in case of interception, shot blocking and spiking (Stojanovic T and Kostic R., 2002).

De Almeida & Soarres (2003), states that volleyball, is one of the most amazing sports, that includes fast movements, jumps, lands and sudden shifts which need high power and strength for optimized performance. One of the main purpose of volleyball players in a match is to have superiority net play against the other team and the players with higher jumping abilities have the advantage compared to the others (Ciccarone *et al.*, 2007). Lower extremity power and vertical jumps are important factors of successful volleyball performance (Stec and Smulsky, 2007).

A study showed that there a significant correlation between vertical jump ability with success rate of spikes and blocks in volleyball games (Xing *et al.*, 2006). One of the most important purposes of training is to improve muscle strength and power for volleyball players (Hertogh and Hue, 2002). Volleyball players' excellent performances are highly associated with the efficiency of jumping or lower extremity explosive power vertical jump as one of the most important characteristics of physical fitness in volleyball players (Zhang, 2010).

2.3 Health-related Fitness

2.3.1 Cardiovascular fitness

Cardiovascular fitness is a direct marker of physiological status and reflects the overall capacity of the cardiovascular and respiratory systems to supply oxygen during sustained physical activity, as well as the ability to carry out prolonged exercise. The maximal oxygen consumption ($\text{VO}_{2\text{max}}$) attained during a graded maximal exercise is considered to be an objective measure of the cardiovascular fitness performance (Taylor, 1955). It is one of the most important components of physical fitness. With well developed cardiovascular fitness, a person will be able to perform dynamic exercise involving large muscle groups at moderate-to-high intensity for prolonged periods (American College of Sport Medicine, 2014).

In volleyball, it needs players to participate in frequent short bouts of high-intensity exercise. With the various demands of speed, jumps and court movement that occurs repeatedly during competition requires players to have well developed cardiovascular fitness. (Kunslinger *et al.*, 1987). Beside that the high- intensity bouts of exercise, coupled with the total duration of the match about 90 min, requires players to have well-developed aerobic and anaerobic alactic (ATP-CP) energy systems (Polglaze & Dawson, 1992; Viitasalo *et al.*, 1987)

Exercise physiologists consider directly measured maximum oxygen uptake ($\text{VO}_{2\text{max}}$) the most valid measure of functional capacity of the cardiovascular system. The $\text{VO}_{2\text{max}}$ reflects the capacity of the heart, lungs and blood to deliver oxygen to the working muscles during dynamic exercise involving large muscle mass. The $\text{VO}_{2\text{max}}$ is

widely accepted as the criterion measure of cardiovascular fitness (Heyward and Gibson, 2014). Heyward and Gibson (2014) stated that, beep test have been devised to predict VO₂max, this test are practical, inexpensive less-time consuming, easy to administer to large groups and suitable for personal training settings. Besides, it can be used to classify the cardiovascular fitness level.

Level	Shuttle	Predicted VO ₂ Max.	Level	Shuttle	Predicted VO ₂ Max.	Level	Shuttle	Predicted VO ₂ Max.
4	2	26.8	10	2	47.4	16	2	68.0
4	4	27.6	10	4	48.0	16	4	68.5
4	6	28.3	10	6	48.7	16	6	69.0
4	9	29.5	10	8	49.3	16	8	69.5
			10	11	50.2	16	10	69.9
						16	12	70.5
						16	14	70.9
5	2	30.2	11	2	50.8	17	2	71.4
5	4	31.0	11	4	51.4	17	4	71.9
5	6	31.8	11	6	51.9	17	6	72.4
5	9	32.9	11	8	52.5	17	8	72.9
			11	10	53.1	17	10	73.4
			11	12	53.7	17	12	73.9
6	2	33.6	12	2	54.3	18	2	74.8
6	4	34.3	12	4	54.8	18	4	75.3
6	6	35.0	12	6	55.4	18	6	75.8
6	8	35.7	12	8	56.0	18	8	76.2
6	10	36.4	12	10	56.5	18	10	76.7
			12	12	57.1	18	12	77.2
						18	15	77.9
7	2	37.1	13	2	57.6	19	2	78.3
7	4	37.8	13	4	58.2	19	4	78.8
7	6	38.5	13	6	58.7	19	6	79.2
7	8	39.2	13	8	59.3	19	8	79.7
7	10	39.9	13	10	59.8	19	10	80.2
			13	13	60.6	19	12	80.6
						19	15	81.3
8	2	40.5	14	2	61.1	20	2	81.8
8	4	41.1	14	4	61.7	20	4	82.2
8	6	41.8	14	6	62.6	20	6	82.6
8	7	42.4	14	8	62.7	20	8	83.0
8	11	43.3	14	10	63.2	20	10	83.5
			14	13	64.0	20	12	83.9
						20	14	84.3
						20	16	84.8
9	2	43.9	15	2	64.6	21	2	85.2
9	4	44.5	15	4	65.1	21	4	85.6
9	6	45.2	15	6	65.6	21	6	86.1
9	11	46.8	15	8	66.2	21	8	86.5
			15	10	66.7	21	10	86.9
			15	13	67.5	21	12	87.4
						21	14	87.8
						21	16	88.2

Figure 2.1 Predicted VO₂max for 20m shuttle run

(source : Krasilshchikov, 2015)

According to the Figure 2.1, it showed that the predicted of VO₂max only started when the athletes exceed the level 4 shuttle 2. In this study, the cardiovascular fitness of the players were assessed through the 20m shuttle run and predicts their VO₂max from the table.

2.3.2 Flexibility

Flexibility is the ability of a specific muscle or muscle group to move freely through a full range of motion. It is of importance in a variety of athletic performances but also in the capacity to carry out the activities of daily living, which is very important from a public health perspective (Bouchard, 1994). Adequate levels of flexibility are needed for maintenance of functional independence and performance of activities of daily living. (Heyward and Gibson, 2014).

According to Malliaras (2006), in volleyball, flexibility is important because requires players squatting or lunging down low to return the ball. Besides that, flexibility also helps to prevent injuries e.g. preventing cramp and pulled muscles when moving around the court since volleyball requires player to have repeated movement spiking and blocking, therefore a proper stretching to allow flexibility is important for a volleyball player.

In this study, sit and reach was used to determine the flexibility. Dillon and Wells (1952) highlighted that the sit and reach test is a common measure of flexibility, and specifically measures the flexibility of the lower back and hamstring muscles. In

volleyball, lower back and hamstring muscles are the common muscles used when playing therefore this test is important as because tightness in this area is implicated in lumbar lordosis, forward pelvic tilt and lower back pain.

2.3.3 Muscular strength & endurance

Muscular strength is the maximal force or tension level that can be produced by a muscle group while muscular endurance is the ability of a muscle to maintain submaximal force levels for extended periods. Heyward and Gibson (2014), states that both strength and muscular endurance can be assessed for static and dynamic muscular contractions. The assessment are used to establish baseline values before training, monitor progress training and assess overall effectiveness of resistance training.

The ACSM (2014) recommend using a push-test to assess endurance of the upper body musculature. While sit-ups test is commonly included health-related fitness test batteries to identify abdominal strength and endurance.

According to De almeida and Soarres (2001), volleyball includes fast movements, jumping's, landings and sudden shifts that need high power and strength for optimized performance. Besides, it is demonstrated that muscle strength and endurance are important parameters for success in volleyball (Zhang, 2010).

2.3.4 Body composition

Body composition refers to body height and body weight in terms of the absolute and relative amounts of muscle, bone and fat tissues. It is important to measure body composition for estimating a healthy body weight and formulating nutrition recommendations and exercise prescriptions. It is also important for estimating competitive body weight and height for athletes participating in sports (Heyward and Gibson, 2014).

For volleyball players, they are typically taller than other players of other games because they require handling ball above the head. Barzouka *et al.* (2008) states that body height is considered a determinant factor for good performance in volleyball and, together with its relation to body mass, it is used as a criterion for the selection of promising volleyball players.

Besides that, volleyball players were reported to have mesomorphic-ectomorph somatotype that means they have a muscular yet body with little body fat (Rahmawati *et al.*, 2007). Shyamal and colleagues (2010) also states that number of anthropometric and physical characteristics (body height, body weight) and physical-performance parameters seem to be advantageous to the volleyball players and were positively correlated with better performance. From the existing data, it appears that the body mass index values seen in the literature for female volleyball players of different age, nationality and competition level vary between 20.5kg/m² and 22.5kg/m² (Fleck *et al.*, 1985).

CHAPTER 3

METHODOLOGY

3.1 Participants

The total participants in this study were 52 volleyball players in total, 26 male volleyball players of off-season stage (14 from the Kuala Lumpur team and 12 from the national team) and 26 female volleyball players (14 from the Kuala Lumpur team and 12 from the national team). The age range for state team was from 17-21 years old while the age range for national team was from 19-26 years old. The 52 volleyball players, participants in this study, were assessed for physical fitness test, four health related fitness test and three skill related fitness.

3.2 Sample Size Calculation

GPower calculation was used in this study. With an effect size of 0.8, alpha level of 0.05, power of 0.80 and allocation ratio of 1, the sample size required was 26 participants for each category.

3.3 Procedure

After obtaining the ethical approval from Ethical Committee Council of Universiti Sains Malaysia, a formal letter was sent to the coach of the state (Kuala Lumpur) and national team, explained about the research and seek their permission to let their players take part in the research. After receiving coaches approval, the participants which were the players from state and national players were voluntarily participated in this study based on logistics and availability. The fitness test was done separately for the national team and state team which state team was done the fitness test at the Sri Petaling court while national was done at the JKR Salak Selatan court, both in Kuala Lumpur. The selection of the state team was based on the coaches approval, there are three teams that had been approached but only Kuala Lumpur's coach approved and wanted to take part in this research project.

Before the research started, participants were briefly explained about the background, purpose of the research and how the research will be conducted. The participants then completed and sign the information form and consent form to be part of this study. The participants who are below 18 years old were asked to obtain information and consent form to their parents or guardians to be part of the study.

Next, the skill related fitness and health related fitness parameters that were critical for volleyball players were assessed. Skill related fitness was divided into three components which were agility (T-test), speed (sprinting 20 yard test) and power (vertical jump test). While for health related fitness was divided into four components which were cardiovascular fitness (beep test), flexibility (sit and reach test), body

composition and muscle strength and endurance (sit ups and push ups in 30 seconds). All of the components were arranged properly in seven stations in the volleyball hall.

3.4 Protocol

3.4.1 Cardiovascular fitness

Aerobic fitness of the participants was tested by the beep test. The test involved continuous running between two lines placed 20m apart in time of recorded beeps. The participants was asked to stand behind one of the lines facing the second line, and to begin running when instructed by the audio tape. The speed at the start was quite slow. The participants continued running between the two lines, turning when signaled by the recorded beeps. After about one minute, a sound indicated an increase in speed, and the beeps were closer together. The process continued each minute for a single level. If the line was not reached in time for each beep, the participants would run to the line turn and try to catch up with the pace within 2 more 'beeps'. Also, if the line was reached before the beep sounds, the participants would wait until the beep sounds. The test was stopped if the participants failed to reach the line (within 2 meters) for two consecutive ends. The score was calculated over the level and number of shuttles (20 m) reached by the players before they were unable to keep up with the recording. The last completed level was recorded for scoring. The level recorded was converted into VO_{2max} as per standard technique (Leger & Lambert, 1982)

3.4.2 Flexibility

Flexibility of the participants was tested by sit and reach test using a sit and reach box. The participants then was flex their body towards the box and the nearest centimeters as the distance touch by the hand was recorded. This test was run one time in a protrude position with no shoes.

3.4.3 Anthropometry

Height and weight of the participants was measured in this station using stadiometer and weighing scale without shoes. The participants was asked to standing straight and stand still until the measurement was recorded.

3.4.4 Muscle strength and endurance

Muscle strength and endurance was tested by push ups and sit ups test in 30 seconds. They did each test with partner and their partner was calculated how many they can do it. For push up test, the participants was tested with full push up which means they need to bend their elbow completely, however, for female players, they are allowed to put their knees on the ground. While for sit ups, the participants was asked to complete the test with their hands across the chest.

3.4.5 Agility

Agility of the participants were tested by T-test for three times based on the time (stopwatch) using four cones that was are set in the T-shape. Agility

times were measured to the nearest 0.01 s with the best value obtained from three trials used as the agility score.

3.4.5 Speed

Speed of the participants was tested by sprinting 20m sprint test to determine their body ability to move quickly using a whistle and cones (start and end point). Stopwatch was used to set their running time. Players were instructed to run as quickly as possible along the 20m distance from a standing start. Speed was measured to the nearest 0.01 s with the best value obtained from three trials used as the speed score.

3.4.7 Power

Power of the participants was tested by vertical jump test. Players were requested to stand with feet flat on the ground, extend their arm and hand, and mark the standing reach height. After assuming a crouch position, each participant was instructed to spring upward and touch the at the highest possible point by paste the colored tape given. No specific instructions were given about the depth or speed of the countermovement. Vertical jump height was calculated as the distance from the highest point reached during standing and the highest point reached during the vertical jump. Vertical jump height was measured to the nearest centimeter with the best value obtained from three trials used as the vertical jump score.

3.5 Statistical Analysis

Statistical analysis followed the most important descriptive statistics, such as mean and SD. A Independent t-test was used to determine significant differences among state and national volleyball players. The level of significance was set at $p < 0.05$ and all data are expressed as mean \pm SD.