FITNESS PROFILE OF MALAYSIAN ADOLESCENT SQUASH PLAYERS

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ABSTRACT

Squash is an indoor game that is the second fastest racket sports if compared to badminton and tennis. Squash game puts a high demand on physical fitness of elite players which requires a quick development of high force, rapid changes of direction and fast reaction. The objective of this study was to develop the physical fitness profile of Malaysian junior state squash players. Sixty five 10 to 18 years old male Kelantan state squash players were tested with seven skill-related fitness tests. SPSS version 20.0 was used to analyze the data collected from the tests. A one-way ANOVA was used to detect statistical differences between groups. A post-hoc test (LSD) was performed to determine differences in in the variables between groups. The data was collected for flexibility, speed, muscular endurance, power of upper and lower extremities, agility and cardiovascular endurance. There were significant differences in the mean speed, muscular endurance, agility, power of lower extremities, power of upper extremities, flexibility and predicted VO_2max between 13-15 and 16-18 years of age groups when compared to 10-12 years old players ($p<0.05$). Similarly, there were significant differences in speed, muscular endurance, agility, power of lower extremities, power of upper extremities, flexibility and VO_2max between 16-18 and 13-15 year old players ($p<0.05$).
Key words: *squash, fitness, adolescent players*

INTRODUCTION

Squash is an indoor game that is the second fastest racquet games if compared to badminton and tennis. It is a complex sport that requires superior coordination, endurance, speed and power (David, 1992). Cardiovascular endurance, local muscular endurance, speed and speed endurance are collectively referred to as the energy system demands critical to a sport of squash (Wollstein & Ellis, 1995).

Squash game puts a high demand on physical fitness of elite players which requires a quick development of high force, rapid change of direction and fast reaction. Squash at elite level has been reported as being predominantly aerobic with a major speed (alactic anaerobic) component and a small but variable lactic acid (anaerobic) component (Sharp, 1988).

Physical Fitness

Physical fitness is defined as a capacity to perform activity and it makes reference to full range of physiological and psychological qualities (Ortega *et al*, 2008). Factors associated with physical fitness in squash include aerobic capacity, anaerobic power, strength, speed, flexibility, balance and

coordination (Rensburg *et al.*, 1982). The most important qualities for squash are cardiovascular, strength and flexibility because they are the foundation for the development of all others (Wollstein & Ellis, 1995).

Physical fitness for squash consists of cluster of items. Among the most important is cardiorespiratory fitness and muscle endurance (combination of the ability to deliver appropriate anaerobic and aerobic power together with and equally important ability to recover). Another one is strength and speed-related and consists of muscle strength (particularly important to have a strong abdomen and lower back with reasonable grip strength that is not below the threshold level) and muscle speed (particularly off- the mark speed of movement and racquet speed). Flexibility (especially elasticity/ flexibility of quadriceps and hamstring, mainly to help prevent injury) and low percentage body fat (counting 7-12% for men and 18-27% for women at elite level) are of equal importance among the fitness components (Sharp, 1988).

Physiological demands of Squash

Squash is considered the most physiologically demanding of the four racquet sports where players are active 50% to 70% of the playing time. Squash, reportedly requires intermittent activity with frequent bursts of near-maximal intensity play (Kingsley *et al.*, 2006) and although activity during play is intermittent, heart rate response during competitive match play can be equivalent to about 90% of individual maximum heart rate. Squash matches last up to three hours (Steininger & Wodick, 1987) and therefore a high level of energy reserve for anaerobic glycolysis and aerobic processes is required (Blanksby *et al.,* 1973). Both aerobic and anaerobic energy systems are highly taxed during squash match play for energy supply (Girard *et al,* 2007). Because of the high aerobic demand of the game, a physiological characteristic that is greatly associated with success in squash at elite level is a performer's maximum oxygen uptake (VO_2max) which is commonly used as an indicator of an individual potential for endurance performance. Adequate aerobic and anaerobic fitness levels have a serious impact on all squash skills (i.e. consistency of technical skill production, efficiency of tactical and anticipatory thought processes), it is therefore desirable to elevate fitness levels to enhance overall performance and reduce the risk of injury (Wollstein & Abernethy, 1998).

Squash is often regarded as a moderate to high intensity game (Montpetit, 1990) which demands a high level of specific fitness (Locke *et al.*, 1997). To become a champion in squash, players need both wide range of skills and high standard of fitness (Chin *et al.*, 1995).The game also demands fast reaction, quick acceleration, fast arm, leg and whole body movements and an ability to change direction quickly (Reilly and Halsall, *1995*).

Objective of the Study

The objective of this study was to develop the physical fitness profile of Malaysian junior state squash players.

METHODOLOGY

Subjects

Sixty five male Kelantan state squash players were tested with seven skill-related physical fitness tests. Twelve of the players were ranked among best 16 in the national level. Subjects in this study were 10 to 18 years old and had two or more years of competition experience at the National level. The research data were collected between 2005 and 2012 at the Kelantan state squash coaching centre.

According to their age subjects were divided into three groups:

- Group 1 - 10 to 12 years old (n= 10)
- Group 2 - 13 to 15 years old (n= 32)
- Group 3 - 16 to 18 years old (n= 23)

Ethical clearance was obtained from the human ethics committee, USM Health Campus, Kubang Kerian prior to the commencement of the study. Required consent forms were signed by the subjects and their coaches.

Tests battery

Height: Subject height was measured by using SECA 206 mechanical measuring tape with measuring range 0 to 220 centimetres and 1 mm gradation. SECA 206 mechanical measuring tape was hanged on the wall with height over the floor of 200 centimetres. Subjects were instructed to remove their shoes and socks before measuring the height and to stand properly with assistance from the measurer before the height value was taken. Height was recorded to the nearest 0.5 cm.

Weight: TANITA weighing scale was used in this test to measure weight of the subjects with the capacity of 440lb and readability of 0.2lb (0.1 kg). Subjects were instructed to remove their shoes and socks before measuring and put out anything that can influence the weight reading from the pockets. The subjects were instructed to stand properly on the scale. Weight was recorded to the nearest 0.1 kg.

30 meters sprint: The subjects were instructed to perform the warm-up before the test was conducted in order to prevent the injury. The test required subjects to run a sprint over 30 meters thrice with timing of the best effort recorded to the nearest one hundredth of a second. Subjects were instructed to start the test with a stationary position with one foot is in front of the other and subject's front foot behind the starting line. The time was measured with a stop watch when subject crossed the finishing line.

Sit-ups in 30 seconds: Subjects were briefly explained the correct technique of performing sit-ups with chest crossed arms and knee bent at 45˚ with a partner holding the feet during the test. The test starts when instructor blows the whistle and finishes in 30 seconds time. Number of completed sit-ups counted within the 30 second time interval was recorded.

6x10m shuttle run: Before the test conducted, subjects were given an instructions and explanations on the test protocol. This test required subject to perform six successive 10 meter sprints with turning in the opposite direction after each straight 10m run. The flat surface with approximately 30 meter distance was used in this test. 10 meters distance was marked with cones at starting line

and the end of 10 meters. The subjects were to sprint from the starting line to the opposite line, step behind the line with one foot and run back to the starting line to step out the line with one foot. The 10 m runs were repeated for five times, with the sixth run completed by running across the starting line. The time was recorded to the nearest one hundredth of a second.

Standing broad jump: During this test, standing broad jump mat was used with the subjects standing with feet comfortably apart behind the line. Subjects were asked to jump maximal distance and were allowed to perform counter movement prior to take off with arm swing. The best of three jumps was recorded to the nearest cm. The distance from the take-off line to the back of the heel closest to the take-off line was recorded.

Medicine ball toss: This test required the subject to throw the medicine ball (1 kg) by using the dominant hand as far as possible with the correct technique. Subjects were instructed to hold the medicine ball right on the shoulder as starting position and throw the ball similar to a standing shot putting technique. Subjects were allowed three attempts to toss the medicine ball in and the highest throw value was recorded to the nearest centimeter.

Sit and reach test: Flex-Tester (Novel Products Inc.) was used in this test in order to measure subject's flexibility. Subjects were instructed to do gentle stretching before the test to prevent injury. After two or three warm up trials, three 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 centimeter.

Bleep test: This test was involving continuous running between two lines 20 meter apart in accordance to pre-recorded beeps. Subjects were instructed to stay behind one of the lines facing the second line and begin running when instructed by the CD playback. The subjects continues running between two lines and turning when signalled by the recorded beeps. After about one minute, a sound indicated an increase in speed and the beeps will close together and the same continues for each minute or level. If the line is not reached in time for each beep, the subject must run to the line turn and try to catch up with the pace within two more beeps and if the line is reached before the beep sounds, the subject must wait until the beep sounds. The test is stopped if the subject fails to reach the line for two consecutive ends.

Statistical Analysis

Statistical analyses were performed using a commercial software package (SPSS version 20.0 for Windows). Results were expressed in means ± standard deviation. A one-way ANOVA was used to detect statistical differences between groups. A post-hoc test (LSD) was performed to determine differences in in the variables between groups. The differences were considered significant at $p<0.05$).

The descriptive analysis further served to generate general sample means and standard deviations for seven parameters tested which are related to flexibility, speed, muscle endurance, power of upper extremities, and power of lower extremities, agility and cardiovascular endurance. Descriptive statistical analysis was used to generate score of the sample according to the age group.

At the later stage of the analysis, in order to develop fitness norms, data was converted into standard scores. With the T-scores value ranged from 0 to 100 and based on traditional percentiles, the raw data was transformed in T- score grades based on 5 categories, namely: excellent, good, average, below average and poor.

RESULTS

Age Group Physical Fitness Profile

Results presented in Table 1 show the means and SD for variables tested in this study for the various age groups.

Table 1: Descriptive statistics for various age groups (mean ± SD)

Variables	Group 1 (n=10)	Group 2 (n= 32)	Group 3 (n=23)
30 meters run (sec)	5.64± 0.32	4.98± 0.37	4.51± 0.28
Sit-ups / 30 sec (reps)	11.78± 8.50	33.77± 7.37	40.68± 11.77
6x10m shuttle run (sec)	18.18± 0.84	15.63± 0.82	14.90± 0.58
Standing broad jump (cm)	146.00± 14.76	187.03± 24.29	212.09± 28.78
Med ball toss (m)	5.87 ± 1.23	10.91 ± 2.48	13.48 ± 2.26
Sit and reach (cm)	1.40 ± 1.19	7.90 ± 7.59	13.75 ± 6.94
V_{O2}Max (ml/kg/min)	35.31 ± 4.23	42.84 ± 6.36	48.01 ± 4.67

There was a statistically significant difference between groups in 30m run as determined by one-way ANOVA ($F(2,59) = 38.51$, $p = .000$). A LSD post-hoc test revealed that the running time was statistically significantly lower in groups 2 and 3 as compared to group 1, and in group 3 as compared to group 2 ($p = .000$ in all three pairs).

Statistically significant difference between groups was determined in sit-ups performed in 30 seconds ($F(2,59) = 30.98$, $p = .000$). The post-hoc test revealed that the number of sit-ups was statistically significantly higher in groups 2 and 3 as compared to group 1 ($p = .000$ for both pairs), and in group 3 as compared to group 2 ($p = .01$).

There was a statistically significant difference between groups in 6x10m shuttle run as well ($F(2,58) = 62.57$, $p = .000$). The post-hoc test revealed that the running time was statistically significantly lower in groups 2 and 3 as compared to group 1 ($p = .000$ for both pairs), and in group 3 as compared to group 2 ($p = .001$).

There was a statistically significant difference between groups in the standing broad jump ($F(2,60) = 24.56$, $p = .000$). The post-hoc test revealed that the distance jumped was statistically significantly higher in groups 2 and 3 as compared to group 1 ($p = .000$ for both pairs), and in group 3 as compared to group 2 ($p = .001$).

Statistically significant difference between groups was determined in 1kg medicine ball toss ($F(2,60) = 39.10$, $p = .000$). The post-hoc test revealed that the distance tossed was statistically significantly higher in groups 2 and 3 as compared to group 1, and in group 3 as compared to group 2 ($p = .000$ for all three pairs).

There was a statistically significant difference between groups in the sit and reach test ($F(2,56) = 10.53$, $p = .000$). The post-hoc test revealed that the distance reached was statistically significantly higher in group 2 as compared to group 1 ($p = .021$), in group 3 as compared to group 2 ($p = .004$), and in group 3 as compared to group 1 ($p = .000$).

As of V_{O2}Max, a statistically significant difference was there between groups ($F(2,61) = 18.95$, $p = .000$). The post-hoc test revealed that the oxygen consumption was statistically significantly higher in groups 2 and 3 as compared to group 1 ($p = .000$ for both pairs), and in group 3 as compared to group 2 ($p = .001$).

As mentioned, data collected in this study was on a later stage converted into standard scores by using SPSS version 20.0. The T-scores value ranged from 0 to 100 and was based on traditional percentiles, the raw data was subsequently transformed into T- score grades based on five categories. That allowed developing norms and standards for grading physical fitness of squash players for both assessment and selection purposes. Table 2 presents developed norms for speed (30m run) and endurance (predicted VO2Max).

Table 2: Norms and standards developed for various age groups in speed and endurance

Test/ grade	Speed (30m run, sec)			Endurance (VO_2max, ml/kg/min)		
	10-12	13-15	16-18	10-12	13-15	16-18
Excellent	<4.21	<3.88	<3.68	>49.54	>61.92	>62.02
Good	4.21-5.00	3.88-4.61	3.68-4.23	40.09-49.54	49.21-61.92	52.69-62.02
Average	5.01-6.80	4.62-5.35	4.24-4.79	30.63-40.08	36.49-49.20	43.35-52.68
Below Average	6.81-8.61	5.36-6.10	4.80-5.36	21.16-30.62	23.76-36.48	34.00-43.34
Poor	>8.61	>6.10	>5.36	<21.16	<23.76	<34.00

Results presented in Table 3 include norms and standards, developed for the adolescent squash players to meet the requirements of assessment and selection in power of lower extremities (standing broad jump) and upper extremities (1kg medicine ball toss).

Table 3: Norms and standards developed for various age groups in power

Test/ grade	Lower extremities (standing broad jump, cm)			Upper extremities (1kg med ball toss, m)		
	10-12	13-15	16-18	10-12	13-15	16-18
Excellent	>193.18	>248.11	>271.75	>9.89	>18.35	>20.26
Good	161.07-193.18	210.84-248.11	233.20 - 271.75	7.28-9.89	13.40-18.35	15.75-20.26
Average	128.95-161.06	173.56-210.83	194.64 - 233.19	4.66-7.27	8.44-13.39	11.23-15.74
Below Average	96.82- 128.94	136.27-173.55	156.07 - 194.63	2.03-4.65	3.47-8.43	6.70-11.22
Poor	<96.82	<136.27	<156.07	<2.03	<3.47	<6.70

Results presented in Table 4 include norms and standards, developed for the adolescent squash players to meet the requirements of assessment and selection in agility (6x10m shuttle run) and flexibility (sit and reach test).

Table 4: Norms and standards developed for various age groups in agility and flexibility

Test/ grade	Agility (6x10m shuttle run, sec)			Flexibility (Sit and reach, cm)		
	10-12	**13-15**	**16-18**	**10-12**	**13-15**	**16-18**
Excellent	<15.59	<13.18	<13.17	>5.63	>30.67	>34.57
Good	15.59-17.20	13.18-14.81	13.17-14.32	2.84- 5.63	15.50-30.67	20.70-34.57
Average	17.21-18.82	14.82-16.45	14.33-15.48	0.04-2.83	0.32-15.49	6.82-20.69
Below Average	18.83-20.45	16.46-18.10	15.49-16.65	-2.8-0.03	-4.9-0.31	-7.08-6.81
Poor	>20.45	>18.10	>16.65	< -2.8	< -4.9	<-7.07

As it is seen from the table, norms for the 15-17 years of age and 16-18 of age players in agility are almost similar. It is perhaps because the mean values in both groups are close: 15.63 and 14.90 respectively (Tab. 1); and the minimum to maximum range of the measurements were close for two groups as well (14.00 to 17.42 and 13.95 to 16.20 respectively).

DISCUSSION

Most studies show that aerobic fitness is important for squash players of various standards (Locke *et al*, 1997; Mellor *et al.*, 1995; Sharp, 1998; Todd *et al.*, 1995). It was shown that maximal heart rate (MHR) in squash players' match play was close to the age-related maximum (Lees, 2003). The mean intensity of 86% and 92% of maximal oxygen uptake (VO_2max) and MHR, respectively sustained during squash game suggest a predominant contribution of aerobic metabolism to energy requirements (Girard *et al.*, 2007).

Several studies (Lees, 2003; Mellor, Hughes, Reilly and Robertson, 1995; Reilly & Halsall, 1995) revealed that low-skill players (much like the younger players in the present study) respond in a different way than higher skilled players, mainly because of processes of adaptation within the cardiovascular system. For example, Reilly & Halsall (1995) reported that the heart rate and rating of perceived exertion (RPE) responses to squash match play were 12–20% higher in recreational players than in regular competitors.

Furthermore, Brown, Weigland and Winter (1998) while studying the transition from elite junior to elite senior squash, reported that elite junior players had a 7–9% lesser capacity to consume oxygen than elite senior players, suggesting that physiological factors, technical and tactical differences affected the transition.

CONCLUSIONS

Not many studies were conducted with an objective to determine fitness profile or to create norms and standards for physical fitness components in squash, and specifically for the adolescent players. Based on this study, data collected and presented shows the significant differences in each variable tested based on squash players' age groups. With the norms and physical fitness standards created based on this study, young or junior squash players stand a good chance to be fairly graded based on their age groups and players' ability will not be overrated or underrated.

Conversion of the normative data to T-scores made the results of this study practically usable to the coaches in order to grade their squash player's physical fitness age-appropriately. Additionally, creating local athletes-based norms is essential, since quite often we are obliged to use norms imported from different countries, which usually relate to different ethnic groups (Eveleth & Tanner, 1991), leading to improper and sometimes biased judgment and results. This study quantifies physical fitness profile and provides norms for testing that can help accurately grading Malaysian youth male squash players according their age group for the assessment and selection purposes.

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