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COMPARISON OF BODY FAT PERCENTAGE AND PHYSICAL PERFORMANCE OF MALE NATIONAL SENIOR AND JUNIOR KARATE ATHLETES

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ABSTRACT

The purpose of the present study was to compare the body fat percentage and physical performance of male national senior and junior karate athletes. Sixteen male karate kumite competitors of the national karate team (senior n = 8; junior n = 8) participated in this study. The tests included both assessment of selected anthropometric variables (body height, weight and body fat percentage) and the following physical performance namely strength, power of lower extremity, agility, flexibility and maximal oxygen consumption. Senior athletes revealed a significant on lower body fat percentage, greater strength and leg power, lesser time in agility and higher in oxygen consumption ($p < 0.05$) but no significant difference in flexibility compared to junior team ($p > 0.05$). It can be concluded that senior karate athletes' physical performance are superior compared to the junior athletes.

Keywords: body fat percentage; physical performance; senior and junior karate athletes.

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1. INTRODUCTION

Karate-do is a very popular Japanese martial art which has been practiced both inside and outside of Japan, characterized by striking and kicking with speed and power and traditional karate training consists of basic techniques, kata and sparring activities [1]. While according to the World Karate Federation (WKF), karate consists of two disciplines which are kata and kumite. Kata represents defined established series of offensive and defensive techniques that correspond to actual fights against fictitious opponents, while kumite represents an actual match against one opponent where the two competitors are free to move, kick and punch in defensive and offensive actions under the strict rules and restricted area [2]. Additionally, kumite is a free sparring that involves the implementation of freely selected defensive and offensive techniques executed against an opponent [3]. Additionally, karate fight is characterized by changeable effort intensity for example, the periods of lower intensity or short intervals alternate with periods of maximum work [4]. An individualized level of intensity of physical exercise, artistic presentation and self fulfilment through an internalized process of learning carried out through one's life is required by martial arts [5].

Karate is also recognized as an official sport at the World Championship, Asian Games and Sea Games. It is important to note that, two major movements in karate are punches and kicks where it requires high physically challenging. Different weight and rule will affect sport science training for Karate competition. It also focuses on one's fitness which includes cardio respiratory endurance, muscle endurance, power, strength and flexibility. By considering the physiological parameters of physical training, it would provide understanding of a specific cause and effect into performance efficiency and function of the athletes [6]. In order to attain successful performance, it is suggested that a specific training program is highly recommended to improve the physical fitness components such as aerobic and anaerobic capacity, speed, muscle strength, recovery and neuromuscular coordination during the training course [7].

Great karate athletes need good body composition. Karate athletes should have the proper body composition since this sport is competed based on weight category. A lower body fat percentage and a lean muscle mass is a desirable characteristic, where it would be quicker for

athletes to move the body mass in scoring points. Apart from that, karate training requires one to train both extremities equally where it develops great balance when delivering punches and kicks. Intermittent hopping movements, which allow rapid change in body position consists of burst consecutive techniques in kumite [8]. Phenomenal form of agility and motor coordination capability occupy a high position in the specification equation for achievement in karate [9]. Good agility would allow karate athlete to strike the opponent with speed and power at any directions. Striking movements in karate requires a great strength, power, endurance, agility, balance, timing and skill and at the same to be alert for counterattacks. Speed and power are the most significant motor abilities and important to ensure success in kumite [10]. Not only that, flexibility also plays an important aspect when executing the techniques. A higher flexibility of the lower extremity could be importance of designing specific testing series not only for early selection, but also for training in karate [11].

Kumite is correspond to intermittent interval activity that characterized by intervals of the maximal (high speed) action and force alternating with periods of low intensity performance [2]. In a typical karate bout, athletes fight in 2:1 effort by temporary halt relationship (in particular 18 ± 6 s of effort with 9 ± 6 s of interval) resulting in 16.3 ± 5.1 s high intensity performance throughout the entire match or 3.4 ± 2.0 s actions for each minute lasting 1 to 3 second each [12]. A similar action time (0.3 ± 0.1 s) was found in a recent published study which resulting in a total high intensity action time of 13.3 ± 3.3 s and 19.4 ± 5.5 s in 2 minutes and 3 minutes matches correspondingly [8]. Although the decisive actions are anaerobic alactic and less prevalent (16.0 ± 4.6 %), the karate match is mainly aerobic in nature (77.8 ± 5.8) as a result of such effort by temporary halt relationship and action interval [12]. Furthermore, the physiological responses such as effort intensity, intensity of the recovery processes, effort duration, recovery duration and ratio between effort and recovery are the influence factors during the interval matches [13]. As a consequence, by taking into consideration of these factors and the studies mentioned above, karate matches can be considered as physical actions in which the involvement of aerobic metabolisms predominate process. However, the actions which resulted in scoring points, anaerobic alactic metabolism is in charge. Nonetheless, during prolonged matches or during competitions where the

competitor has several matches in the same day, aerobic fitness preserved to be very important [12].

The athletes are required to have a good physical fitness, which will enable them to have successful performance at the competitive level. Athletes use almost all muscles during training and competition, but the two events (kumite and kata) differ significantly with regards to style and corresponding muscle use [14]. In addition, movement structures of the sport are considered to be highly demanding to athletes most muscle groups [15]. So, it is important to know the level of physical characteristics of karate athletes where these can help to boost athletes' performances at national and international level tournaments. Information of the physical demands of the sport and physiological characteristics of the national athletes possibly will help to assist the improvement of specific training series for optimal performance in the sport. Therefore, physical performance factors such as power, oxygen consumption (VO_{2max}), strength, agility and flexibility might be relevant to successful performance in karate. Therefore, the aim of the study is to determine the body fat percentage and physical performance (power of lower extremity, agility, oxygen consumption, flexibility and maximal isometric strength) among national senior and junior karate athletes. The study comprises of skinfolds measurement for body fat percentage, maximal isometric hand-grip strength, vertical jump test for leg power, T-test for agility, sit and reach test for flexibility and 20 meter shuttle run test for maximal oxygen consumption (VO_{2max}) with the purpose to design a specific training program based on individualization and simultaneously support the athletes' training.

2. METHODOLOGY

2.1. Participants

Participants involved in this study were the male national senior and junior karate athletes' age ranged between 20-30 years old. This study involved 16 participants representing senior squad (n = 8) and junior squad (n = 8). The senior squad was karate athletes who had won the Senior Makaf at national level and had more than 2 years of experience competing in SUKMA. The senior team also has competed in the Sea Games, Asian Games and other

European Opens. The junior squad was karate athletes who had won the Junior Makaf at national level and had more than 2 years of experience competing in SUKMA. They also have competed in the international level such as ASEAN University Games and invitational championships. All participants are at least black belt holder (1st degree).

Upon the acknowledgment of approval by the UITM ethics committee, researcher proceeded to get on into the study by approaching the National Sport Institute (ISN) ethics committee. With written official letter seeking permission and letter of approval from the university's ethics committee board, researcher underwent the ethical approval in ISN. Subsequent to the ISN ethics committee approval, prior to the test, researcher seeks permission from the national head coach. Writing approval was obtained, all athletes signed consent forms.

2.2. Battery Test Procedure

2.2.1. Body Fat Percentage

Skinfold measurement was used to determine the body fat percentage. The skinfold thickness was measured using the Harpenden caliper from four body sites (biceps, triceps, subscapular and suprailiac). It is reported to have higher reliability r = 0.99 [16]. Measurements were made on the right side of the body by the same experienced investigator to ensure consistency in results. The tester pinched the skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calipers were then applied 1 cm below and at right angles to the pinch, and a reading in millimeters (mm) taken two seconds later. In order to measure the body fat percentage, two formulas were utilized. The body density was estimated from the sum of four skinfold sites and percentage of body fat calculation.

2.2.2. Power of Lower Extremity

Vertical jump test was employed to estimate the lower extremities strength. The equipment used in this test was the Force Platform (AMTI, model OR 5-1; Newton, MA) and it is reported to have a high reliability r = 0.98 and validity r = 0.78 [17]. Participants placed their both feet on the middle of the force plate with their knee flexed at 90 degrees. They began each jump from an upright position. The protocol allowed for countermovement jump with both hands at the hip. Once the participant was set on the force platform, the investigator gave the command "go," which initiated the participant's jump. 5 seconds were given to each

participant to complete the jump. Participants rested 1 minute between trials and were encouraged to jump maximally on each trial. Three trials were given and the best score were recorded.

2.2.3. Strength

Participants were in a standing position with arms and elbow at the side of the body. The handle of the dynamometer was adjusted according to participants' fitting-the base rested on first metacarpal (heel of palm), while the handle rested on middle of four fingers. Then, the participants were asked to squeeze the dynamometer with maximum isometric effort. There is no body movement was allowed. The result appeared on the dynamometer's screen was recorded. Three trials were given with a pause of about 10-20 seconds in between each trial to avoid the effects of muscle fatigue. The best score was recorded.

2.2.4. Agility

The T-test course consisted of two 10 m straight sections forming the shape of letter T. It included a forward sprint (10m), side shuffle to the left (5 m), side shuffle to the right (10 m), side shuffle back to the left (5 m) and back peddled 10 m back to the start. The participants ran when the command "go" was signal from the researcher. Three trials were given and the best results were recorded in second(s).

2.2.5. Flexibility

Participants sat with legs fully extended with the bare soles of the feet placed flat against the flexibility box. The knees fully extended, arms evenly stretched, palms down, the participant reached forward without jerking. The participants pushed the sliding marker along the scale with the fingertips as far as possible. The position of maximum trunk flexion was held for about two seconds. Three trials were given and the best score were recorded. Results were recorded in centimeter (cm).

2.2.6. Oxygen Consumption

The objective was to measure the maximal oxygen consumption (VO_{2max}) and the 20 meter shuttle run was utilized in this test [18]. Cones marker, tape, shuttle run CD and CD player were employed. It is reported to have high reliability r = 0.98 [19]. Participants started ran and finished in 20 meters apart. Mark the end of start and finish line with two cones spaced 3

meters. The participants stood with the front foot exactly on the start line. The participants listened to the CD and started run according to the beep. The level and shuttle were recorded when the participants' finished and estimated VO_{2max} will be calculate.

2.3. Data Analysis

In prior of the key data analysis, data were tested for the normality, homogeneity of variance, missing and outlier data by using box plot and Kolmogorov-Smirnov and Levene's Test [20-24]. This study employed T-test, thus the formula for effect size is computed as Eta squared = $t^2 / t^2 + (N_1 + N_2 – 2)$ whereas 0.0 represent small effect, 0.06 for moderate effect and 0.14 for large effect. All analysis, significance level was accepted at $p < 0.05$ and operating XLSTAT 2014 add-in software to achieve the objective of the study.

3. RESULTS

Data from sample size of 16 participants were collected from senior and junior team. The descriptive statistic characteristics selected for discussion were age, height, weight, body fat percentage, hand grip, vertical jump, agility, flexibility and VO_{2max}. Table 1 shows the demographic data for senior karate athletes and Table 2 shows the demographic data for junior karate athletes. The variable for age from eight respondents with mean aged of 23.62 ± 2.88 years old. Table 1 revealed the youngest athlete in senior team was 20 years old while the oldest was 27 years old. For the height, the shortest was 164.80 cm and the tallest was 184.30 cm, with a mean of 173.11 ± 7.29 cm. For the weight, the lightest athlete was 53.75 kg and the heaviest was 84.50 kg with a mean of 66.27 ± 10.50 kg. For the body fat percentage, the minimum was 6.64 % and maximum was 11.32 % with a mean of 8.02 ± 1.62 %. The mean for hand grip test was 47.41 ± 6.12 kg. The minimum score was 39.10 kg, while the maximum was 58.40 kg. For the vertical jump, the mean was 37.88 ± 2.47 cm. The lowest score was 32.00 cm and the highest was 40.00 cm. The agility T-test mean was 10.76 ± 0.33 sec. The fastest was 10.28 sec and the slowest was 11.28 sec. For the flexibility, the mean was 41.56 ± 1.38 cm. The least flexible was 37.00 cm and the most flexible was 51.50 cm. Finally, the mean for VO_{2max} was 56.65 ± 4.16 ml/kg/min. The lowest was 50.84 ml/kg/min and the highest was 62.49 ml/kg/min.

Table 1. Demographic data for senior karate athletes

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	8	20.00	27.00	23.6250	2.87539
Height (cm)	8	164.80	184.30	173.1125	7.29137
Weight (kg)	8	53.75	84.50	66.2688	10.50255
Body Fat (%)	8	6.64	11.32	8.0175	1.62014
Hand Grip (kg)	8	39.10	58.40	47.4125	6.11542
Vertical Jump (cm)	8	32.00	40.00	37.8750	2.47487
Agility T (second)	8	10.28	11.28	10.7637	0.33890
Flexibility (cm)	8	37.00	51.50	41.5625	4.78418
VO_{2max} (ml/kg/min)	8	50.84	62.49	56.6506	4.16635

For the variable for age, we have information from eight respondents with mean aged of 21.88 ± 1.64 years old. Table 2 projected the youngest athlete in junior team was 20 years old, while the oldest was 24 years old. For the height, the shortest was 158.50 cm and the tallest was 178.70 cm with a mean of 171.01 ± 6.48 cm. For the weight, the lightest was 53.20 kg and the heaviest was 78.30 kg, with a mean of 64.60 ± 8.12 kg. For the body fat percentage, the minimum was 8.30 % and the maximum was 11.80 %, with a mean of 10.52 ± 1.40 %. The mean for hand grip test was 35.71 ± 4.92 kg. The minimum score was 29.40 kg and the maximum score was 45.80 kg. For the vertical jump, the mean was 31.50 ± 4.34 cm. The lowest score was 25.00 cm and the highest score was 37.00 cm. The agility T-test mean was 11.98 ± 0.53 sec. The fastest was 11.50 sec and the slowest was 13.10 sec. For the flexibility, the mean was 38.56 ± 7.93 cm. The least flexible was 27.00 cm and the most flexible was 51.50 cm. Finally, the mean for VO_{2max} was 44.27 ± 4.31 ml/kg/min. The lowest was 36.20 ml/kg/min and the highest was 49.90 ml/kg/min.

Table 2. Demographic data for junior karate athletes

	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	8	20.0	24.0	21.875	1.6421
Height (cm)	8	158.5	178.7	171.013	6.4892
Weight (kg)	8	53.2	78.3	64.606	8.1216
Body Fat (%)	8	8.3	11.8	10.520	1.3973
Hand Grip (kg)	8	29.4	45.8	35.712	4.9198
Vertical Jump (cm)	8	25.0	37.0	31.500	4.3425
Agility T (second)	8	11.5	13.1	11.983	0.5324
Flexibility (cm)	8	27.0	51.5	38.562	7.9392
VO_{2max} (ml/kg/min)	8	36.2	49.9	44.271	4.3125

3.1. Comparison of Body Fat Percentage

An independent-samples t-test was conducted to compare the body fat percentage for senior and junior athletes. Homogeneity of variance was determined by the Levene's test for equality of variances. The significance level for Levene's test of body fat percentage is 0.805 as shown in Table 3. This means that the assumption of equal variances has not been violated.

An independent-samples T-test was conducted to compare the body fat percentage for national senior and junior athletes. Based on Table 3, there was a significant difference in scores for senior (8.02 % ± 1.62 %) and junior (10.52 % ± 1.40 %); $t(14) = -3.30$, $p < 0.05$. The magnitude of the difference in the means (mean difference = -2.50, 95% CI: -4.12 to -0.88) was very large (eta squared = 0.44). Null hypothesis is therefore rejected. It is suggested that there is a significant difference in body fat percentage between national senior and junior karate athletes.

Table 3. Independent samples T-test for body fat percentage

	t	df	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Body Fat	-3.30	14	0.005	-2.50250	0.75642	-4.1248	-0.88014
	-3.30	13.704	0.005	-2.50250	0.75642	-4.1281	-0.87685

3.2. Comparison of Hand Grip Strength

An independent-samples t-test was conducted to compare the hand grip strength for senior and junior athletes. Homogeneity of variance was determined by the Levene's test for equality of variances. Based on Table 3, the significance level for Levene's test of hand grip strength is 0.689. This means that the assumption of equal variances has not been violated.

An independent-samples T-test was conducted to compare the hand grip strength for national senior and junior athletes. Table 4 shows there was a significant difference in scores for senior (47.41 kg ± 6.12 kg) and junior (35.71 kg ± 4.92 kg); $t(14) = 4.22$, $p < 0.05$. The magnitude of the difference in the means (mean difference = 11.70, 95% CI: 5.75 to 17.65) was very large (eta squared = 0.56). Null hypothesis is therefore rejected. It is suggested that there is a significant difference in hand grip strength between national senior and junior karate athletes.

Table 4. Independent Samples Test for hand grip

	t	df	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Hand Grip	4.216	14	0.001	11.70000	2.77494	5.74834	17.65166
	4.216	13.386	0.001	11.70000	2.77494	5.72262	17.67738

3.3. Comparison of Leg Power Test

An independent-samples t-test was conducted to compare the vertical jump test for senior and junior athletes. Homogeneity of variance was determined by the Levene's test for equality of variances. The significance level for Levene's test of vertical jump test is 0.43. This means that the assumption of equal variances has been violated. Therefore, equal variances not

assumed has been used.

An independent-samples T-test was conducted to compare the vertical jump test for national senior and junior athletes. Table 5 shows there was a significant difference in scores for senior (37.88 cm ± 2.47 cm) and junior (31.50 cm ± 4.34 cm); t (11.11) = 3.61, $p < 0.05$. The magnitude of the difference in the means (mean difference = 6.375, 95% CI: 2.49 to 10.26) was very large (eta squared = 0.48). Null hypothesis is therefore rejected. It is suggested that there is a significant difference in vertical jump test between national senior and junior karate athletes.

Table 5. Independent samples T-test for vertical jump test

	t	df	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Vertical Jump	3.608	14	0.003	6.37500	1.76714	2.5847	10.16513
	3.608	11.113	0.004	6.37500	1.76714	2.49040	10.25960

3.4. Comparison of Agility

An independent-samples t-test was conducted to compare the agility for senior and junior athletes. Homogeneity of variance was determined by the Levene's test for equality of variances. The significance level for Levene's test of agility is 0.404. This means that the assumption of equal variances has not been violated.

An independent-samples T-test was conducted to compare the agility for national senior and junior athletes. Table 6 show there was a significant difference in scores for senior (10.76 sec ± 0.34 sec) and junior (11.98 sec ± 0.53 sec); t (14) = -5.46, $p < 0.05$. The magnitude of the difference in the means (mean difference = -1.219, 95% CI: -1.70 to -0.74) was very large (eta squared = 0.68). Null hypothesis is therefore rejected. It is suggested that there is a significant difference in agility between national senior and junior karate athletes.

Table 6. Independent samples T-test for agility

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Agility	-5.46	14	0.000	-1.21912	0.22312	-1.6977	-0.74058
T	-5.46	11.873	0.000	-1.21912	0.22312	-1.7058	-0.73242

3.5. Comparison of Flexibility

An independent-samples t-test was conducted to compare the flexibility for senior and junior athletes. Homogeneity of variance was determined by the Levene's test for equality of variances. The significance level for Levene's test of flexibility is 0.249. This means that the assumption of equal variances has not been violated.

An independent-samples T-test was conducted to compare the flexibility for national senior and junior athletes. Table 7 projected there was a significant difference in scores for senior (41.56 cm ± 4.78 cm) and junior (38.56 cm ± 7.93 cm); t (14) = -0.915, p > 0.05. The magnitude of the difference in the means (mean difference = 3.000, 95% CI: -4.03 to 10.03) was very small (eta squared = 0.056). Null hypothesis is therefore accepted. It is suggested that there is no significant difference in flexibility between national senior and junior karate athletes.

Table 7. Independent samples T-test for

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Flexibility	0.915	14	0.375	3.00000	3.27719	-4.0289	10.02887
	0.915	11.492	0.375	3.00000	3.27719	-4.1756	10.17568

3.6. Comparison of Oxygen Consumption

An independent-samples t-test was conducted to compare the oxygen consumption for senior and junior athletes. Homogeneity of variance was determined by the Levene's test for equality of variances. The significance level for Levene's test of oxygen consumption is 0.873. This

means that the assumption of equal variances has not been violated.

An independent-samples T-test was conducted to compare the oxygen consumption for national senior and junior athletes. As shown in Table 8, there was a significant difference in scores for senior (56.65 ml/kg/min ± 4.16 ml/kg/min) and junior (44.27 ml/kg/min ± 4.31 ml/kg/min); t (14) = 5.84, $p < 0.05$. The magnitude of the difference in the means (mean difference = 12.38, 95% CI: 7.83 to 16.93) was very large (eta squared = 0.26). Null hypothesis is therefore rejected. It is suggested that there is no significant difference in oxygen consumption between national senior and junior karate athletes.

Table 8. Independent samples T-test for oxygen consumption

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
VO_{2max}	5.840	14	.000	12.38000	2.12001	7.83302	16.92698
	5.840	13.983	.000	12.38000	2.12001	7.83251	16.92749

4. DISCUSSION

The present study found that the senior team were having lower percentage of body fat compared to the junior team. This indicated that those senior athletes' body mass were very lean. This is due to the experiences for years of training which made the senior team to have lower body fat percentage. It should be noted that movement velocity may be affected by the anthropometric variable. A lower body fat percentage is a desirable characteristic, where it would be lighter for athletes to move the body mass. At the same time, it would allow higher velocity to be attained [25]. This result supports that karate athletes try to maximize lean body mass and lessen the fat percentage intended for a specified weight class. The advantage by having less body fat percentage is that the athletes would be able to move rapidly when delivering blows towards the opponent. Not only that, a quick move is an advantageous for the kumite athletes to counter or to defence the opponent from getting points.

In fact, the body fat percentage were found on both groups in the present study are similar to those found in other studies with national teams of high-level martial arts competitors. This

study is in agreement to four sites skinfold measurement because most of other studies applied the same procedures which measured the physiological responses during matches and profile of elite *Pencak Silat* exponents [26]. The anthropometry was measured by 4 sites of skinfold measurement which are biceps, triceps, subscapular and suprailiac. The mean values for body fat percentage were 11.3 % (5.4 %) for male exponents. Nevertheless, it is proven that an examination of heart rate and lactate responses to taekwondo fight in elite women performers [27]. Four sites of skinfolds (subscapular, suprailiac, triceps and biceps) were measured and the mean scores were 14.8 % ± 1.7 %. The body fat percentages showed lower scores compared to the athletes studied in similar studies and it was a true expression of elite Taekwondo performers.

In contradictions with the previous study on physiological profile of Indian boxers, the junior boxers (12.2 % ± 1.1 %) were found to have lower body fat percentage compared to the senior boxers (16.4 % ± 3.8 %) [28]. While in other study of measuring the association between neuromuscular tests and kumite performance on the Brazilian Karate National Team, the result in the study presented that there were no differences between winner and defeated groups. However, the values were higher than the previous published data for taekwondo athletes (36.7 mm ± 6.8 mm) and boxers (38.1 mm ± 7.4 mm) [15, 25]. Some study estimated body fat percentage from the skinfold measurement [29]. It is presented that the fat percentage of male French national team were 12.2 % ± 1.9 %. Nevertheless, in kumite events, weight categories match up to body size of kumite competitors. The maximum movement velocity which is the ability for crucial success in kumite competition should remain unaffected by body size [11]. This is due to longitudinal body dimensions of karate athletes which enable them to reach and punch the opponent earlier, especially in intercepting actions [19].

In order to produce more speedily movement, it should be noted that the karate athletes must possessed a lower body fat percentage. The junior athletes must increase more muscle mass and reduce the body fat percentage, which can make them lighter and faster in kumite event. The head coach should design and provide good training program to the junior athletes in order to enhance performance especially at international level tournaments.

The finding for the hand grip strength test showed that the senior athletes' mean hand grip

strength test was substantially higher than junior athletes. Differences in strength between senior and junior team might influence the kumite performance. This might due to the longer period of training years for the senior athletes. This is understandable that the duration of training years may influence the strength development of karate athletes. Strength is proportional to muscle size, where this can be indicative of a higher muscle mass cross-sectional area and therefore a higher power and force output may be produced [30]. Strength is an essential attribute where in sparring (kumite) event, strength is a basic fundamental to deliver a punch or a kick towards the opponent and not only that they still require upper body strength to block and absorb kicks from their opponents.

A study on *Pencak Silat* exponents consisted of hand grip strength where the forearm grip strength was measured by an electronic dynamometer with standardized protocols [26]. The results showed that the *silat* athletes' mean absolute grip strength was substantially lower those of than other martial arts. This is due to the nature of *silat* where the necessity to strongly grip the opponent might not be crucial as in other martial arts for example Judo.

Additionally, higher values of loaded for example 10% of their maximal voluntary isometric contraction and unloaded elbow extension velocity was observed in experienced compared to novice karate players [31]. Likewise, studies on taekwondo and judo athletes of different levels presented similar 1RM values [4]. Hence, muscle powers at low loads were dependent by karate performance rather than high loads or on maximal dynamic strength (1RM). Therefore, the association of usual power and maximum strength assessments with kumite performance were identified [25].

The hand grip test is a test which not only shows the contractile capacity of the hand, but also of the other muscle groups such as the leg muscles and the strength of the whole body [32]. The test is essential for karate athletes where in kumite event, the athletes need strength to deliver punches or kicks towards the opponent. Although it is probably advantageous to seize a strong grip to take down an opponent, karate matches are won by collecting points through kicking and punching. Note that there is difference between senior and junior in terms of strength, where it could be one of the factors why senior athletes are better than junior athletes. Specifically, a success of both attacking and defensive kumite skills are greatly depends on

the strength in delivering blows to the opponent. Strength is essential in kumite competitors in order to initiate techniques in dynamic positions.

It is suggested that specific strength training program should be designed to improve the strength of junior athletes. This is crucial for the athletes to develop strength as competing at international level would be more challenging. By developing overall body strength, it would help those athletes to be more confidence and be able to accomplish successful results at the international level competitions.

Vertical jump is broadly used as a good marker for lower limbs power. As we compared between senior and junior athletes, we can see the differences in scores. Senior team was able to express significantly greater leg power of lower extremity than the junior team. Karate kicking techniques and footwork movements are really important to be primarily increased the rate of force development during the fight. It is clear to notify that senior athletes have more power of lower limb due to a lot of tournaments participation. The duration of training might also be a factor of the power development and at the same time, years of conditioning training in gym my reflected the leg power of senior team. Nevertheless, the importance of power of lower limb in karate performance is expectable. Different body weight will resulted in difference of relative power obtain. It is shows that greater vertical jump values for international level junior karate athletes when compared to national level athletes [29]. However, the vertical jump results presented in this study are lower than those observed on Brazilian karate national team [25]. In karate match, decisive actions such as a kick or a punch are greatly dependent on muscle power and higher power represents a higher velocity considering that power is the product of force and velocity [25]. The American varsity taekwondo-in team revealed that the comparison taekwondo group with the control group presented higher values for peak torque through knee flexion in equally absolute terms and relative to ratio body mass [33]. Furthermore, greatest percentage of motor units may also play a role as the effect of the proportion of non-contractile tissue to body mass [34-35].

A study on *Pencak Silat* exponents by the Singapore National *Silat* athletes scored 59.9 cm ± 5.8 cm in vertical jump test, meanwhile 45.4 cm ± 4.5 cm scored by the National Czech Taekwondo athletes [26]. Judo athletes from Australia National scored 52.0 cm ± 8.0 cm and

the Canadian Judo athletes scored 55.0 cm ± 9.5 cm. In addition, the Korea Judo athletes scored fairly higher 58.1 cm ±5.6 cm while the Belgium National Judo athletes scored 52.5 cm. It can be observed that those athletes have good power of lower extremity, which would enable them to use techniques that involve lower body strength such as grappling to execute body throws or take-downs [36]. Training routines for karate players consists of performing unloaded punches and kicks, which will result in greater segment velocity are being induced by a greater adaptation in the velocity portion of the force-velocity curve. It is assumed that most of the karate actions relies more on contraction velocity than on muscle strength. Nonetheless, when comparing senior and junior national athletes, we found that senior athletes presented higher maximal power in vertical jump test. The statistics suggest that power of lower extremity variable could help out clarify that performance in power actions involved in karate. Based on geometric similarity theory, strength may be accepted to be relative to height (m^2) and lean body mass (kg) [37]. However, strength may no scale geometrically. It is suggested that strength increases at a higher rate than expected by geometric similarity theory and not only that athletic and sedentary humans were found not to be geometrically similar in strength [38-39].

Although there were differences between the senior and junior team, by comparing the results with other international athletes, our national athletes are still lower in leg power. This may be due to more of upper body training rather than lower limb part. It should be noted that a specific training program that encompasses overall body power should be designed. Consequently, this would improve the performance of national karate athletes competing in different level of tournaments.

Researcher found differences between the two groups regarding agility. The senior team performed better compared to junior team. The involvement in various tournaments either national or international levels, it seems that senior team have a lot of experiences compared to junior team. Different levels of tournament make the athletes to be more focus in terms of speed, skill, techniques and agility. Experiences would train the senior athletes to be more agile when facing a tough opponent especially at the international levels. Since in kumite competition requires rapid changes in movement direction, this test is vital to determine the

ability of athletes to be able to change body positions in any direction. A similar result showed by the elite Croatian female taekwondo athletes [40]. The results demonstrated that the A group (32.8 sec ± 3.9 sec) have better leg power compared to the B group (28.7 sec ± 1.9 sec). However, it remains possible that other factors such as anticipation and pattern recognition or a selection of proper movement techniques could be relatively more important for a kumite competitor than the ability to rapidly change movement direction [41].

Here, we can see the differences between the two teams where the national senior athletes performed better than the junior athletes. The side step was utilized in assessing the agility of the female Croatian taekwondo athletes [40]. The observed female taekwondo athletes from the group A achieved significantly better results (7.8 sec ± 0.3 sec) in the side step test than the athletes from B group (8.21 sec ± 0.2 sec). It can be defined that agility is a quick reaction of breaking and changing directions and accelerate again, while maintaining motor control horizontal and lateral direction [42]. The differences of physical characteristics of both teams are the indicator why the national junior athletes still cannot achieve the level of senior athletes. In order to become senior (elite) level, one should have those characteristics which enable them to perform better in tournaments especially international levels.

To enhance the junior athletes' performances, the national head coach should improve the agility by providing well developed training program. The junior should have better agility in order to compete at international tournaments. A rapid change in movement direction is very important to attack or to defence in kumite matches. Greater agility would promote athletes to be more agile and at the same time would prepare the athletes to react quickly as of rapid attacks from the opponent.

Flexibility was evaluated using a standardized sit-and-reach box test. This test measures the flexibility of the lower back and hamstrings. In this study, it showed no significant difference in flexibility of male national senior and junior karate athletes. This is due to the nature of karate training. Karate especially in kumite session, flexibility is the one of the main criteria for athletes to achieve the high level in learning advanced techniques. It not only will that in national squad as well every week, there will be a flexibility training program which emphasize to increase the range of motion of the national athletes. Furthermore, flexibility is

crucial in karate training where every athlete will be possessed to be having good flexibility in order to be more accurate in delivering techniques. However, the senior karate athletes attained higher results (41.56 cm) than the junior athletes (38.56 cm). Nevertheless, compared to the Croatian female taekwondo athletes, they achieved substantially higher results (55.8 cm) while the Puerto Rican (35.2 cm) and Czech (37.9 cm) accordingly. These differences were probably due to the result of extra strength and conditioning training that the analyzed sample completed in previous years of training. Several exercises were included in the additional training which aimed at improving flexibility of the low back region and hamstrings [40].

Nevertheless, it is known that women are more flexible compare to men. By looking at the results of this study, our national athletes have better flexibility compared to the Puerto Rican and Czech. This might be due to the flexibility training program imposed by the national head coach, which conclusively increases the range of motion of the national athletes. Flexibility is vital in karate training, where it helps the karate practitioner to deliver proper techniques with speed and power.

Additionally, flexibility plays an important role in karate where high kicks are frequently performed in kumite and it is considered as the important physical fitness performance. Besides that, flexibility is fundamental for karate athletes to launch a punch where they need a specific stance which required the flexibility of hamstrings to stretch to get to the opponent. Furthermore, flexibility is also vital for karate athletes when delivering kicks against the opponents.

Finally, the present study demonstrated that there was a significant difference in maximal oxygen consumption (VO_{2max}) between the two analyzed groups. It should be noted that the maximum oxygen consumption volume was 56.65 ml/kg/min achieved by the senior team, while 44.27 ml/kg/min attained by the juniors. Again, years of training period would be the factor why senior team are having higher maximal oxygen consumption compared to the junior team. On top of that, the senior athletes already familiarized with the 20 meter shuttle run test and have been doing the test for many times conclusively determine the seniors to have higher oxygen consumption. For the comparison, it is founded that the maximum oxygen consumption volume for the Spanish international Taekwondo athletes was 57.0

ml/kg/min and 53.8 ml/kg/min for the Czech international athletes [43]. However, the maximum oxygen uptake in Taekwondo black-belt athletes was 44.0 ml/kg/min. Recreational Taekwondo athletes had a mean VO_{2max} about 44.0 ml/kg/min. However, the maximum oxygen consumption values for the elite athletes should be significantly higher than the recreational level athletes [44]. On the other hand, National Taekwondo Team of China had an average of 57.57 ml/kg/min of VO_{2max}, while the Korean National Team was 59.56 ml/kg/min [45]. Mean of VO_{2max} (57.3 ± 4.3 ml/kg/min) of experience karate athletes of 4 months to 10 years. Furthermore, lower mean of VO_{2max} (45.5 ± 5.0 ml/kg/min) has been reported [31]. On the other hand, a study using a bicycle ergometer for subjects with one to three years of experience, showed a lower mean VO_{2max} (36.8 ± 5.4 ml/kg/min) [44].

Regarding physical performance for the Malaysian Karate athletes, researcher found that the VO_{2max} for the senior team was 56.65 ml/kg/min which are almost at par to Spanish International Taekwondo athletes and China National Taekwondo team. However, the national junior team is still distant from the benchmark. As for improvement of the physiological functions of highly sport contestants is by adapting intensive aerobic training [46]. In addition, a quick and powerful start of an offensive skill prevents an opponent from using an effective action which was investigated in boxing and martial arts [47]. It is believed that to deliver quick action and powerful starts, the elastic and reactive component of muscle is very important.

An aerobic capacity is crucial since it allows relatively quick recovery between rounds and fights [40]. On top of that, high aerobic capacity also helps to facilitate faster recovery during and after training or competition sessions. The comparison between the senior and junior teams showed that the significant differences observed from the results; senior team had a significantly higher performance values than junior team. This is reasonable due to the senior ranked athletes have been training for a longer period of time if compared to the junior athletes [48]. It can be identified that an indicator of excellent sports skill performance is due to the long duration of training [49]. Furthermore, during the promotion examinations, martial artists are screened so as to ensure mastery of techniques and skills which become more complicated and difficult as the athletes rises in rank [14].

5. CONCLUSION

To conclude, this study showed differences between both groups since the findings presented differentiation in parameters were strictly at descriptive level as inferential statistical level also found differences in all mentioned parameters except the flexibility of male national senior and junior karate athletes. The findings suggest that senior kumite competitors have less body fat percentages compared to junior athletes. It appears that less body fat percentage would correspond to a lighter body mass to be moved, which permitting a high speed and power to be attained.

The strength of both team showed that senior team presented higher scores than the junior team. Strength is essential in kumite when delivering punches or kicks to the opponent. At the same time, a total body strength is also important for the karate competitors to receive abusive attacks during the fight. Next is the power of lower extremity, where there was a difference between senior and junior athletes. The finding showed that the senior athletes showed to be more superior to the junior athletes. Therefore, it is viable to conclude that mechanical factor (power of lower limb) play an important part in karate performance. Hence, as to national level karate athletes' kumite match performance is influenced by higher levels of upper and lower limbs power production.

For the agility parameter, the senior team have a better agility if to compare to the junior team. It is critical to have a good agility in kumite in which the athletes should be able to move or change the body position rapidly. High agility would be an advantage for karate players to score point or to react by blocking the attacks from the exponent. In flexibility, there is no difference between both teams. Both teams showed a moderate score in sit and reach test. Flexibility is very important in distributing techniques during fight either hand or leg techniques. Successful karate players are players with good flexibility where they fulfil the full range of motion when scoring points particularly with leg skills.

The final parameter is the maximum oxygen consumption where there is significant difference between senior and junior athletes. It emerges that karate match and training is characterized by high anaerobic and aerobic metabolic responses. High maximum oxygen consumption is crucial for karate competitors to recover faster and to prevent injuries. Since

only the national athletes were tested, the findings could be of value for both selection and training design for karate athletes.

Future clarification of the discipline specific profiles of the kumite athletes could include larger numbers of the body fat measurements, physical performance and skill-related tests to be more specific. Not only that, extension of the same research should be applied for the female athletes as well. However, based on the essential differences in the physical performance and body fat percentage from the national senior and junior athletes, a predominantly capable extension of this type of study could be en route for more physiological oriented investigations such as lactate responses, reaction time and the ability for a rapid stimulus reaction processing. In particular, simulations of competitive performance should be enhanced to match the physiological demands of real tournaments.

It is meaningful and supportive for athletes and coaches to observe the physiological characteristics involving training and competition phase. Thus, it is also benefiting the athletes and coaches to control the peak performance and keep away from over training and in the meanwhile, to keep in a steady state and to recover quickly is very important as well. Fatigue will kick in when the athletes drive themselves beyond their physiological limits. This is due to exceeding the tolerance threshold, where athletes are constantly exposed to various types of training loads. Alternatively, a proper and specific training program needs to be constructed in a holistic manner consecutively to support the athletes' training and to attain better performance in competition especially at the international levels.

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