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Research Article

Assessment of Nutritional Status, Body Composition Parameters, & Physiological Profiles of Young Male Taekwondo and Wushu Players -

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ABSTRACT

Background: Present study was undertaken to assess and compare the nutritional status, body composition profiles and physiological parameters of taekwondo and wushu players.

Methods: Twelve male taekwondo (15.9 ± 1.83 years) and fourteen wushu (15.5 ± 1.82 yrs) players belonging to the weight category of 60kg and 55kg respectively with minimum of 3 - 4 years of formal training history were evaluated for height, weight, skin fold thicknesses, body composition, handgrip strength, relative back strength, VO_2 max and nutritional status following standard protocols.

Results: Mean weight and height of taekwondo and wushu players were found to be 57.8 ± 7.79 kg and 55.0 ± 5.73 kg and 170 ± 4.95 cm & 167.4 ± 5.08 cm respectively. No significant difference was observed in Body Mass Index (BMI) and body fat% when compared between them, although taekwondo players showed higher mean values. They also exhibited insignificantly higher handgrip and relative back strength (right: 41.3 ± 8.09 kg; left: 41.1 ± 9.25 kg; 2.0 ± 0.39 kg/kg body wt) than their wushu counterpart (right: 40.2 ± 5.76; left: 38.9 ± 6.44; 1.8 ± 0.20). Wushu players exhibited higher aerobic capacity ($VO_{2\,max}$ = 44.3 ± 7.41 ml/kg/min), whereas taekwondo players showed higher anaerobic capacity (average power = 265.3 ± 39.53 watt) as compared to their respective counterpart. Dietary assessment revealed that total calorie consumption was significantly higher ($p < 0.05$) in taekwondo players than wushu players although both the groups failed to meet their RDA. Both Taekwondo and wushu players showed optimal dietary intake of phosphorus (2670.8 ± 406.43 mg; 2308.4 ± 182.11 mg), ascorbic acid (55.8 ± 15.34; 53.6 ± 15.78 mg) and vitamin B_{12} (1.7 ± 0.55 µg; 1.8 ± 0.59 µg). Whereas, crude fiber (9.8 ± 2.30 mg; 8.6 ± 1.45 mg), calcium (679.4 ± 78.94 mg; 694.6 ± 88.43 mg), iron (24.1 ± 5.06 mg; 22.2 ± 1.92 mg) and vitamin A (503.1 ± 114.25 µg; 507.1 ± 141.72 µg) intake were low in both the groups than the standard dietary guidelines respectively.

Conclusion: Above findings indicated that taekwondo players have lower body fat percentages, higher body cell mass and muscle mass which may be explained as their indulgence in more resistance training although both the groups consumed adequate protein. It can also be concluded that better nutrition of taekwondo players may have resulted in comparatively better static strength and body composition profile.

Keywords: Taekwondo; Wushu; Martial art; Nutrition; Body composition; Physiological status

INTRODUCTION

Taekwondo and wushu, both are the finest forms of martial arts. Since Taekwondo (TKD) was selected as an official event in the 2000 Sydney Olympics, it has evolved as a martial art sport, undergoing various changes [1]. Considering it as a weight category game, distinct body compositional factors like low body fat percentage and high fat-free mass can serve as sensitive indicators of athletic performance [2-4]. The physical fitness factors that are important for executing strong and accurate moves in taekwondo reportedly include power, muscular strength and muscular endurance [5,6]. Even though wushu (WSU) is not one of the 28 official Olympic sports yet, it was included as a demonstration sport in the 2008 Beijing Olympic Games [1]. This game demands aforementioned physical preparation in a synchronized form to be succeeded. There exists an evidential lack of literature about nutritional and physiological traits of wushu and taekwondo players in this regard [1]. Kazemi [1] reported that martial art requires maximum muscle power and endurance as the muscular structure is responsible to execute better performance. Beneficial effects of nutrition on exercise and sports performance are well established since long back [7]. There is no doubt that nutrition can affect health, body weight and composition, substrate availability during exercise, recovery after exercise, and ultimately, exercise performance [8] which ultimately leads to excel in sports performance. Dietary strategies to improve sports performance include optimizing intakes of macronutrients, micronutrients, and fluids, including their composition and spacing throughout the day [9]. Carbohydrate intake has been shown to enhance performance for events lasting approximately 1 hour [10]. Protein consumption prior to and during endurance and resistance exercise has been shown to augment rates of Muscle Protein Synthesis (MPS) [11]. There are certain micronutrients of chief concern for athletes in accordance to their metabolic demands. Increases in hemoglobin production, blood volume, and muscle mass are normal characteristics of growth and maturation and account for the majority of amplified iron needs [12,13]. Vitamin A is considered as an essential micronutrient for epithelial differentiation and maintenance processes, and is well known because of the negative effects of deficiency [14]. Vitamin C is an essential micronutrient with many important biological functions, and a cofactor for the biosynthesis of collagen, carnitine, neurotransmitters and peptide hormones as well as has an anti-catabolic effect and also accelerates muscle recovery [15,16]. On the other hand, due to the role of vitamin B12 in energy metabolism, it is frequently promoted as an energy enhancer and an athletic performance and endurance booster [17,18]. Since there is a direct relationship between dietary intake and body composition, the measurements of body composition is considered as valuable tool for determining appropriate nutritional intakes thus revealing an important aspect in relation to an athlete's performance [19,20]. Kazemi & Pieter [1] have also studied the relationship of somatotype and body composition with physical performance. Evidences have demonstrated that somatotype varies with age, sex, nutritional status and physical activity [2,5,21]. Very little evidential studies on physiological and nutritional assessment of both taekwondo & wushu players are available which if done may help to build the basic anthropometric & physiological profile for such above mentioned combat sports. Hence, the present study was undertaken to

i) Assess and evaluate the nutritional status, body composition profile and physiological parameters of taekwondo and wushu players and

ii) To compare these parameters between the group along with international counterparts.

MATERIALS AND METHODS

Subjects

Present study was carried out on 26 male wushu (N = 14, mean age = 15.5 ± 1.89 years) & taekwondo players (N = 12, mean age = 16.2 ± 1.98 years). Both taekwondo and wushu players were at least a state level performer with minimum 2.5 years of formal training history. The subjects were not having any history of hereditary and cardio-respiratory diseases. They were considered homogeneous as they belonged to almost similar socio-economic status, similar dietary habits and undergoing training in the same environmental/ climatic condition. All the subjects were evaluated for various anthropometric, body composition and physiological parameters along with assessment of nutritional status. Before the commencement of test, all the subjects were clinically examined by the physicians specialized in Sports Medicine following standard procedure [22]. Prior to initial testing, a complete explanation of the purposes, procedures and potential risks and benefits of the tests were explained to all the subjects and a signed consent was obtained from them.

Training Regimen

The formulation and implementation of systematic training program was made by the qualified coaches with the guidance of the scientific expert from Sport Science Department, Sports Authority of India, Kolkata. The training regimen for both the groups of the present study was held on an average 4 to 5 hours every day except Sundays and which comes about 30 hours in a week. There were two sessions in a day i.e. morning and evening session and both of which comprised of physical conditioning for one hour and skill training for about two hours. The physical training schedule includes different strength and muscular endurance training program along with flexibility exercises. Warm up and cool down session before and after starting of the main practice session were also included in the program. Besides the technical and tactical training the players were also provided psychological or mental training session thrice in a week.

Anthropometric measurement

The physical characteristics of the subjects including height (cm) & weight (kg) were measured by anthropometric rod and digital weighing machine respectively followed by standard procedure [23]. Skinfold thicknesses were recorded by the Herpenden skinfold caliper at the site of biceps, triceps, sub scapular, and supra-iliac [24]. Body density was calculated by the equation of Siri [25] and body fat percent was calculated by the formula of Brozek et al. [26]. Body Mass Index (BMI) was calculated from the body height and weight [27]. Handgrip strength and relative back strength were measured by handgrip and back dynamometer respectively (SENOH, Japan) following the standard procedure [22].

Measurement of VO_2max & anaerobic power

Maximum aerobic capacity (VO_2max) was assessed using an indirect method of multistage fitness test (Beep test) from where VO_2max was predicted [28]. The procedures and purpose of the above test were elaborately instructed to all the players. In a typical shuttle run test, the players ran back and forth between two lines, spaced 20-m apart, in time with the "beep" sounds from a compact disc (20-m Shuttle Run test CD). Each successful run of the 20-m distance marks the completion of a shuttle. The frequency of the "beep" sound increases progressively with every minute of the test and correspondingly the player increases his/her running speed accordingly. The player is warned verbally if he did not reach the end line in time once. The test is terminated when he/she i) could not follow the set pace of the "beeps" for two successful shuttles and/or ii) stops voluntarily. Typically, the scores in the test are expressed as levels and shuttles, which estimate a person's maximum oxygen uptake capacity (VO_2max) from the standard chart. Draper and Whyte (1997) [29] developed the Running-based Anaerobic Sprint Test (RAST) which was done to test a runner's anaerobic performance. For RAST, participants performed six maximal 35 m sprints on an Astroturf pitch with 10s rest periods between each sprint. Players were instructed to wear their normal training footwear. Each sprint was recorded using a Brower timing gate system (Brower Timing Systems, USA) with photocells positioned 35 m apart at approximately waist height. Participants were asked to start each sprint 0.3 m behind the timing gate and perform repeated sprints in alternate directions. The 10s rest periods were timed accordingly using a stopwatch and the participant were alarmed with a 3 sec countdown prior to each sprint.

Bioelectrical impedance analysis (BIA)

Body composition including Fat Free Mass (FFM), Total Body Water (TBW), Extra Cellular Water (ECW), Intra Cellular Water (ICW), ratio between Extra and Intra Cellular Water (ECW: ICW), Body Cell Mass (BCM), Muscle Mass (MM), Total Body Potassium (TBK), Total Body Calcium (TBCa), glycogen and minerals were measured using Bioelectrical Impedance Analysis (BIA) (Maltron Bioscan 920 - 2, Made in UK). Total body electrical impedance to an alternate current (0.2 mA) with four different frequencies (5, 50, 100 and 200 KHz) was measured using a multi-frequency analyzer. Measurements were taken followed by the standard testing manual of Maltron International (Maltron Bioscan 920 - 2 operating and service manual [30].

Nutritional assessment

Information on dietary habits like meal pattern, meal frequency, and food likes and dislikes and skipping of meals were elicited. The intake of various food groups and their portion of intake were ascertained by using a pre-tested 24 hour dietary recall questionnaire. Water consumption and supplement intake per day was also recorded. Based on the information obtained by 24-h recall method, the cooked foods were converted to raw amounts and the nutrients were calculated accordingly. The nutrients were calculated using software Diet Soft (version 1.1.6) developed by the Department of Dietetics, All India Institute of Medical Sciences (AIIMS), New Delhi. The nutrients in the software are based on the values published in the "Nutritive value of Indian Foods" by ICMR [31]. The laboratory tests were performed at a room temperature varying from 23°C to 25°C with the relative humidity varying between 50 and 60%. The field test was performed at temperature about 30°C with relative humidity of maximum about 70 - 80%.

STATISTICAL ANALYSES

All values were expressed as means ± Standard Deviation (SD). Data were analyzed using the Statistical Program for the Social Sciences (SPSS) version 16.0 for Windows (SPSS Inc., Chicago, Il, USA). Differences between groups for all variables in accordance to their specific sport disciplines were calculated using T - test at 95% ($p < 0.05$) confidence interval.

RESULTS

Table 1 depicts the mean, standard deviation and level of significance of comparison of anthropometric & static strength parameters of male taekwondo & wushu players. All these parameters were found insignificantly differed when compared between the two combat sports group. Height, weight, muscle mass & isometric strengths (both handgrip & relative back strength) were found to be higher in taekwondo athletes than their wushu counterpart whereas body fat was higher in wushu players.

The comparison of body composition profile of male taekwondo & wushu players was listed in table 2. Taekwondo players were recorded with insignificantly higher body cell mass, muscle mass, level of potassium and calcium and significantly higher glycogen store ($p < 0.01$) than their wushu counterpart.

Table 3 revealed the comparison of anaerobic power & endurance capacity of taekwondo & wushu players. Wushu players showed significantly higher aerobic capacity ($p < 0.05$) and lower minimum anaerobic power ($p < 0.001$) and average anaerobic power ($p < 0.05$) than their taekwondo counterpart. No such significant difference was observed in fatigue index when compared between the groups.

Table 4 represented the comparison of RAD and nutritional status of male taekwondo & wushu players. Both total calorie ($p < 0.01$) & phosphorus intake were found to be significantly higher ($p < 0.05$) in taekwondo athletes than their wushu counterpart. All other nutritive parameters were insignificantly differed when compared between the groups. Although, the total calorie intake fetched by carbohydrate, protein and fat were maintained by both the groups, but both the groups had lower overall all calorie intake when compared to the RDA.

Comparison of age, height, weight, body fat percentage, aerobic capacity and anaerobic power of taekwondo players of present study with their international counterparts was represented in table 5. The table reveals that the age of present players is almost same as Malaysian club players, Athence taekwondo team and Korean players was much younger than Czech National players & Sydney 2000 Olympic Games players. But height of our subjects was more than Malaysian club players and Korean players. Body fat percent of the present players was well comparable as compared with Czech National taekwondo athletes. Similarly, VO2 max of the present players was also similar to the players of Korean taekwondo team. But on the other hand the relative anaerobic power of the present study was recorded much lower as compared to Czech and Tunisian national taekwondo players.

Table 1: Comparison of mean, standard deviation and level of significance of various anthropometric and static strength parameters of young male taekwondo and wushu players.

Parameters	Taekwondo (n = 12)	Wushu (n = 14)	t value (Level of significance)
Age (yrs)	15.9 ± 1.83	15.5 ± 1.82	0.658 (NS)
Height (cm)	170 ± 4.95	167.4 ± 5.08	1.479 (NS)
Weight (kg)	57.8 ± 7.79	55.0 ± 5.73	1.137 (NS)
BMI (kg/m^2)	19.9 ± 2.06	19.7 ± 2.25	0.311 (NS)
Body Fat %	7.8 ± 2.14	10.2 ± 4.23	2.009 (NS)
Fat Free Mass (%)	92.2 ± 2.14	89.8 ± 4.23	2.009 (NS)
Handgrip strength Right (kg)	41.3 ± 8.09	40.2 ± 5.76	0.423 (NS)
Handgrip strength Left (kg)	41.1 ± 9.25	38.9 ± 6.44	0.789 (NS)
Relative back strength (kg/kg body wt)	2.0 ± 0.39	1.8 ± 0.20	1.610 (NS)
Hemoglobin (mg/dl)	13.2 ± 0.58	13.9 ± 0.55	1.380 (NS)

NS = Not Significant.

Table 2: Comparison of mean, standard deviation and level of significance of body composition profile of young male taekwondo and wushu players.

Parameters	Taekwondo (n = 12)	Wushu (n = 14)	t value (Level of significance)
Body cell mass (kg)	28.1 ± 3.89	26.4 ± 2.79	1.354 (NS)
Muscle mass (kg)	25.3 ± 3.51	23.7 ± 2.87	1.469 (NS)
Total body potassium (gm)	135.3 ± 16.08	126.2 ± 13.44	1.732 (NS)
Total body calcium (gm)	989.3 ± 107.45	924.6 ± 137.87	1.479 (NS)
Glycogen mass (gm)	495.4 ± 42.16	448.5 ± 53.48	2.753 **
Mineral content (gm)	3.9 ± 0.49	3.6 ± 0.64	1.606 (NS)

**= $p < 0.01$, NS = Not Significant.

Table 3: Comparison of mean, standard deviation and level of significance of anaerobic power & endurance work capacity of young male taekwondo and wushu players.

Parameters	Taekwondo	Wushu	t value (Level of significance)
Aerobic capacity (ml/kg/min)	38.3 ± 5.73	44.3 ± 7.41	2.569 *
Max anaerobic power (watt)	320.9 ± 62.26	307.7 ± 50.96	0.656 (NS)
Min anaerobic power (watt)	220.3 ± 26.28	184.9 ± 27.57	3.708 ***
Average Anaerobic power (watt)	265.3 ± 39.53	237.2 ± 37.66	2.061 *
Relative anaerobic power (watt/kg)	5.7 ± 1.35	5.6 ± 1.03	0.071 (NS)
Fatigue Index (watts/sec)	2.6 ± 1.12	2.9 ± 0.92	0.964 (NS)

* = $p < 0.05$, *** = $p < 0.001$, NS = Not Significant.

Table 4: Comparison of mean, standard deviation and level of significance of RDA and nutritional status of young male taekwondo and wushu players.

Parameters	RDA.	Taekwondo	Wushu	t value (Level of significance)
Calorie (kcal)	3600	3129.8 ± 518.95	2784.4 ± 175.82	2.522*
Carbohydrate (%)	65	63.8 ± 2.51	64.5 ± 2.33	0.748(NS)
Protein (%)	15	16.1 ± 0.99	15.0 ± 2.07	1.951(NS)
Fat (%)	20	20.1 ± 2.36	20.5 ± 1.09	0.707(NS)
Crude Fiber (gm)	30	9.8 ± 2.30	8.6 ± 1.45	1.904(NS)
Calcium (mg)	800	679.4 ± 78.94	694.6 ± 88.43	0.512(NS)
Phosphorus (mg)	1600	2670.8 ± 406.43	2308.4 ± 182.11	3.255**
Iron (mg)	28	24.1 ± 5.06	22.2 ± 1.92	1.376(NS)
Vitamin A (mcg)	600	503.1 ± 114.25	507.1 ± 141.72	0.088(NS)
Vitamin C (mg)	40	55.8 ± 15.34	53.6 ± 15.78	0.397(NS)
Vitamin B_{12} (mcg)	1	1.7 ± 0.55	1.8 ± 0.59	0.302(NS)

*= p <.0.05, *= p <0.01, NS= Not Significant, RDA = Recommended Dietary Allowance.

Figure 1 depicts the pictorial representation of daily excess or under nutrient intake of male taekwondo & wushu players as compared to the Recommended Dietary Allowances (RDA). Phosphorus, vitamin C & vitamin B_{12} were found to be excessively consumed by these athletes. Whereas, they consumed all the other nutrients lower than their RDA, especially crude fiber i.e., < 60%.

DISCUSSION

It is well established that performance in combat sports is dependent on several factors, such as anthropometric characteristics, physiological profile and nutritional requirements [3]. Present study was executed with an aim to compare two popular combat sports in

Table 5: Comparison of age, height, weight, body fat percentage, aerobic capacity and anaerobic power of taekwondo players of present study with their international counterparts.

Author (s)	Age (yrs)	Height (cm)	Weight (kg)	Body fat (%)	VO_2max (ml/kg/min)	Relative anaerobic power (W/kg BW)
Pieter et. al., 2009 Taekwondo club of Malaysia	15.9 ± 1.20	166.8 ± 7.98	65.9 ± 16.86	-	-	-
Kazemi et. al., 2006 Sydney 2000 Olympic Games	24.4 ± 0.3	183.0 ± 0.08	73.4 ± 12.10	-	-	-
Heller et al, 1998 Czech National taekwondo athletes	20.9 ± 2.2	179.0 ± 6.00	69.9 ± 8.70	8.2 ± 3.10	53.9 ± 4.4	-
Melhim, 2001 Korean taekwondo team	13.8 ± 2.2	155.4 ± 15.80	52.4 ± 3.60	13.1 ± 4.90	36.3 ± 9.2	-
Nikolaidis et al, 2016 TKD teams from Athens (Greece)	15.1 ± 1.1	172.7 ± 8.10	62.3 ± 10.40	13.7 ± 4.20	-	-
Pieter, 1991 Czech National taekwondo athletes	-	-	-	-	54.60	14.7
Erie et al., 2007 Tunisian national team elite male	-	-	-	-	56.22	12.1
Dizon et. al., 2012 2008 elite Filipino taekwondo athletes	23.8 ± 2.3	173.4 ± 5.7	70.7 ± 14.0	11.4 ± 5.2	50.5 ± 5.0	-
Heller et. al., 1998 Czech taekwondo athletes	18.5 ± 2.6	168.0 ± 5.0	62.3 ± 7.4	15.4 ± 5.1	53.9 + 4.4	-
Present study on young Indian taekwondo players	15.9 ± 1.83	170 ± 4.95	57.8 ± 7.79	7.8 ± 2.14	38.3 ± 5.73	5.7 ± 1.35

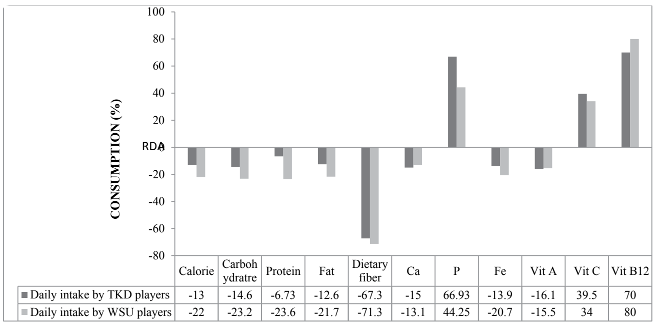

Figure 1: Daily intake of nutrient of male taekwondo & wushu athletes as compare to RDA.

accordance to their physical, physiological & nutritional needs. Present study revealed that the taekwondo players have higher body height (Czech, Malaysian and Korean taekwondo athletes) and lower body fat content as compare to wushu players and as well as their international taekwondo counterparts (Czech national taekwondo athletes- 8.2%, Korean taekwondo team- 13.1%, Taiwanese Taekwondo athletes- 13.2%, and Tunisian national team Taekwondo athletes- 11.8%) [6,32,33]. Markovic and his colleagues have reported that successful taekwondo athletes have lower body fat and are taller than less successful ones. As the nature of taekwondo involves fast and powerful kicks and therefore, requires a lean physique. Taller athletes are believed to have an advantage over their opponents as they have a longer reach and a longer body 'lever' allowing them to attack the opponent in a short time covering a larger distance and to use smaller amounts of energy. Further, it has been suggested that lower body fat percentage and higher lean body mass is needed to gain the highest aerobic capacity [34]. Maughan et al concluded that higher muscle mass & higher body calcium content has got a positive relation with the muscle contraction and the increased high-velocity muscular strength [35]. Calcium is not only significant for bone growth but also cellular and muscular contractions [36]. Proper resistance training may result in 'Muscular hypertrophy' which is the main cause for higher muscle mass development [37]. Eventually, the strong correlations between isometric strength with BCM & MM are possibly due to the strength training induced muscular hypertrophy. It has been reported in a study of endurance sports that aerobic demand of energy release is high with a greater BCM content. Taekwondo players reported higher muscle mass, body cell mass, isometric strength than wushu athletes which may have developed due to training in a high intensity resistance program [38]. Results of the present study also corroborated with the above findings and the reason of such results as mentioned by the above authors are true in this case. A study on Czech national taekwondo athletes reported the VO_2max values of 54.6 ml/kg/min [39], which was lower than the value as reported in Tunisian national team elite male taekwondo athletes (56.22 ml/kg/min) [40]. Consequently, we found that the TKD players had lower aerobic capacity when compared to their international counterparts except the Korean taekwondo players. Lower aerobic capacity in both Korean and present taekwondo players may be due to their lower age as compared to their international counterparts. On the other hand wushu players were found to have significantly higher ($p < 0.05$) aerobic capacity than their taekwondo counterpart. This may be due to the nature of the game and their higher hemoglobin level. Due to explosive high-intensity nature of the sport, taekwondo & wushu athletes require high anaerobic power and anaerobic capacity [31]. Anaerobic power and capacity represent energy production from phosphagen and from combined phosphagen and glycogenolysis respectively. It has been reported that glycogen may limit the anaerobic capacity of an athlete during play [41]. The present values for relative anaerobic power (5.7 W/kg BW) were considerably lower than the 14.7 W/kg BW as reported in Czech national Taekwondo athletes [32], elite American senior taekwondo athletes (11.8 W/kg BW) [33] and Tunisian national team taekwondo athletes (12.1 W/kg BW) [40]. As reported, the anaerobic power of wushu players was almost similar to that of Brazilian wushu athletes (5.8 watt/kg) [41]. Although, scarce resources are available regarding the anaerobic power of WSU players but it has been reported that that they have lower mean anaerobic power than other fighter athletes [21,23]. In accordance to the nutrition and hydration guidelines set under the collaboration of Indian Life Science Institute, National Institute of Nutrition and

Sports Authority of India, weight division games like TKD and WSU are categorized under Group-IV sport event which demands a minimum of 3600 Kcal of daily calorie consumption with an energy bifurcation of 65%, 15% and 20% to be fetched from carbohydrate, protein and fat respectively [42]. Although TKD players were found to have significantly higher ($p < 0.05$) Daily Calorie Consumption (DCC) 3129.8 ± 518.95 Kcal/day than WSU players (2748.4 ± 175.82 Kcal/day), but both the groups failed to meet the optimal DCC adding convincing results to the earlier research studies [43]. A study conducted on Indian martial artists found mean energy intake of taekwondo and wushu players to be 2038 ± 337 Kcal and 2074 ± 366 Kcal respectively [44]. They have also reported Taekwondo martial artists to have highest mean carbohydrate and protein intake whereas Wushu martial artists were found to have highest fat intake [44]. Even if the overall distribution of macronutrients with respect to their actual calorie consumption is well maintained by both taekwondo and wushu players, but there exists a remarkable deficit of calorie, carbohydrate, protein and fat deficit which among taekwondo players was found to be 13%, 15%, 7% and 13%; whereas among wushu players was noted to be 23%, 23%, 24% and 22% respectively when compared to the standard guidelines. Carbohydrate being the prime source of energy was observed to fetch 63.8 ± 2.51 % and 64.5 ± 2.33 % among taekwondo and wushu players showing no significant difference. Carbohydrate being highly used for moderate intensity exercises, its intake is associated with physical performance of muscle under exertion. Low-carbohydrate diets may compromise physical performance, causing negative effects in those who practice physical activities [45]. Factors such as intensity and duration of exercise/ physical training and diet may change intake needs of this nutrient [46]. Our results showed convincing results as previous studies have demonstrated that male athletes seem to be more frequently follow the recommended carbohydrate intake range [47]. It can be predicted that optimal carbohydrate intake may also result in optimal glycogen concentration that can further enhance anaerobic performance [41]. Protein consumption of the taekwondo and wushu athletes were considered to be near to the RDA (16.1 ± 0.99; 15.0 ± 2.07) which further coincided with the previously done research following the classic recommendations [39]. Even though the fat consumption by the players of both the sports (20.1 ± 2.36 %, 20.5 ± 1.09 % respectively) was found to be optimal while considering the percentage of its portion from the total calorie consumed but there still exists deficiency when compared to the recommended range. Taekwondo and wushu players showed lower crude fiber intakes i.e., 9.8 ± 2.30 gm (67%) and 8.6 ± 1.45 gm (71%) respectively as the nutrition guidelines as set for athletes recommends a daily intake of 25-48gm dietary fiber a day for daily consumption of 3000-7000 Kcal [42]. Crude fiber is responsible for retention of calcium & phosphorus in the body from vegetables as from milk. The enlisted daily diet of the players of both taekwondo and wushu was observed to fetch very low amount of calcium i.e. 679.4 ± 78.94mg/day and 694.6 ± 88.43mg/day respectively as compared to the recommended dietary allowances (800mg/day) [43]. Poor calcium intake is also supported by the report made by Canadian Pediatric Society as it recommends an average of 1300mg/day of calcium consumption by the athletes of 9 – 18 years age [47]. Adolescent period marks an increased need for calcium, particularly for growth and development, and it is the time of life when 50 percent of the bony mass is acquired, as it is generally fully formed by the age of 18 and growth stretch marks 37% of its development. To maintain serum levels in dietary calcium deficient state, mobilization of calcium and phosphorus from the bones occurs to normalize serum calcium concentrations [48]. Iron is a trace mineral that influences athletes' capability to perform and if deficient may directly hamper their physical performance [46,47]. Our data revealed poor intake of both calcium and iron by both the groups in comparison to the RDA. Phosphorus intake was found to be approximately 1.5 times more than their recommended intake. It has been referenced that too much intake of phosphorus can limit body's ability to absorb minerals like calcium, iron, magnesium and zinc and may contribute to anemia. Energy intake has direct links with B vitamins, as it is documented that the more availability of vitamins is found in higher energy intake [49]. Both the groups failed to meet the optimal vitamin A requirement i.e.; 600 IU/day as documented in the RDA. Our study revealed optimal intake of vitamin C & vitamin B_{12} by both the groups when compared to RDA [42]. Vitamin C is involved in number of metabolic reactions as it acts on the synthesis of collagen, immunologic function, and also increases absorption of non-heme iron thereby preventing iron-deficiency anemia acting as an effective anti-oxidant [49]. Higher vitamin B_{12} intake by both the groups reveals fair animal protein intake as it is commonly found in foods such as fish, shellfish, meat, and dairy products [50]. This research article adds baseline observation in reference to anthropometric status, nutritional intake, body composition, aerobic work capacity and anaerobic power of taekwondo and wushu athletes. Taekwondo athletes were found to have lower body fat percentages, higher body cell mass and higher muscle mass which may be explained as their indulgence in more resistance training resulting in muscular hypertrophy. Although athletes consumed adequate protein, carbohydrate intake was below the recommendation as most often occurs with weight-classed combat sports. Inspite of both the games being dependent on anaerobic energy system but results revealed higher aerobic power among wushu players & anaerobic capacity among taekwondo players which may have occurred due to physiological adaptive response, metabolic systems development and nature of game in both the games. So, it can also be inferred that training specified for taekwondo can increase strength and muscle tone, reduce body fat and improve anaerobic power. Contrarily, formal training specified for wushu can increase aerobic power. The obtained results observed among both the games were found to be corroborating with the international standards.

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REFERENCES

1. Kazemi M, Pieter W. Injuries at the Canadian National Tae Kwon Do Championships: a prospective study. BMC Musculoskelet Disord. 2004; 5:1-8. https://goo.gl/MiT5mX
2. Claessens AL, Hlaatky S, Lafevre J, Holdhaus H. The role of anthropometric characteristic in modern pentathlon performance in female athletes. J Sports Sci. 1994; 12: 391-410. https://goo.gl/gZf9q9
3. Mudd LM, Fornetti W, Pivarnik JM. Bone mineral density in collegiate female athlete: comparisons among sports. J Athl Train. 2007; 42: 403-408. https://goo.gl/4AyDZS
4. Fong SS, Ng GY. Does taekwondo training improve physical fitness? Phys Ther Sport. 2011; 12: 100-106. https://goo.gl/mzvK1x
5. Markovic G, Vucetic V, Cardinale M. Heart rate and lactate responses to taekwondo fight in elite women performers. Biol Sport. 2008; 25:135-146. https://goo.gl/6FwVVM
6. Bouhlel E, Jouini A, Gmada N, Nefzi A, Abdallah KB, Tabka Z. Heart rate and blood lactate responses during taekwondo training and competition. Sci Sports. 2006; 21: 285-290. https://goo.gl/ySehJE

7. Brown LN. The effects of 5 - week nutrition education intervention on collegiate athletes' knowledge and dietary intake. Oklahoma State University Stillwater, Oklahoma. 2009. https://goo.gl/bJwazK

8. Rodriguez NR, DiMarco NM, Langley S. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. J Am Diet Assoc 2009; 109: 509-527. https://goo.gl/NwgcHC

9. Wright DA, Sherman WM, Dernbach AR. Carbohydrate feedings before, during, or in combination improves cycling endurance performance. J Appl Physiol. 1991; 71:1082-1088. https://goo.gl/UUDeRN

10. Jeukendrup A. A step towards personalized sports nutrition: carbohydrate intake during exercise. Sports Med. 2014; 44: 25-33. https://goo.gl/nn5uuy

11. Beck KL, Thomson JL, Swift RJ, Hurst PR.Role of nutrition in performance enhancement and postexercise recovery. Open Acc J Sports Med. 2015; 6: 259-267. https://goo.gl/4otiL7

12. Ekblom B, Goldbarg AN, Gullbring B. Response to exercise after blood loss and reinfusion. J Appl Physiol. 1972; 33: 175-180. https://goo.gl/AHn3RX

13. PS Hinton. Iron and the endurance athlete. Appl Physiol Nutr Metab. 2014; 39: 1012-1018. https://goo.gl/hxSdm8

14. Graebner IT, Saito CH, de Souza EM. Biochemical assessment of vitamin A in schoolchildren from a rural community. J Pediatr (Rio J). 2007; 83: 247-252. https://goo.gl/u2epJe

15. Carr AC, Bozonet SM, Pullar JM, Simcok JW, Vissers MC. Human skeletal muscle ascorbate is highly responsive to changes in vitamin C intake and plasma concentrations. Am J Clin Nutr. 2013; 97: 800-807. https://goo.gl/fk6z6T

16. Guimaraes N, Waldemar M. Musculaçao: anabolismo total: treinamento, nutricao, esteroidesanabolicos e outros ergogenicos. 9th edn. Phorte Company, Sao Paulo, Brazil. 2009. https://goo.gl/vYm8Gb

17. Herbert V. Vitamin B12 in present knowledge in nutrition. 17th Edition. Washington, DC. International Life Science Institute Press. 1996.

18. Herbert V, Das K. Vitamin B12 in modern nutrition in Health and Disease. 8th Edition. Baltmore.1994.

19. Armstrong EL, Meresh CM. Vitamin and mineral supplements as nutritional aids to exercise performance and health. Nutr Rev. 1996; 54:149-158. https://goo.gl/TYcKuf

20. Charzewski J, Glaz A, Kuzmicki S. Somatotype characteristics of elite European wrestlers. Biol Sport. 1991; 8: 213-21. https://goo.gl/k5N8yC

21. Cools AM, Greerooms E, Van den Berghe DF, Cambier DC, Witvrouw EE. Isokinetic scapular muscle performance in young elite gymnasts. J Athl Train. 2007; 42: 458-463. https://goo.gl/8Hykax

22. Debnath M, Roy M, Chatterjee S (nee Karmakar), Dey SK. Body composition profile of elite Indian male and female archers: a comparative study. IJHPECSS. 2016; 23:19-25.

23. Sodhi HS. Sports anthropometry (a kinanthropometric approach). Chandigarh, India. ANOVA Publications. 1991.

24. Heath BH, Carter JEL. A modified somatotype method. Am. J Phys Anthropol. 1967; 27: 57-74. https://goo.gl/V8hWkE

25. Siri WE. Technique for measuring body composition. National Academy of Science, Nation Research Council. Brojak JA. (Ed.) Washington, USA. 1961: 223-244.

26. Brozek J, Grande F, Anderson JT, Keys A. Densiometric analysis of body composition: revision of some quantitative assumption.Ann N Y Acad Sci. 1963; 110: 113-140. https://goo.gl/FH4EoZ

27. WHO. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep. 1995; 854: 1-452.

28. Léger LA, Lambert J. A maximal multistage 20-m shuttle run test to predict\ dot VO_2max. Eur J Appl Physiol Occup Physiol. 1982; 49:1-12. https://goo.gl/SgWZgt

29. Draper N, Whyte G. Here's a new running based test of anaerobic performance for which you need only a stopwatch and a calculator. Peak Performance. 1997; 97.

30. Dey SK, Jana S, Bandhopadhyay A, Chatterjee S. Comparison of Single- and Multi-Frequency Bioelectrical Impedance Analysis and Skinfold Method for Estimation of Body Fat % in Young Male Indian Athletes. 2016; 3: 37-55.

31. Singh A, Gupta V, GhoshA, LockK, Ghosh JS. Quantitative estimates of dietary intake with special emphasis on snacking pattern and nutritional status of free living adults in urban slums of Delhi: impact of nutrition transition. BMC Nutrition. 2015; 1: 22. https://goo.gl/hPvh6j

32. Heller J, Peric T, Dlouha R, Kohlikova E, Melichna J, Novakova H. Physiological profiles of male and female taekwondo (ITF) black belts. J Sports Sci. 1998; 16: 243-249. https://goo.gl/eWRpY1

33. Melhim AF. Aerobic and anaerobic power responses to the practice of taekwondo. Br J Sports Med. 2001; 35: 231- 234. https://goo.gl/y4oeNZ

34. Gao B, Zhao Q, Liu B. Measurement and evaluation on body composition and figure of taekwondo athlete. Journal of Xi'an Institute of physical Education. 1998; 15: 29-33.

35. Maughan RJ, Depiesse F, Geyer H. The use of dietary supplements by athletes. J Sports Sci. 2007; 25: 103-113. https://goo.gl/LZX7oE

36. Misra M, Pacaud D, Petryk A, Collett-Solberg PF, Kappy M. Vitamin D deficiency in children and its management: Review of current knowledge and recommendationsPediatrics. 2008; 122: 398-417. https://goo.gl/jb94dH

37. Stolen T, Chamari K, Castagna C, Wisloff U. Physiology of Soccer: an update. Sports Med. 2005; 36: 501-536. https://goo.gl/BEP6bk

38. Andreoli A, Melchiorri G, Brozzi M, Di Marco A, Volpe SL, Garofano P, et al. Effect of different sports on body cell mass in highly trained athletes. Acta Diabetol. 2003; 40: 122-125. https://goo.gl/1i3oDN

39. Pieter W. Performance characteristics of elite taekwondo athletes. Korean J Sports Sci. 1991; 3: 94-117. https://goo.gl/arw4Pk

40. Erie ZZ, Aiwa N, Pieter V. Profılıng of physıcal fıtness of malaysian recreatıonal adolescent taekwondo practıoners. Acta Kinesio. Univ Tartu. 2007; 12: 57-66.

41. Burke LM, Hawley JA, Wong SH, Jeukendrup AE. Carbohydrates for training and competition. J Sports Sci. 2011; 29: 17-27. https://goo.gl/8GVfjw

42. Artioli GG, Gualano B, Franchini E, Batista RN, Polacow VO, LanchaAH Jr. Physiological, Performance, and Nutritional Profile of the Brazilian Olympic Wushu (Kung-Fu) Team. J Strength Cond Res. 2009; 23: 20-5. https://goo.gl/FGwhqj

43. Panandiker DHP, Satyanarayana K, Ramana YV, Sinha R. Nutrition and Hydration Guidelines for Excellence in Sports Performance. Guidelines for Excellence in Sports Performance. 2007. https://goo.gl/rVeUwQ

44. Nutrient Requirementsand Recommended Dietary Allowances for Indians.A Report of the Expert Group of the Indian Council of Medical Research. NIN, ICMR. 2010. https://goo.gl/z7GwMZ

45. Alexander S, Beatrice A. Assessment of the nutritional status and dietary pattern of martial art exponents. Indian journal if applied research. 2014; 12: 264-267.

46. Jacobs KA, Sheman WM. The efficacy of carbohydrate supplementation and chronic high carbohydrate diets for improving endurance performance. Int J Sport Nutr. 1999; 8: 92-115. https://goo.gl/iR7rsc

47. Ainsworth B, Haskel WL, Leon AS, Jacobs DR, Montoye HJ Jr, Sallis JF, et al. Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc. 1992; 25: 71-80. https://goo.gl/UPiy1f

48. Zambrano ME. Perceived Importance and Actual Intake of Calcium and Vitamin D in Young Female Athletes. Nutrition & Health Sciences Dissertations & Theses. 2011; 28. https://goo.gl/Zb4MTD

49. Huskisson E, Maggini S, Ruf M. The role of vitamins and minerals in energy metabolism and well-being. J Int Med Res. 2007; 35: 277-289. https://goo.gl/iXoXiU

50. Natural Medicines Comprehensive Database. In Vitamin B_{12}: Medline Plus Supplements. 2010.