



DETERMINATION OF NUTRITIONAL STATUS, PHYSIOLOGICAL AND PERFORMANCE PARAMETERS OF TAEKWONDO ATHLETES

Preeti Srivastava*

Post Graduate Student, Department of Nutrition and Dietetics, Mount Carmel College, Autonomous, Bengaluru. *Corresponding Author

Dr. V. Padma

Assistant Professor, Department of Nutrition and Dietetics, Mount Carmel College, Autonomous, Bengaluru.

ABSTRACT Taekwondo (TKD) is a Korean combat sport, recognised by Olympics, involving the combination of kick movements which include power, speed, agility, muscular strength and endurance. Nutrition is an important determinant of physical fitness of athletes. Cross sectional study was undertaken to investigate the nutritional status along with fitness parameters of the 150 TKD players of 8-24 years age through purposive random sampling in training centres of Kolkata. Pre-tested questionnaire was used to elicit information on training pattern, physical, physiological, performance parameters and nutritional status. Mean $\text{Vo}_{2\text{max}}$ uptake in males ranged between 22.0 ± 2.0 - 34.1 ± 1.8 ml/kg/min in 8-24 year athletes whereas in female it was reported 22.3 ± 1.7 - 32.5 ± 1.9 ml/kg/min indicating as low in majority of the athletes. Average performance was observed among the athletes on assessing physical fitness components. Adequate consumption of cereals, pulses, milk and vegetables were reported however low consumption was noted in green leafy vegetables, fruits and nuts. Nutritional inadequacy of protein, iron and calcium as indicated through 24 hour diet recall was found significant difference at 0.05 level. Therefore, guidance in nutrition is required to make prudent dietary choices that will improve the body composition, thereby increasing sport performance.

KEYWORDS : Taekwondo Athletes, Physical Characteristics, Performance Parameter, Nutritional Inadequacy

INTRODUCTION

Taekwondo (TKD) is contact combat sport. It involving the combination of kicks movement which include power, speed, agility, muscular strength and muscular endurance (Olympic.org, 2019). It is weight category game; athletic performance can be determined by specific body compositional factors. Techniques, tactical, psychological, physical and physiological characteristics are parameters in taekwondo to assess their individual performance.

The physical performance and physiological requirements of taekwondo competition require athletes to be competent in several aspects of fitness, including aerobic and anaerobic power, muscular strength, muscular power, flexibility, speed and agility (Bridge, *et al.*, 2014). Training and nutrition are the two major gears to attain desired performances in the sport. Adaption to physical load can be ensured by proper nutrition intake. However, nutrition is an overlooked factor in athletes, despite its importance during sporting performance (i.e., training and competition), post-exercise recovery and in the prevention of risk of injury.

TKD is one of the most demanding competitive sports in terms of nutritional requirements and physical standards during the competition as well as in post-exercise recovery.

MATERIALS AND METHODS

TKD athletes who had participated in the international, national, state, and district levels were selected through purposive random sampling method from the specific training centres comprising of 150 as the study sample size. The athletes were asked to perform 20m shuttle test ($\text{VO}_{2\text{max}}$), 30m acceleration tests (speed), T agility (agility) and vertical jump test (power) for measuring physical fitness levels and muscular endurance were assessed through handgrip strength, sit up and push up test. The questionnaire included information related to demographic characteristics, physiological parameter, performance parameter and nutritional status.

Details pertaining to basic food habits, food frequency and three days 24 hour dietary recall were also captured in the tool to evaluate the nutritional status. A subset sample of population was considered for 24HR which comprised of 20% of population. The nutritive calculation was done using Ntuitive software that uses data provided by Indian Food Composition Table, 2017 and USDA.

The data was put to various statistical analysis like t test, chi square and correlation between age group, gender, dietary intake along with physiological and performance parameters to test for significance using SPSS software (version 23.0).

RESULT

Baseline information revealed that the athletes were of urban

demography with majority receiving primary or secondary school education. The samples were divided into three categories according to their age. Out of 150 athletes, 30.7% belonged to 8-11 years old category, 48% to 12-19 years old and 21.3% belonged to senior category of 20-24 years range. Nearly 2/3rd of the population were males while 1/3rd constituted of female athletes. Most (51.3%) of the athletes initiated their training from the age of 7-9 years followed by 26.7% from 11-18 years old whereas 22% started training by age of below 6 years.

Table 1. Anthropometric And Physiological Characteristic By Age And Gender

Aspects	Gender	Sample Size N=150	8-11 yrs		12-19 yrs		20-24 yrs	
			Mean	SD	Mean	SD	Mean	SD
Height (cm)	Male	94	136.7	9.1	160.2	11.2	167.6	4.0
	Female	56	133.9	7.1	153.4	7.5	161.0	5.5
Weight (kg)	Male	94	34.9	8.8	52.4	10.7	60.4	6.7
	Female	56	30.6	9.6	48.1	9.7	53.8	6.0
Body fat (%)	Male	94	17.8	3.1	18.7	3.9	16.9	2.5
	Female	56	17.7	4.1	20.8	5.1	24.0	3.6
Rt. hand grip strength (kg)	Male	94	13.7	1.6	38.3	12.3	51.0	4.3
	Female	56	12.7	2.1	25.3	10.0	42.5	6.9
Lt. hand grip strength (kg)	Male	94	12.9	1.5	36.3	12.1	48.8	4.6
	Female	56	11.8	1.8	38.0	69.4	39.7	6.7
Aspects	Gender	Sample Size N=150	8-11 yrs		12-19 yrs		20-24 yrs	
Max.O ₂ uptake (ml/kg/min)	Male	94	22.2	2.0	29.7	4.2	34.0	1.8
	Female	56	22.3	1.7	27.5	3.3	32.5	1.9

The mean height of players aging 8-11 years was 136 ± 9.1 cm in male and 133.9 ± 7.1 cm in female players, 160.2 ± 11.2 cm and 153.4 ± 7.5 cm in 12-19 years, male and female respectively and in 20-24 years old athletes, 167 ± 4.0 cm in male and 161 ± 5.5 cm in female.

The mean body fat percent in male athletes was 17.8 ± 3.1 whereas, female athletes had 17.7 ± 4.1 , belonging to 8-11 years category, 12-19 years category athletes had 18.7 ± 3.9 and 20.8 ± 5.1 respectively. In adult athletes, male had body fat% of 16.9 ± 2.5 whereas female had 24 ± 3.6 body fat percent.

The handgrip strength was measured in both hands. The mean handgrip strength of right and left hands in 8-11 years category were

reported to be 13.7±1.6 kg and 12.9±1.6 kg in males while 12.7±2.1 kg and 11.8±1.8 kg were observed in female athletes. In 12-19 years athletes the right and left handgrip strength was 38.3±12.3 kg and 36.3±12.1 kg, respectively in male athletes whereas in female athletes the mean right handgrip strength was measured as 25.3±10 kg and left handgrip strength as 38±6.9 kg. In athletes of 20-24 years category, male had handgrip strength of 51±4.3 kg (right hand) and 48.8±4.6 kg (left hand). On the other hand, female athletes were observed to have 42.5±6.9 kg in right hand and 39.7±6.7 kg in left hand. The max O₂ uptake (VO₂ max) measured by beep test showed mean max O₂ uptake in 8-11 years old, male athletes had 22.2±2.0 ml/kg/min whereas female had 22.3±1.7 ml/kg/min of max O₂ uptake. The mean max O₂ uptake in male and female in 12-19 years category was 29.7±4.2 and 27.5±3.3, respectively. In 20-24 years athletes, the mean max O₂ uptake in male and female athletes was 34±1.8 and 32.5±1.9, respectively.

Table 2. Physical Performance By Age And Gender

Aspects	Gender	Sample Size N=150	8-11 yrs		12-19 yrs		20-24 yrs	
			Mean	SD	Mean	SD	Mean	SD
30 metres Acceleration test	Male	94	10.0	1.7	7.3	1.7	6.0	1.2
	Female	56	10.1	0.9	9.0	1.8	6.1	1.0
Vertical Jump	Male	94	30.3	14.0	44.9	16.1	54.5	4.7
	Female	56	26.5	8.3	36.3	15.1	45.3	7.3
T- Agility test	Male	94	11.9	1.2	9.8	1.8	8.2	1.2
	Female	56	12.5	1.1	11.1	1.2	9.0	1.2
Sit Up	Male	94	17.1	3.3	27.4	6.8	36.2	6.6
	Female	56	17.5	4.0	24.7	7.6	33.8	6.1
Push Up	Male	94	23.9	5.7	32.3	7.2	40.2	4.1
	Female	56	22.0	4.7	29.3	8.1	35.2	4.8

Physical performance in TKD athletes can be assessed by the speed, power, muscular and agility test which is also referred to as fitness components.

Mean acceleration test in 8-11 years old category was found to be 10±1.7 seconds and 10.1±0.9 seconds, in 12-19 years old athletes, 7.3±1.7 seconds and 9±1.8 seconds whereas in 20-24 years athletes, 6±1.2 seconds and 6.1±1.0 seconds was observed in male and female athletes respectively. The mean vertical jump in age group of 8-11 years in male and female athletes was observed 30.3±14 and 26.5±8.3, respectively. In athletes aged 12-19 years, mean vertical jump in male was reported to be 44.9±16.1 and in female athletes 36.3±15.1. In athletes of 20-24 years, the mean vertical jump in male athletes was noted to be 54.5±4.7 whereas 45.3±7.3 mean vertical jump was reported in female athletes.

T-agility test noted that mean agility in male was 11.9±1.2 seconds whereas in female it was found 12.5±1.1, in the age group of the 8-11 years old. The mean agility in male and female athletes was 9.8±1.8 and 11.1±1.2, respectively in 12-19 years category. In athletes aged 20-24 years athletes, mean agility was found 8.2±1.2 seconds in male while 9±1.2 seconds in female athletes.

The mean sit up of 8-11 years, in male and female was found 17.1±3.3 and 17.5±4.0, respectively whereas mean sit up in 12-19 years athletes was 27.4±6.8 in male athletes and 24.7±7.6 in female. While in athletes of 20-24 years was found to be 36.2±6.6 in male and 33.8±6.1 in female. The mean push up performed by male athletes was 23.9±5.7 in male and 22±4.7 in female athletes belonging to 8-11 years group. The mean push up performed by the male and female athlete of 12-19 years category was 32.3±7.2 and 29.3±8.1, respectively whereas in 20-24 years athletes mean push up was 40.2±4.1 by male and 35.2±4.8 was by female.

Table 3. Frequency Of Consumption Of Major Food Groups

Food Group	Food Item	D	W1	W2	W3	F	O	N
Cereals	Rice	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Wheat	80.7	2.7	3.3	12.0	0.0	1.3	0.0
	Rice Flake	0.7	12.7	4.0	0.0	36.0	19.3	27.3
Pulses	Dal	94.0	0.0	6.0	0.0	0.0	0.0	0.0
	Chickpea	6.0	12.0	5.3	6.0	16.7	37.3	16.7
	Horsegram	8.7	12.7	12.0	0.0	20.7	20.7	25.3
	Soyabean	10.7	43.3	13.3	4.0	11.3	14.7	2.7

Milk and Milk products	Milk	70.7	4.7	5.3	4.7	0.0	3.3	11.3
	Curd	7.3	17.3	17.3	19.3	8.0	20.7	10.0
	Paneer	0.7	34.7	20.0	5.3	6.7	29.3	3.3
Egg, Meat and Fish Product	Egg	37.3	7.3	22.0	14.7	2.0	1.3	15.3
	Meat	6.0	28.7	26.0	16.0	0.7	4.0	18.7
	Fish	24.7	16.0	14.7	19.3	0.0	2.7	22.7
Leafy Vegetables	Green leafy vegetables	52.0	7.3	8.7	16.7	0	0	15.3
Roots and Tubers	Potato	93.3	1.3	0.0	3.3	0.0	0.0	2.0
	Beetroot	1.3	12.7	16.0	0.0	5.3	40.0	24.7
	Carrot	13.3	21.3	17.3	11.3	0.7	28.7	7.3
Other Vegetables		80.0	6.7	0.0	12.7	0.7	0.0	0.0
Fruits	Banana	31.3	8.7	26.0	22.0	1.3	8.0	2.7
	Apple	16.7	11.3	26.7	8.0	8.7	23.3	5.3
	Guava	8.0	18.0	10.0	14.7	3.3	34.7	11.3
	Papaya	2.0	10.7	7.3	8.7	11.3	42.7	17.3
Nuts and Dry fruits	Groundnut	14.7	21.3	0.0	9.3	8.7	20.0	26.0
	Almond	24.7	14.7	4.0	6.0	5.3	32.0	13.3
	Cashew nut	5.3	15.3	4.7	7.3	9.3	46.7	11.3
Fats	Raisin	15.3	14.0	4.7	3.3	9.3	30.0	23.3
	Oil	99.3	0.0	0.0	0.0	0.0	0.7	0.0
	Ghee	46.0	8.7	16.7	12.7	1.3	11.3	3.3
Sugar	Butter	42.0	16.7	14.0	4.0	2.7	14.0	6.7
	Sugar	92.7	0.0	0.0	3.3	0.0	3.3	0.7
	Jaggery	16.0	7.3	0.7	3.3	13.3	22.7	36.7

(D:Daily; W1= Weekly Once; W2:Weekly Twice; W3: Weekly Thrice; F: Fortnightly; O: Occasionally; N: Never)

Rice consumption was high (80%) among the athletes. Dal was consumed by 94% of the athletes regularly as a part of their diet along with weekly consumption of other pulses like soyabean, chickpea. Around 70% of athletic population had milk habitually. Majority of the athletes were non vegetarian and 37.3% of them preferred egg daily. Green leafy vegetables consumption was seen in only 52% of the athletes. Potato (93.3%) was largely consumed by athletes among roots and tubers. It was very encouraging to note that other vegetables like ladyfingers, eggplant etc., were consumed by 80% of the athletes on daily basis. Consumption of fruits was low among athletes however 31.3% athletes had banana regularly. Almond (24.7%) was greatly consumed by athletes among the variety of nuts and dry fruits. Oil (99.3%) and sugar (93.3%) consumption on daily basis was high.

Age	Gender	Protein (g)	Adequacy (%)	Student 't' Test
7-9 yrs	Female	38.1±5.4	129.2	3.56*
10-12 yrs	Male	28.1 ± 4.4	70.4	5.36*
	Female	42.5±10.5	105.2	0.28 ^{NS}
13-15 yrs	Male	42.1±9.9	77.5	1.74 ^{NS}
	Female	32.9	63.4	-
16-17 yrs	Male	28.1	45.7	-
18-24 yrs	Male	56.2 ± 16.1	93.7	0.58 ^{NS}
	Female	48.7 ± 7.5	88.5	1.68 ^{NS}

Table 4. Twenty Four Hour Diet Recall Of The Nutrients

Age	Gender	Energy (Kcal)	Adequacy (%)	Student 't' Test
8-9 yrs	Female	1675.7± 307.5	99.2	0.10 ^{NS}
10-12 yrs	Male	1464.2± 194.1	66.9	7.48*
	Female	2028.1± 84.2	100.9	0.30 ^{NS}
13-15 yrs	Male	2116.8± 41.2	77.0	21.73*
	Female	1673.7	71.8	-
16-17 yrs	Male	1245.0	41.2	-
18-24 yrs	Male	2579.8±94.5	94.5	0.93 ^{NS}
	Female	1938.4± 157.9	86.9	3.70*

Age	Gender	Carbohydrate(g)	Adequacy (%)	Student 't' Test
8-9 yrs	Female	273.6±89.4	107.9	0.62 ^{NS}
10-12 yrs	Male	258.0±43.4	78.5	0.0019 ^{NS}
	Female	297.7±52.9	98.7	1.05 ^{NS}
13-15 yrs	Male	347.6±17.7	84.3	5.23*
	Female	301.5	86.3	-
16-17 yrs	Male	198.8	43.9	-
18-24 yrs	Male	457.9±99.2	111.8	2.13 ^{NS}
	Female	287.1±56.9	85.8	1.68 ^{NS}

Age	Gender	Fat (g)	Adequacy (%)	Student 't' Test
8-9 yrs	Female	39.2±8.0	130.7	2.57 ^{NS}
10-12 yrs	Male	27.2±4.6	77.7	3.39*
	Female	56.7±22.4	162.0	1.37 ^{NS}
13-15 yrs	Male	38.5±3.4	85.6	2.70*
	Female	29.4	73.5	-
16-17 yrs	Male	24.8	49.6	-
18-24 yrs	Male	43.4±18.2	144.7	1.80 ^{NS}
	Female	55.3±14.8	221.2	4.09*

Age	Gender	Iron (mg)	Adequacy (%)	Student 't' Test
8-9 yrs	Female	9.4± 4.7	58.8	3.14*
10-12 yrs	Male	24.5± 24.9	116.7	0.28 ^{NS}
	Female	27.8 ±27.0	103.0	0.04 ^{NS}
13-15 yrs	Male	9.8 ±0.6	30.6	52.33*
	Female	10.2	37.8	-
16-17 yrs	Male	5.9	21.1	-
18-24 yrs	Male	21.3±8.7	125.3	1.21 ^{NS}
	Female	14.2±6.4	67.6	2.13 ^{NS}

Age	Gender	Calcium (mg)	Adequacy (%)	Student 't' Test
8-9 yrs	Female	300.5 ± 88.7	50.1	7.55*
10-12 yrs	Male	272.3 ± 73.5	34.0	14.36*
	Female	352.4± 67.6	44.1	9.36*
13-15 yrs	Male	216.2 ±19.7	27.0	41.91*
	Female	236.8	29.6	-
16-17 yrs	Male	163.9	20.5	-
18-24 yrs	Male	379.6± 135	63.3	3.99*
	Female	292.8 ±83.8	48.8	7.33*

*Significant at 5% level, NS : Non-significant.

Information on 24 hour dietary recall revealed that energy intake was better in female athletes of 8- 12 years whereas in 13-24 years range, male athletes had better energy consumption as compared to the female. A study was conducted on Indian martial artists which highlighted the mean energy intake of taekwondo athletes to be 2038 ± 337 Kcal, although actual calorie intake was maintained by taekwondo athletes yet there existed a notable deficit of calorie which was found to be 13%, when compared to the standard guidelines (Sarkar, *et al.*, 2018). The energy intake of high school and college Taekwondo players of Korea, were analyzed, which depicted energy consumption of 2754.3 Kcal in college player group 3,157.0 Kcal in high school players, which were not at par with the Korean Dietary Recommended Intake which recommended daily levels in all high school athletes and college athletes (Cho, *et al.*, 2013).

Carbohydrate intake was satisfactory in all the athletes. However protein intake was better in female 8-12 years old while in 13-15 years aged, male had better protein intake. In a Lithuanian study, combat athletes were analysed for their nutritional status which highlighted that protein consumption were irrational among combat athlete, the dietary intake in 46.5% athletes were deficit and 41.9% had excess intake however only 11.6% of the Lithuanian elite combat athletes consumed proteins according to the recommendations (Baranauskas, *et al.*, 2014). High fat consumption was found in majority of the female athletes of all the age groups except 13-15 years. The moderate intake of fat was seen in most of the male athletes with the exception of 20-24 year age group. High consumption of fat could possibly have negative impact on the performance hence it was essential to be restricted in the diet for better performance. A study on Indian swimmer by Prajakta, *et al.* (2010), concluded that mean intake of fat consumption was higher in all the athletes with respect to the RDA and was highly significant for $t = 3.05-8.79$, $p < 0.01$. This is in similarity with the study which highlight that female athletes (Mean 45.44±13.32) have higher consumption of fat compared to their male (35.60±7.71) counterpart (Vici, *et al.*, 2019).

Iron consumption was found to be low in athletes and significance difference was found in 8-9 years female athletes and 13-15 years male athletes. Result on calcium consumption revealed that all players had calcium inadequacy with significant difference ($p < 0.05$) and there was an immediate need for improvement in their dietary calcium intake. In contrast to the present study, iron intake in junior hockey player was inadequate among male (65%) and female (100%) player hence the iron deficiency was observed by 47% in female players. On contrary male had excess iron consumption of 18% with respect to RDA (Roy, *et al.*, 2018).

In a study conducted by Anyzewska, *et al.*, (2018), deficiency of calcium intake by 45% in the athletes was highlighted in comparison to the recommendation, which was also found to be similar in athletes of current study. In agreement to the present study, calcium consumption was deficit by 62% was noted in sports person of Coimbatore hence the result indicated that health risk for players of that study in the future (Sangeetha, *et al.*, 2014).

CONCLUSION

Nutrition is essential for sport performance as well as for the maintenance of general health of the athletes, therefore athletes diet should be comprised of balanced diet. Taekwondo is a combat sport which requires the athletes to sustain till the end of the match, hence role of nutrition comes into picture, providing adequate nutrients and aid in recovery from sport injury. The aim of the study was to assess the nutritional status of athletes along with their physical, physiological characteristics and performance. The study was undertaken due to lack of evidential data on nutritional status of TKD athletes in India. Athletes fitness component in term of power, speed, agility, flexibility were compromised which could be rooted to improper nutrient distribution though mean energy and protein intake were adequate. Micronutrient status as assessed through dietary habits highlighted iron and calcium inadequacy posing risk on bone health in future. Athletes requirement for nutrients are high to prevent cramps, fast recovery from injury, delay fatigue and maintenance of strength and endurance, which should be taken care by expert - sport dietician/nutritionist. Sport dietician/nutritionist can provide athletes the winning edge in competition by guiding them about selection of foods before, during an event and maintaining time and type of diet which can help maintain physical and physiological characteristic and improve sport performance. The study highlights the necessity for a nutrition education program from a subject experts for better physical and physiological component translated into overall good performance.

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