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Original Article

Physical Fitness of Male Eastern Indian Judo Players

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Abstract

The present study was aimed to evaluate the fitness profile and physiological characteristics of Eastern Indian male Judo players.

State level male Judo players (n = 60, age: 22.87±1.51 yrs) were recruited from different sports academies of Kolkata, India. Sedentary control subjects (n = 60, age: 22.56±1.53 yrs) were recruited from the same area. Physical and fitness parameters (VO_{2max}, high intensity effort, agility, flexibility and body composition) were measured by standard methods.

Fitness parameters were significantly (p<0.001) better and % lean body mass (%LBM) was significantly (p<0.001) higher in Judo players whereas %fat and total fat (TF) were significantly (p<0.001) lower in Judo players than the control group.

Therefore, Judo seems to be not only a method for self defence but also it is important for promotion of health. Hence, fitness instructors may use this martial art as a beneficial mean to promote health and physical fitness.

Introduction

Sedentary life style increases the fat deposition and weight gain. It decreases physical fitness, aerobic capacity as well as bone density (1). Regular exercise improves cardiorespiratory fitness, muscular endurance, muscular strength, flexibility and also helps to maintain optimal body composition (1, 2). Judo is an Olympic event and it is one of the most popular martial art practiced worldwide (3). Regular practicing of Judo improves physical fitness in sedentary population (3, 4). Awareness about the martial arts, especially in case of Judo has increased radically in the recent past (5).

Different forms of martial arts have similar characteristics but they have different forms of actions (6). Throwing and gripping techniques are used in the high intensity sport like Judo. It is one of the

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most popular Japanese martial art in which competitors use balance and body weight, with little physical effort, to throw or grip each other in lock (7, 8, 9). Anaerobic capacity, strength, aerobic power and body composition have been considered the main characteristics developed in Canadian Judo players (10).

It is evident from earlier reports that regular practice of Judo improves one's fitness profile and also protects from potential health risks (1, 2). Fitness profile and physiological characteristics of Judo players have been reported from different countries but to our knowledge only one study has reported about the fitness profile of South Indian Judo players (3). We did not come across similar studies in eastern Indian Judo players. Hence the present study was aimed to evaluate the important fitness profile parameters in young male eastern Indian Judo players and also to compare the data with subjects leading sedentary lifestyle.

Materials and Methods

State and national level male Judo players (n=60, age: 22.86±1.51 yrs, range 21–25 yrs) with at least five years of regular involvement in high intensity Judo training were recruited from different reputed sports academies of Kolkata, India. They participated in the regular Judo training in the morning and evening sessions at least for five days a week. Sedentary control subjects (n=60, age: 22.61±1.39 yrs, range 20–25 yrs) with same socio-economic background were randomly selected from the localities where the players reside. The subjects who did not take part in any physical conditioning programme were considered as sedentary control subjects. Subjects were neither suffering from any disease nor under any medication during the study period. They had no history of major diseases, injury or bone fracture. The study was conducted at temperature ranging between 20–23°C and relative humidity ranging between 40–45%. The study was approved by the Institutional Human Ethics Committee of the Department of Physiology, University of Calcutta and conformed to the Declaration of Helsinki. Written informed consent was taken from all the subjects. The sample size was computed using PS Power and Sample Size calculation version 2.1.30 where power was set at 80 with 95% confidence interval.

Each subject reported in the laboratory at 10 am and they came to the laboratory for three times with a gap of at least 7 days in between two consecutive days of visit to ensure complete abolishment of fatigue generated due to previous day's trial. They were explained and familiarized with the experimental procedure on the first visit. The fitness profile parameters were measured during the second and third visits. Subjects took rest for half an hour on arrival in the laboratory during which the entire experimental protocol was again explained to them to allay apprehension. Body weight, height, heart rate, blood pressure, agility and high intensity effort (HIE) were measured in the second visit whereas body composition and cardiorespiratory fitness (VO_{2max}) were measured during the third visit. Body height and body mass were measured to an accuracy of ±0.50 cm and ±0.1 kg, respectively, by using a weight measuring instrument fixed with a height measuring rod (Avery India Ltd., India) with the subject standing barefoot and wearing minimum clothing. The subjects refrained from any energetic activity on the days of evaluation and took light breakfast at least 3 hrs before the test. The body surface area (BSA) and body mass index (BMI) were calculated by using the following equations: (11, 12)

$$BSA\ (m^2) = (Body\ mass)^{0.425} \times (Body\ height)^{0.725} \times 71.84$$

$$BMI\ (kg/m^2) = Body\ Mass\ (kg)/(Body\ Height\ in\ meter)^2$$

Determination of Body Composition: (13)

A skin-fold calliper with constant tension (Holtain Ltd., UK) was used to determine the body composition by using the following formulae:

$$Body\ density\ or\ BD\ (gm.cc^{-1}) = 1.10938 - 0.0008267X_1 + 0.0000016X_1^2 - 0.0002574X_2$$

(X_1 = sum of chest, abdominal and mid–thigh skinfolds, X_2 = Age in nearest yrs)

$$\%Fat = 495/BD - 450 (14)$$

Total body fat, lean body mass (LBM) and percentage of LBM (%LBM) were calculated from the following equations :

- Total Fat (TF)(kg) = %Fat/100 × Body Mass (kg)
- % Lean Body Mass (%LBM) = 100 – %Fat
- LBM (kg) = Body Mass (kg) – Total Fat (kg)

Direct estimation of VO_{2max}: (15)

The direct estimation of VO_{2max} was performed according to the protocol of Dalui and Bandyopadhyay (15). Muller's magnetic brake bicycle ergometer (Model of Max Plank Institute of Ergology, Germany) was used for this study. All the subjects were warmed up at a submaximal intensity of 75 watt for 5 minutes. Immediately after performing the warm up, the intensity was increased to the first incremental intensity of 155 watt and thereafter the intensity was increased by 25 watt every 3 min until the subject stopped due to exhaustion. In the present study, the oxygen uptake was considered maximum when peak heart rate was greater than 180 beats per min and also by levelling off, i.e., when no further increase in oxygen uptake took place despite further increase in work load.

Low resistance high velocity Collin's Triple "J Type" plastic valve was used for the collection of expired gas by open circuit method. The valve remained connected with the Douglas Bag (150 L) and the expired gas was collected at the last minute of final intensity of exercise. The volume of expired gas was measured in a wet gasometer (Toshniwal, Germany, CAT. No. CG05.10) and the aliquots of gas samples were analyzed in a Scholander micro-gas analysis apparatus following the standard procedure. The peak heart rate was recorded manually from the time taken for 10 carotid pulsations immediately following the cessation of exhaustive exercise (15).

Determination of High intensity effort (HIE): (15)

HIE was determined by 60 yard dash shuttle run test which is a steps shuttle of progressing distances. Three marker cones were placed at the yard lines 5 yards away from each other. The athlete started from one end, ran 5 yards and returned to the start point, 10 yards and back, then 15 yards and reached back the start line. A total of 60 yards was completed. It was ensured that the subject touched the line with their hand in each turn i.e. total for five times. The duration of this test was recorded in seconds.

Measurement of agility by shuttle runs method: (15)

The subject was asked to run back and forth between two parallel lines as swift as possible. Two lines were put up 30 feet apart. Two wooden blocks were kept behind one line which was opposite to the starting line. The subject started running from the starting to the other line and picked up one block and returned it to place behind the starting line, then returned again to pick up the next block, then ran back with the block to place it back across the starting line. The time taken for the entire running period was recorded in seconds by a stop watch.

Measurement of flexibility by modified sit and reach test: (15)

The subject sat on the floor with legs stretched out straight in front with shoes removed. The soles of the feet were positioned flat against the box. Both knees were locked and pressed plane to the floor. With the palms facing downwards, and the hands on top of each other or side by side, the subject was asked to reach ahead along the measuring line as far as possible. It was ensured that the hands remained at the same plane, not one reaching further forward than the other. After some practice the subject reached out and held that position for at one or two seconds while the distance was recorded. No jerky movement was allowed.

Statistical analysis

Data have been presented as mean±SD. Two-tail student's t-test was performed to test the significance of difference between mean values recorded in Judo group and sedentary control group.

Results

Values of age, body height, body weight, BMI, BSA, pre-exercise heart rate, pre-exercise systolic and diastolic blood pressure are presented in Table I. Age did not show any significant difference between the groups. Body height depicted significantly (p<0.05) higher value in the Judo players while other parameters were significantly lower in them compared to the sedentary group (Table I). Both the groups belonged to the normal range of BMI values.

The value of chest, abdominal and mid-thigh skinfolds and the sum of skinfolds were significantly (p<0.001) lower in Judo players than the sedentary group (Fig. 1).

Different components of body composition, flexibility, agility, HIE and VO_{2max} are tabulated in Table II. BD, %LBM, flexibility, agility, HIE, and VO_{2max} depicted significantly (p<0.001) higher values in Judo group, but %fat and TF exhibited significantly (p<0.001) lower values in Judo players than the sedentary group.

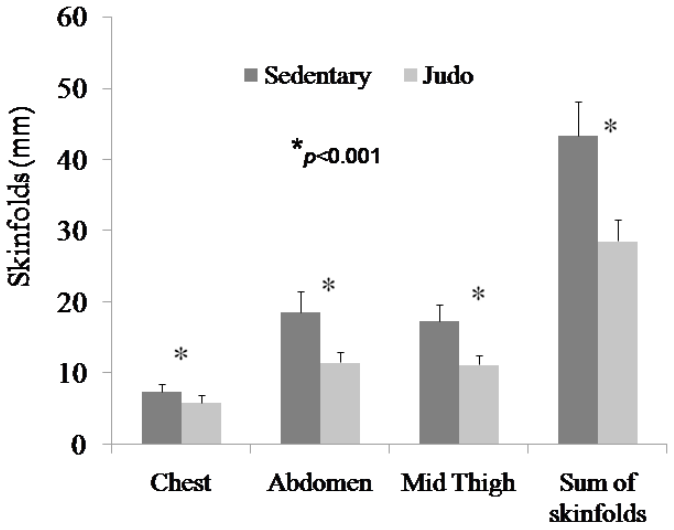

Fig. 1: Different skinfold parameters and sum of all the three skinfolds in sedentary group and Judo Players.

Discussion

The aim of this study was to evaluate the effect of Judo training on selective fitness profile parameters in Indian young male Judo players. Results demonstrated that Judo training influenced the body composition, aerobic and anaerobic power (as depicted from their

TABLE I: Physical and physiological parameters of the subjects.

	Age (yrs)	*Body height (cm)*	*Body weight (kg)*	*BMI (kg/m^2)*	*BSA (m^2)*	*Blood Pressure (mm of Hg)*		*Pre-exercise Heart Rate ($beats.min^{-1}$)*
						Systolic	*Diastolic*	
Sedentary (n=60)	22.52±1.53	164.99±2.63	61.56±3.34	22.62±1.28	1.68±0.05	118.31±4.77	78.45±8.68	84.71±5.60
Judo (n=60)	22.86±1.51	166.03±1.72*	58.93±2.83**	21.37±0.78**	1.65±0.04*	108.47±3.92**	75.43±5.4*	69.10±4.20**

Values are expressed mean±SD, *p<0.05, **p<0.001.

TABLE II: Values of body composition, Agility, flexibility and HIE and VO_{2max}.

	Body density ($gm.cc^{-1}$)	*%fat (%)*	*Total body Fat or TF (kg)*	*%LBM (%)*	*LBM (kg)*	*Agility (sec)*	*Flexibility (cm)*	*HIE (sec)*	*VO_{2max} ($ml.min^{-1}.min^{-1}$)*
Sedentary (n=60)	1.07±0.003	12.28±1.41	7.59±1.19	87.71±1.41	53.95±2.45	12.08±0.72	20.49.±4.92	9.70±0.88	41.05±4.65
Judo (n=60)	1.08±0.002**	7.84±0.90**	4.64±0.70**	92.16±1.41**	54.29±2.21	11.70±0.46**	37.01±3.23**	9.14±0.57**	53.18±3.39**

Values are expressed mean±SD, *p<0.05, **p<0.001

cardio-respiratory fitness and HIE, respectively), agility and flexibility scores in the studied population.

Subjects of both the groups were in normal range of BMI, heart rate and blood pressure (Table I). Age did not show any inter–group variation but body height, weight, BMI, BSA, heart rate and systolic and diastolic blood pressure were significantly higher in the sedentary control group. Existence of significantly lower values of body weight, BMI, BSA, heart rate and systolic and diastolic blood pressure among the Judo players might be attributed to their regular participation in the Judo training (Table I).

Judo is one of the dynamic, high intensity intermittent sport that requires complex skills and planned excellence for success (16). Muscular strength plays an important role towards the success of Judo athletes (16). Judo athletes of the present study had significantly (p<0.001) lower value of %fat than their sedentary control group as also reported in earlier studies in Tunisian Judo athletes (16). Value of %fat observed in the Judo players of the present study was lower than their Canadian (12.3%), Japanese (16.2%), Brazilian (13.7%) and North American (8.3%) counterparts (17). But Tunisian male national Judo athletes (25.1±3.7 yrs) depicted insignificant change in %fat following Judo training (18) (Table III). Body fat percentage is a key determinant of Judo performance as established in earlier studies which showed significant negative correlation between %fat and performance in different categories (state level, national level, etc.) of Judo athletes. This was most probably due to reduction in %fat is associated with a concomitant increase in aerobic capacity (3, 17).

Table III compared the values of different fitness profile parameters of Judo players reported in different populations with the values recorded in the present study.

The %LBM was significantly higher in Judo players than the control group but LBM (kg) did not show any intergroup variation. Fat mass (kg) and %fat were significantly higher in the control group. The values of fat mass, %LBM and LBM of the presently studied Judo athletes could not be compared due to unavailability of data in other populations. However, the present result supported the common belief that judo players try to maximize their lean body mass and minimize the fat mass (19).

Caucasian adult male Judo athletes had significantly higher muscle mass and lower %fat than non-athletes (20). It had been accepted that weight bearing forms of energetic exercises were associated with gaining higher muscle mass and the potentiated the benefits of %fat (20). Although higher than in the present study, one study reported that Roman Judo players had lower fat mass (7.5±3.6 kg) than the control group (11.6±5.7kg) (20). They hypothesised that the Judo training played the beneficial role to increase the muscle mass in Judo athletes (20).

TABLE III : Comparison of present data with the earlier studies.

Authors	*Population*	*%Fat (%)*	*VO_{2max} ($ml^{-1}kg^{-1}min^{-1}$)*	*HIE (sec)*	*Agility (sec)*	*Flexibility (cm)*
Ouergui et al. (2014)	Tunisian	–	58.7±5.2	–	16.2±1.0	18.2±0.5
Toskovic et al. (2002)	Spanish	–	52.8±7.9	–	–	–
Borkowski et al. (2001)	Polish	–	57.6±4.6	–		–
Taylor et al. (1981)	Canadian	–	57.5±9.5	–		–
Tumilty et al. (1986)	Australian	–	53.2±5.7	–	–	–
Kim et al. (1996)	Korean	–	62.8±5.9	–	–	–
Callister et al. (1991)	American	8.3±1.0	55.6±1.8	–	–	–
Franchini et al. (2011)	Brazilian	–	48.3±8.1	–	–	–
Taylor and Brassard (1981)	Canadian	12±3.9	–	–	–	–
Franchini et al. (2007)	Japanese	16.2±5.7		–	–	–
Franchini et al. (2007)	Brazilian	13.7±5.2		–	–	–
Saraiva et al. (2014)	Brazilian	–	–	–	–	25.83±3.07
Present study	Indian	7.84±0.90	53.18±3.39	9.14±0.57	11.70±0.46	37.01±3.23

Values are expressed mean±SD.

Judo is a suitable exercise to improve cardiorespiratory fitness (18). Toskovic et al., (20) reported that training of martial art had beneficial effect on aerobic fitness (21). Ouergui et al. (18) demonstrated significantly (p<0.001) greater value of VO_{2max} (58.7±5.2 ml $kg^{-1}min^{-1}$) of young (age 20.9±1.4 years) Tunisian Judo players than their control group as also reported in Spanish young (19.7±1.9 years) male Judoka (22). All these findings were in agreement with the present study. A comparative account of VO_{2max} values in different populations is given in table 3. Significant improvement (13.2±6.0%) in aerobic fitness was noted following 5 weeks of kickboxing training (27). Contradictory findings were also reported in some other studies that revealed insignificant change in cardiorespiratory fitness following Judo training (25, 28). Franchini et al. (17) reported that male Brazilian Judo team exhibited (age 25.6±4.0 years) medium aerobic capacity (48.3±8.0 $ml.kg^{-1}.min^{-1}$) tested by Cooper Test method and the values were lower than the presently studied Judo players (53.18±3.39 $ml.kg^{-1}.min^{-1}$). However, Brazilian national and international Judo athletes (age 22.3±3.6 years) had better VO_{2max} (63.0±10.3 $ml.kg^{-1}.min^{-1}$) than Brazilian Jiu-Jitsu players (49.4±3.6 $ml.kg^{-1}.min^{-1}$) and present study (31). Laskowski et al. (29) correlated changes in heart morphology induced by long term (10 yrs) Judo training with an increase in VO_{2max} in Polish male (age: 22.1 years) and female (age: 19.4 years) players. Bonato et al. (30) concluded that aerobic fitness of elite Italian male and female Judokas was further improved by adding 12 weeks specific aerobic training programme. French Judo athletes (age 24.4±0.9 years) had better VO_{2max} (55.0±2.9 $ml.kg^{-1}.min^{-1}$) score than the presently studied Judo athletes (31).

Cardio respiratory fitness of Olympic Italian male and female Judokas exhibited the VO_{2max} score of 47.3±10.9 and 52.9±4.4 $ml.kg^{-1}.min^{-1}$, respectively (31). The values of both the genders were lower than the present study.

However, regular practicing of other forms of dynamic martial art exercises, e.g., taekwondo, karate, etc. significantly improved the cardiorespiratory fitness (21, 31, 32). Regular involvement in Judo training probably reduced the body's %fat and increased the LBM that in turn might have helped the presently studied Judo players to achieve significantly higher value of VO_{2max} than their sedentary control subjects.

Judo is a dynamic, high intensity intermittent sport that requires complex skills and tactical quality for achievement (16, 17, 18). Maximal strength plays the beneficial role for success in Judo athletes (16, 17). Tunisian young male Judo athletes (20.9±1.4 years) had significantly (p<0.001) better speed than their control group (18). Sterkowicz et al. (28) reported significant improvement of anaerobic performance after Judo training programme. This observation was similar to the present investigation where significantly (p<0.001) higher value of HIE was depicted than their sedentary counterparts (Table II). These are due to the fact that the kickboxing is distinguished by brief high intensity techniques (punches and kicks) where the effort is possibly maintained by the Adenosine Tri Phosphate-Creatine Phosphate system (27). Specific training type and techniques probably helped the Judo players of the present study to achieve better HIE value.

Agility is the skill that promotes rapid and exact movement of the body or body parts involving majority of the muscles of that region. Besides innate capacity, training contributes a lot to improve the performance level. Both short term and long term Judo training had similar level of beneficial effect on agility, indicating that Judo training influences the agility irrespective of the training duration (19). Present study depicted significantly (p<0.001) higher agility score in Judo players than their sedentary control counterparts (Table II). This finding was similar to the findings in young (20.9±1.4 yrs) Tunisian male Judo athletes who were significantly higher agile (16.2±1.0 sec) than their control group (17.8±0.9sec) (18). Judo training comprises of frequent fast stepping and fast displacement which might have helped the Judo athletes to improve their agility in the course of training (27).

Flexibility is a very important parameter in fight training, especially since it is associated with a broader range of motion that contributes in execution of skills and reduces the risks of injury (19, 33). Flexibility depends on number of specific variables,

muscle viscosity, including distensibility of the joint capsule, adequate warm up, and compliance of various tissues such as ligaments and tendons that affect the range of motion (19). Present study depicted significantly higher value of flexibility in Judo players in comparison to their sedentary counterparts as also reported by Katralli et al. (19) and Ouergui et al. (18) in South Indian and Tunisian Judo players, respectively. Flexibility score of the presently studied male Indian Judo players (37.01±3.23 cm) was higher than the Tunisian Judo players (18.2±0.5 cm) and Brazilian Judo athletes (25.83±3.07 cm) (18, 34). More experienced Judo athletes (21.5±1.63 cm) had significantly higher flexibility score than their less experienced counterparts (16.2±3.61cm), indicating that the flexibility score of the Judo athletes was influenced by the training duration as also reported in Australian Judokas (19, 35). Katralli et al. (19) attributed such training duration related difference in flexibility score among Judo athletes to their exposure to stretching exercises during the training sessions.

The present study concluded that the Judo training had beneficial effects on fitness profile parameters. Cardiorespiratory fitness, HIE, body composition, agility and flexibility were significantly improved in the Judo athletes. These findings suggested that Judo seems to be not only a method for self defence but also a good method which can offer health promotion and a consequential exercise for improving fitness among young adults. Thus fitness instructors, sports professionals may consider the Judo training program as a beneficial form of exercise to promote physical fitness and for preventing injuries by increasing muscles' flexibility. Present data will also help the coaches to design better training regime to improve the fitness profile of Judo athletes to a greater extent.

Limitation of the study:

Although the dietary practice and fluid intake patterns influence the fitness profile parameters, but it is a shortcoming of the study that these parameters were not evaluated in the present study.

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