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Pulmonary Function of Young Indian Male Judo and Karate Players

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ABSTRACT

Present study was aimed to evaluate the pulmonary function in male Indian Judo and Karate players and to compare the data with their sedentary control and overseas counterparts. State level young male non–smoking Judo (n=30) and Karate (n=30) players with minimum five years of regular involvement in training were recruited from different sports academies of Kolkata, India. Non–smoking sedentary control (n=30) subjects were recruited from similar socio-economic background. Physical parameters and pulmonary functions were measured by standard methods. Excepting age and body height all the physical and physiological parameters were significantly ($p<0.05$) higher in the sedentary control group. Tidal volume, vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 second, percentage of forced vital capacity and peak expiratory flow rates depicted significantly ($p<0.05$) higher values in Judo and Karate groups than their sedentary counterparts. Age, body height and body mass were significantly correlated with lung function parameters. Simple and multiple regression equations were computed for predicting pulmonary functions in the studied population. It can be concluded that training in Martial arts

Key Words: *Judo, Karate, Lung function*

like Judo and Karate improved pulmonary function in the athletes. The regression equations were recommended for prediction of pulmonary function in the studied groups.

INTRODUCTION

Poor physical activity in the young generation is associated with several respiratory problems (13). Different forms of Martial arts, e.g., Judo, Karate, Tai Chi, Soo bahk do, Taekwondo etc., have gained worldwide popularity because of their beneficial effects in the maintenance of a healthy lifestyle (7, 20, 21). Judo and Karate are trendy forms of Martial arts that have gained inconceivable popularity in Korea, Japan, China and India (7, 8). Martial art forms are gentle, meditative exercise routines that employ detailed regimens of flowing circular movements, balance and breathing techniques which improve physical fitness and pulmonary function and offer protection from potential health problems (4, 16, 19). Previous studies have reported that there is a connection between exercise and respiratory function among Serbian, Tunisian, Chinese and Korean Martial arts athletes (6, 10, 15, 16). Pulmonary function is influenced by training and exercise, although contradictory findings have also been reported (5, 15, 17). This suggests that lung function may change depending on the sport activity performed (15). Previous study has established significant improvement in respiratory functions following Kalari training (an ancient form of Martial arts) due to synchronization of respiratory muscles with exercise styles, viz. jumping and kicking, long stances, long strides, blows and blocks by stretched arms and hands, etc., which are also important forms of movement involved in Judo and Karate (3). There have been reports that young Serbian Karate athletes showed better lung function than their untrained counterparts (9). Researchers have hypothesised that exercise- or training-induced hypertrophy of respiratory muscles might lead to the betterment of pulmonary function (2, 12, 18). Physically fit athletes possess better-quality respiratory functions relative to less fit subjects (11).

Pulmonary functions of Judo and Karate players have been reported from different countries (6, 10, 15, 16). Data of pulmonary function measurements in Judo and Karate players are unavailable in the Indian context. The present study was therefore aimed to evaluate the pulmonary function in young male Judo and Karate players of Kolkata, India, and also to compare the data not only between these two groups of Martial art athletes but also with their sedentary control group and overseas counterparts. The study was further aimed to propose prediction norms for different pulmonary function measurements in the studied population.

MATERIALS AND METHODS

State level male Judo (n=30) and Karate (n=30) players belonging to the age group of 20-26 yrs with at least five years of regular involvement in training were recruited by simple random sampling from reputed Martial art academies of Kolkata, India. Sedentary control subjects (n=30) with similar age range and socio-economic background as accounted from their monthly family income were selected from the same localities where the Martial art athletes reside. All the subjects were non–smokers and they had identical daily physical activity level. 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. The subjects were neither suffering from any disease nor under any medication during the study period. Subjects who were undergoing any medication or individuals with history of any major diseases were excluded from the study. The entire study was conducted at temperature ranging between 20°C-23°C and relative humidity ranging between 40-45%. Ethical clearance was obtained from the Human Ethics Committee of the Department of Physiology, University of Calcutta and written informed consent was taken from all the subjects.

Subjects reported in the laboratory at 9 am. 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 fitted with height measuring rod (Avery India Ltd., India) with the subjects wearing minimum clothing and standing barefoot.

9-L closed-circuit type expirograph (Toshniwal Technologies Pvt. Ltd, India) was used to measure the tidal volume (TV), vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), FEV_1 as a percentage of FVC ($FEV_{1\%}$), mid expiratory flow rate ($FEF_{25-75\%}$), and end expiratory flow rate ($FEF_{(78-85\%)}$); while peak expiratory flow rate (PEFR) was measured with the help of Wright peak flow meter. Palmer respiratory hand pump was used to calibrate the instruments on each day of data collection. All the measurements were conducted at noon before lunch because the expiratory flow rates are highest at noon (1) in standing posture. Each volunteer performed a practice trial followed by three satisfactory efforts which were documented with at least 3-5 min rest between the consecutive trials (1). Out of these three trials, the maximum value was accepted. All lung function measurements were expressed at body temperature and pressure saturated with water vapour (BTPS). All the measurements were conducted by using the same instrument and subjects were motivated with verbal encouragement to ensure their maximum cooperation. Data were collected by random sampling irrespective of the studied groups to avoid any possibility of bias. In one subject, all the records, i.e. anthropometric measurements and recording of pulmonary function measurements, were conducted in one sitting on the same day.

Data have been presented as mean ±SD. One way analysis of variance (ANOVA) was carried out to detect the significance of difference in mean values obtained among the groups and Tukey's Post-hoc analysis was adopted to detect inter group differences recorded in Judo, Karate and Sedentary control groups. Pearson's product-moment correlation coefficient (r) was computed to evaluate the relationship between pulmonary function measurements and physical parameters. Simple and multiple regression analysis were performed to compute the prediction norms for different pulmonary function variables from the physical parameters. Level of significance was set at $p<0.05$. The entire statistical analysis was performed by using SPSS Software, Version 16.0.

RESULTS

Values of age, body height, body weight, pre-exercise heart rate and blood pressure have been presented in Table 1. There was no significant inter group differences in age and body height. Body weight, pre-exercise heart rate, systolic and diastolic blood pressure were significantly ($p<0.05$) higher in the Sedentary control group in comparison to the Judo and Karate groups (Table 1).

Table 1

Physical and physiological parameters of the Sedentary, Judo and Karate groups

	Age (yrs)	Body height (cm)	Body weight (kg)	Blood Pressure (mm of Hg)		Pre-exercise Heart Rate (beats·min^{-1})
				Systolic	Diastolic	
Sedentary (n=30)	22.33 ±1.35	167.78 ±4.56	66.16 ±4.25	125.03 ±4.82	80.36 ±4.37	80.4 ±4.80
Judo (n=30)	22.6 ±1.63	168.11 ±6.60	62.70 ±3.29*	116.30 ±4.00*	75.96 ±4.26*	71.96 ±4.19*
Karate (n=30)	22.43 ±1.04	168.83 ±5.40	59.02 ±3.62*	116.20 ±4.53*	75.73 ±4.06*	70.47 ±3.74*

Values are mean±SD, *$p<0.05$ (When compared with the sedentary group).

Values of different pulmonary function measurements have been presented in Table 2. TV (P=0.0001), VC (P=0.031), FVC (P=0.015), FEV_1 (P=0.0009), $FEV_{1\%}$ (P=0.005), $FEF_{(25-75\%)}$ (P=0.0039), $FEF_{(75-85\%)}$ (P=0.0178) and PEFR (P=0.00012) were significantly ($p<0.05$) higher in Judo and Karate groups in comparison to the sedentary control group.

Table 2

Values of different pulmonary function parameters in Sedentary, Judo and Karate groups

	TV (ml)	**VC (l)**	**FVC (l)**	**FEV_1 (l)**	**$FEV_{1\%}$ (%)**	**PEFR ($l \cdot min^{-1}$)**	**FEF 25-75% ($l \cdot min^{-1}$)**	**FEF 75-85% ($l \cdot min^{-1}$)**
Sedentary (n=30)	583.67 ±51.96	4.11 ±0.38	4.05 ±0.37	3.23 ±0.55	83.22 ±4.38	601.67 ±43.79	177.21 ±49.01	113.82 ±49.91
Judo (n=30	628.33 ±53.12*	4.37 ±0.47*	4.32 ±0.48*	3.69 ±0.48*	86.93 ±4.93*	671.33 ±38.30*	183.32 ±46.33	86.16 ±37.88*
Karate (n=30)	640.67 ±53.05*	4.38 ±0.45*	4.36 ±0.44*	3.71 ±0.57*	86.03 ±4.02*	675.67 ±38.92*	226.27 ±79.61*	118.79 ±59.75

Values are mean±SD, *$p<0.05$ (When compared with the sedentary group).

Age, body height and body mass depicted significant relationship with different pulmonary function parameters and the values of correlation coefficient (r) between anthropometric variables and lung function parameters in the studied groups have been presented in Table 3. Simple and multiple regression equations were computed for predicting the pulmonary functions, i.e., VC, FVC and FEV_1 from different physical parameters in the studied groups (Tables 3 and 4). Standard errors of estimate (SEE) of the computed regression equations were more or less same in all the groups. Multiple and simple regression equations did not show any significant variation in their SEEs which were considerably small enough to recommend them to predict these lung volumes from the independent variables.

Table 3

Values of Pearson's product moment correlation coefficient (r) between physical parameters (viz, age, height and weight) and lung function measurements and the simple regression equations for the prediction of VC, FVC and FEV_1 from age, height and weight in the studied groups

Pulmonary Function Measurement	Group	Physical Parameter	Correlation Coefficient (r)	Regression equation	SEE (l)
VC (l)	Sedentary	Age	r = 0.38 (p<0.05)	VC= 0.108A+1.70	0.36
		Body height	r= 0.81 (p<0.001)	VC= 0.068H-7.32	0.22
		Body weight	r= 0.68 (p<0.01)	VC= 0.062W+0.03	0.28
	Judo	Age	r = 0.54 (p<0.01)	VC= 0.14A+0.80	0.41
		Body height	r= 0.39 (p<0.05)	VC= 0.03H- 0.34	0.45
		Body weight	r= 0.57 (p<0.05)	VC= 0.08W-0.83	0.39
	Karate	Age	r = 0.48 (p<0.05)	VC= 0.21A-0.31	0.38
		Body height	r= 0.48 (p<0.05)	VC= 0.04H-2.37	0.40
		Body weight	r= 0.52 (p<0.01)	VC= 0.06W+0.58	0.39
FVC (l)	Sedentary	Age	r = 0.49 (p<0.01)	FVC=0.14A+1.03	0.33
		Body height	r= 0.53 (p<0.01)	FVC=0.04H -3.25	0.32
		Body weight	r= 0.41 (p<0.01)	FVC=0.04W+1.66	0.35
	Judo	Age	r = 0.38 (p<0.05)	FVC =0.11A+1.82	0.45
		Body height	r= 0.51 (p<0.05)	FVC =0.04H-1.94	0.42
		Body weight	r= 0.38 (p<0.05)	FVC =0.07W+0.06	0.41
	Karate	Age	r = 0.45 (p<0.05)	FVC=0.19A-0.07	0.38
		Body height	r= 0.44 (p<0.05)	FVC=0.04H-1.76	0.40
		Body weight	r= 0.48 (p<0.05)	FVC= 0.06W+0.91	0.39

FEV_1 (l)	Sedentary	Age	r = 0.67 (p<0.01)	FEV_1=0.28A-2.97	0.42
		Body height	r= 0.48 (p<0.05)	FEV_1=0.06H-6.62	0.49
		Body weight	r= 0.38 (p<0.05)	FEV_1=0.05W-0.08	0.52
	Judo	Age	r = 0.47 (p<0.05)	FEV_1=0.14A+0.53	0.43
		Body height	r= 0.41 (p<0.01)	FEV_1=0.03H-1.33	0.45
		Body weight	r= 0.50 (p<0.01)	FEV_1=0.07W-0.92	0.43
	Karate	Age	r = 0.51 (p<0.05)	FEV_1=0.28A-2.57	0.49
		Body height	r= 0.38 (p<0.01)	FEV_1=0.04H-3.14	0.53
		Body weight	r= 0.69 (p<0.01)	FEV_1=0.11W-2.79	0.41

A = Age, H = Body height, W= body weight, SEE = standard error of estimate.

Table 4

Multiple regression norms for the prediction of pulmonary function measurements in the studied population

Pulmonary Function Measurement	Group	Regression equation	R	R^2	SEE (l)
VC (l)	S	VC=0.069A+0.051H+0.0212W-7.469	0.86	0.75	0.20
	J	VC=0.116A+0.009H+0.0611W-3.613	0.71	0.51	0.35
	K	VC=0.112A+0.024H+0.0423W-4.619	0.66	0.43	0.34
FVC (l)	S	FVC=0.114A+0.034H+0.007W-4.599	0.67	0.45	0.29
	J	FVC=0.068A+0.028H+0.025W-3.529	0.59	0.35	0.41
	K	FVC=0.103A+0.021H+0.038W-3.821	0.61	0.37	0.37
FEV_1 (l)	S	FEV_1=0.251A+0.041H+0.009W-9.801	0.77	0.59	0.38
	J	FEV_1=0.098A+0.014H+0.050W-4.059	0.59	0.35	0.41
	K	FEV_1=0.145A+0.012H+0.089W-6.940	0.76	0.58	0.39

S= Sedentary group, J= Judo group, K=Karate group, A = Age, H = Body height, SEE = standard error of estimate.

DISCUSSION

Results of the present study indicated that the Martial art athletes had better respiratory functions than their sedentary counterparts. Several studies were focused to evaluate the respiratory and circulatory efficiency which are the fundamental factors of aerobic aspect that decides the tolerance of the physical effort of athletes and sedentary individuals (13, 16).

Values of TV, VC, FVC, FEV_1, $FEV_{1\%}$, $FEF_{(25-75\%)}$, $FEF_{(75-85\%)}$ and PEFR were significantly ($p<0.05$) higher in the experimental groups than their sedentary counterparts. Similar findings have been reported in Tunisian boys, Serbian young athletes and Chinese elder Martial art players who had significantly ($p<0.05$) higher values of FEV_1, $FEV_{1\%}$ and maximum voluntary ventilation (MVV) than their sedentary control group (6, 9, 16). VC and FVC are considered as the imperative indicators of respiratory skill (14). Existence of significantly higher values of VC and FVC in the Karate and Judo groups in comparison to the sedentary control group was in agreement with earlier findings in Serbian, Polish, Tunisian and Chinese Martial art athletes (6, 10, 13, 16). It has been recommended that respiratory muscles, like other skeletal muscles, could increase their strength and capacity in response to specific training (11). FVC of the presently studied Karate and Judo players were lower than the Polish (5.42 ± 0.87 *l*) and Korean (5.2 ± 0.4 *l*) wrestling Martial arts players (13, 15).

Significantly higher values of TV, VC, FVC, FEV_1, $FEV_{1\%}$, $FEF_{(25-75\%)}$, $FEF_{(75-85\%)}$ and PEFR in the experimental groups corroborated with earlier report in Serbian athletes (9). This finding was also in agreement with the findings in Kalaripayattu (an ancient traditional Martial art form of Kerala, India) players (3). Significantly higher pulmonary function measurements in Martial art players might be attributed to the better elastic recoil of lungs and improved conductive properties of the larger airways (3). Such changes in the respiratory system in experimental groups might be due to participation in Martial art training that involved repeated bouts of high frequency exercise techniques, e.g., kicking, high jumping, arm and leg stretching along with other various stances that were synchronized with the breathing rhythm (3). This could have resulted in the hypertrophy of respiratory muscles which in turn improved pulmonary function due to increased muscle strength and power (2, 12, 18). Constant arm stretching and upper body exercises improved the surface area of the chest area that might have contributed towards further expansion of the thoracic cage for the betterment of lung volumes in Judo and Karate players (3). There are several potential explanations why athletes have better lung capacities (9). Higher lung parameters indicated that there is a relation between the Karate and Judo training and increases in basic spirometric values and at the same time, the effectiveness of the respiratory system of young athletes, thus the result was statistically important (14).

Research revealed that Martial art training enhanced the endurance and strength of respiratory capacity, diminished resistance in the respiratory canals, increased lung elasticity and developed the alveoli (14). Undoubtedly, Martial art training played a crucial role in reducing airway obstacles, lowering the incidences of respiratory diseases and increasing the efficacy of the pulmonary system (14).

Peak expiratory flow rate (PEFR) is the most closely associated spirometric parameter with training program (14). Existence of significantly higher PEFR score in Judo and Karate group than their sedentary counterparts corroborated with the earlier report in Polish athletes and this finding might be attributed to the fact that engagement in sports or athletic activities strengthens the respiratory muscles with a resultant increase in the lung volumes (14).

Simple and multiple regression equations were computed to predict VC, FVC and FEV_1 from different physical parameters in the studied groups. Standard errors of estimate (SEE) of the computed regression equations were substantially small enough to recommend them to predict VC, FVC and FEV_1 values in the studied populations.

The potential beneficial effects of Judo and Karate training towards improvement of lung function have been clearly reflected in the present study. These martial art athletes might have achieved better pulmonary function due to such training induced increase in muscle strength and power due to hypertrophy of ventilatory muscles, expansion of thoracic cage, improvement in the chest surface area, better elastic recoil of lungs and improved conductive properties of the larger airways which might be the probable contributory factors for the greater lung volumes in both the experimental groups. The data of the present study will also serve as the national database of pulmonary function in male Judo and Karate players and necessary amendments may be made in their training protocol for further development of the studied parameters.

PRACTICAL APPLICATION

Pulmonary function in Indian Judo and Karate players is reported for the first time in the present study. Comparison of the data would help the coaches and physical instructors to judge the level of difference in pulmonary function with their overseas counterparts. The data reported in the present study will serve as the national standard of pulmonary function measurements in male Indian Judo and Karate players and proposed regression norms will help to predict the lung volumes in the studied population. These data will also help the coaches to make necessary amendments in the training protocol of Judo and Karate players for further development of the studied pulmonary function parameters.

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COMPETING OF INTEREST

There is no competing interest in the present study.

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