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Effects of short term yoga training on body composition and cardio-pulmonary functions on healthy male

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Abstract: *Background:* Physical inactivity leads to obesity and increases the risk of cardio-pulmonary diseases. *Objectives:* To study the effects of yoga training on cardio-pulmonary functions on healthy male. *Method:* Eighty-five healthy male volunteers (age 18–20 years) were screened randomly, among them twenty five were excluded from the study, the remaining sixty volunteers were randomly divided into two groups: (a) Yoga Group (n = 30) and (b) Control Group (n = 30). Yoga training (60 min/d, 06 d/wk for 12 wks) was followed in yoga group with no yoga training in control group. Body composition, heart rate, blood pressure and pulmonary functions were assessed in both the groups at 0- week and after 12- weeks. *Result:* Significant reduction (P<0.05) in body fat, body mass, SBP, RHR and RR; and increase (P<0.05) in FVC, FEV1, PEFR, MVV, and BHT were noted in the yoga group after 12 weeks of yoga training when compared to baseline data. Further, the control group had significantly (P<0.05) higher body fat, total fat mass, body mass, SBP, RHR and RR; and (P<0.05) lower FVC, FEV1, PEFR, MVV, and BHT when compared to yoga group after 12 weeks of study. *Conclusion:* These changes might be due to yoga training. Regular yoga practice improves blood pressure and lung functions; and reduces the risk of cardio-pulmonary diseases.

Keywords: Yoga, Body Composition, Blood Pressure, Pulmonary Function.

Introduction

Physical inactivity leads to obesity and increases the risk of cardio-pulmonary diseases [1]. On the other hand, physical activity conveys multiple health benefits including decreased rates of coronary artery disease, hypertension, noninsulin dependent diabetes mellitus, osteoporosis, colon cancer, anxiety, and depression, as well as decreased risk of overall mortality [1].

Yoga, with origins in ancient India, has several sub-types and incorporates asana (posture-physical exercise), pranayama (breathing exercise) and meditation (an approach to training the mind or focusing the mind on a particular object). Yoga and meditation as adjunctive therapies for promoting and maintaining wellness offer an excellent example of the mind-body connection at work. Yoga creates balance, physically and emotionally, by using postures, or asanas, combined with breathing techniques, or pranayama. Meditation supports the physical and emotional work being done by the postures and breathing, they open the door to self-actualization to create the perfect union of the mind, body, and spirit [2]. In addition to low barriers to access, the scientific rationale for yoga effects on the mind is quite strong. The holistic goal of yoga to promote physical and mental health, and also be spiritually and socially conscious, may appeal both to consumers and providers who are concerned about the symptom reduction based focus of psychopharmacology and finding inner peace [1-2].

Practicing yoga, with yogic attitude causes several changes in body physiology. Regular practice of yoga enhances fitness and co-ordination to the brain and muscular activities [3-4]. It helps to maintain a normal healthy lifestyle and physical fitness which is indicated by decreasing body fat, blood pressure, heart rate and maintaining lipid profile [3-4]. The pulmonary functions have been identified as a predictor for overall survival rates as well as a tool in general health assessment [5]. Many studies are available showing the favorable effect of yoga on pulmonary function tests [5]. Stressful working conditions and physical inactivity may lead to various diseases. Thus reducing the number of working days, productivity and enhance the expenditure towards medication. These impose a huge burden on the employers and the country at large. Based on the above, the present study was designed to find out the effects of short term yoga practice on cardio-pulmonary variables of young male volunteers who are the working force of our country.

Material and Methods

Subjects and group: For the present study, eighty-five (n = 85) healthy male volunteers within the age group of 18–20 years were screened randomly from the Midnapore District, West Bengal, India. Subjects had not been engaged in yoga practice or any physical exercise at least two years preceding the study were considered eligible for this study. Subjects without a history of disease and illness were included. This decision was based on the medical examination performed by Physicians.

Participants were excluded from the study if they had a history of disease and illness for at least 03 months before the commencement of the study. All the volunteers went through a medical examination performed by Physicians. Twenty five [n = 25 (Not meeting the inclusion criteria, n = 05; decline to participate, n = 08; inability to perform yoga, n = 5; and unable to follow the schedule, n = 07)] volunteers were excluded from the study. The remaining sixty (n = 60) volunteers were randomly divided into two groups: (a) Yoga Group (n = 30) and (b) Control Group (n = 30).

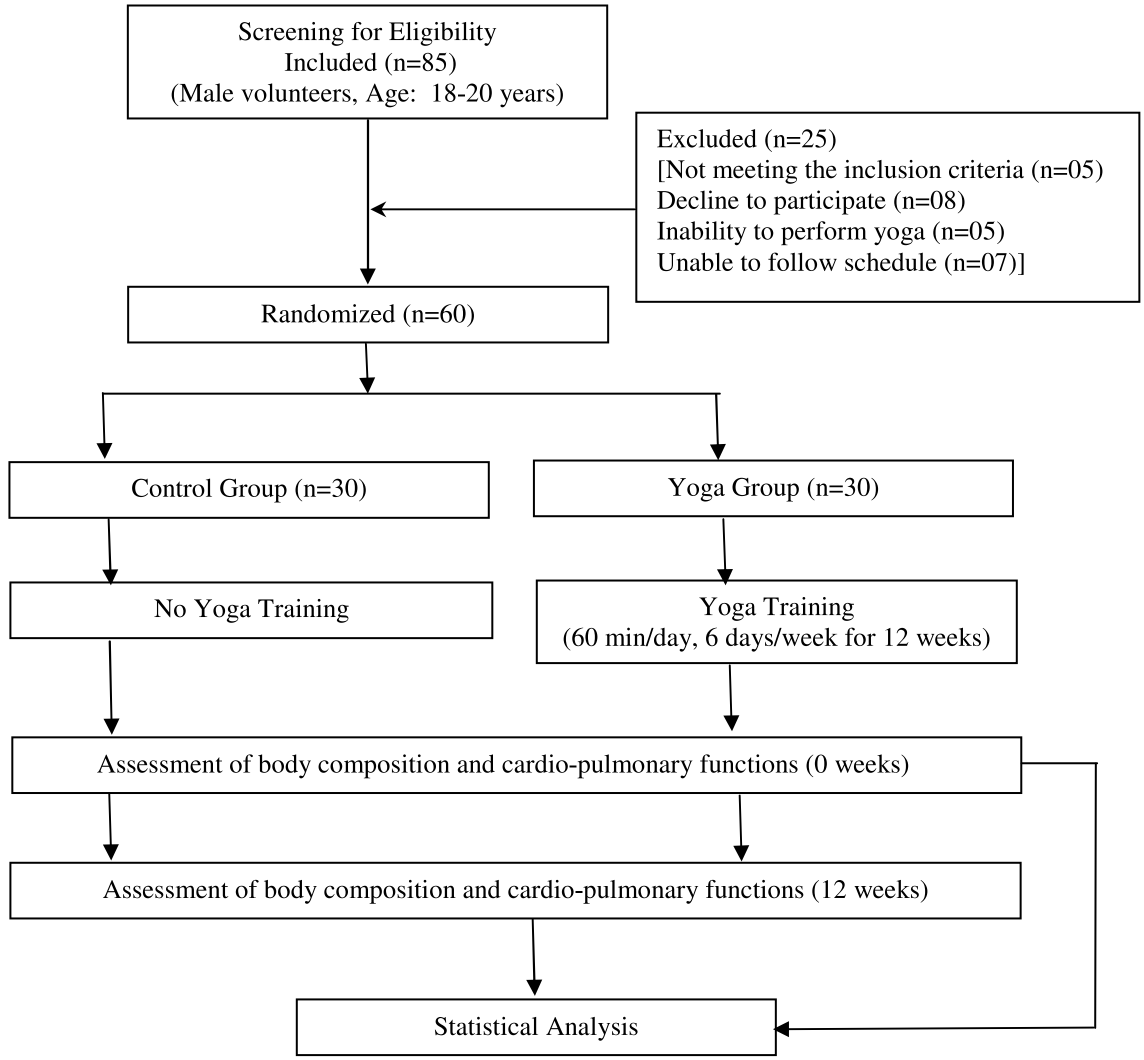
Experimental Design: Yoga training was provided in the yoga group, whereas no yoga training was given to the control group. Yoga training was given by a qualified yoga instructor for 60 min/day, 06 days/week for 12weeks duration following a standard protocol. The detail of the yoga protocol is presented in Table 1. Assessment of body composition and cardio-pulmonary functions were performed in both the groups at 0 weeks and after 12 weeks. The participant flow during the study is shown in Figure 1.

Ethics: The volunteers were informed about the purpose and the possible complications of the study, and written consents were taken volunteers were informed about the purpose and the possible complications of the study, and written consents were taken from them. The volunteers were asked to refrain from smoking and alcohol throughout the experiment. The yoga group participants were informed not to involve in any other physical activity during the entire period of the study. The participants were asked to maintain their normal diet. The experimental protocol was approved by the Institutional Ethical Committee (Human Studies) (Ref No.MC/IEC (HS)/PHY/FP02/2016; date: 07.06.2016).

Table-1: Contents of yogic package practiced by the volunteers during the training schedule

Yogic Training Schedule	Duration of each session (min)
Prayer	02
Om chanting	02
Gayatri Mantra	02
Yogic SukshmVyayam	10
Surya Namaskar	12
Yogasana (i) Shavasana (ii) Supt Pawan Muktasana (iii) Kandrasana (iv) Makarasana (v) Shalabhasana (vi) Bhujangasana (vii) Mandukasana (viii) Usharasana (ix) Gomukhasana	10
Pranayama (i) Kapal Bhati (ii) Mahabandh (iii) Laybadh Shvas Prashwas (iv) Nadi Shodhan (v) Ujjayi & Bhramari Pranaya	15
Meditation (i) Ajpa Jap (ii) Shanti Mantra	 05 02
Total	60

Fig-1: Consort flow chart



Measurements:

Measurement of height (stature) and body mass: The height was measured by the stadiometer (Seca 220, UK) with an accuracy recorded to the nearest 0.5 cm. The subject stood barefoot, and erect with heels along and arms hanging naturally by the perimeters. The heels, buttocks, the upper part of the back and usually but not necessarily, the back of the head were in contact with the vertical wall. The subject looked straight ahead and took a deep breath throughout measure.

The distance from the standing platform, to the highest position of the head (vertex), was measured with the help of a stadiometer, which indicates the subjects' height [6]. The stature was recorded in centimeters.

The body mass was taken on a standard electronic weighing machine (Seca Alpha 770, UK), having an accuracy recorded to the nearest 50 gm. The subject was examined in the clothing of known weight to record nude weight 12 hours after the last meal. The subject stood at the center of the weighing machine looking straight. The body mass was recorded in kilograms [6].

Determination of body mass index and body surface area: Body mass index (BMI) and body surface area (BSA) were derived from the standard equation [6].

$$BMI = Weight\ (kg) / Height\ (m^2)$$

$$BSA\ (sq\ m) = Weight\ (kg)^{0.425} \times Height\ (cm)^{0.725} \times 71.84 / 10000$$

Assessment of percent body fat and lean body mass: A skin fold caliper (Holtain Limited, UK) was used to assess the body fat percentage following standard methodology [7]. The instrument consists of an accurately calibrated dial which indicates the thickness of the skin fold in millimeter (mm) when the skin fold is held by the open jaws. The skin fold was taken from four different sites of the body (biceps, triceps, subscapular and suprailiac) using the skin fold caliper on the right side of the body. The thickness of the skin and subcutaneous fat was grasped between the thumb and index finger. To estimate the errors, reading was made between three and four seconds when essentially all compressions have taken place and the measurements were established.

Computation of Body density (BD): Body density was calculated by the standard formulae [8]. The skin fold thickness at the site of biceps, triceps, subscapular and suprailiac was used to calculate the body density.

BD = 1.1620-0.0630 log (Biceps + Triceps + Sub scapular + Suprailliac) (for 14-19 yrs)

BD = 1.1631-0.0630 log (Biceps + Triceps + Sub scapular + Suprailliac) (for 20-29 yrs)

Computation of Percent Body fat was derived using the standard equation [7].

Body fat (%) = (495 / Body density) – 450

Computation of Lean body mass (LBM) was derived by subtracting fat mass (FM) from total body mass [7] using the following equation.

LBM (kg) = Body mass – Fat mass

FM (kg) = [Body mass (kg) Body fat (%)] / 100

Assessment of cardiovascular functions: The subject was asked to take rest for 15 minutes resting heart rate (RHR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded using the standard procedure [9].

Assessment of Pulmonary Functions: The forced expiratory volume in 1st second (FEV1); forced vital capacity (FVC); peak expiratory flow rate (PEFR); maximum ventilatory volume (MVV) was measured using an electronic spirometer (Spirobank II, MIR, USA) following a standard procedure [10]. Respiratory rate (RR) was recorded by observing abdominal wall movement in the sitting position after sufficient rest. Breath-holding time (BHT) was measured in seconds from the time of holding breath after quit expiration till the breaking point of the held breath by using a stopwatch in comfortable sitting position in which subjects were asked to hold breath by closing both nostrils voluntarily by pinching nose between his/her thumb and index finger and closed mouth.

Statistical Analysis: To find out whether data were normally distributed, the Shapiro–Wilk normality test was performed. All the data were expressed as mean and standard deviation (SD). Analysis of variance with repeated measures followed by multiple comparison (post hoc) tests was performed to find out the significant difference in intra group and intergroup variables. In every case, the levels were chosen at 0.05. All the statistical analysis was performed using SSPSS 20 software for Windows (IBM, USA).

Results

Effect of short term yoga training on body composition: The body composition variables showed that there was a significant reduction ($P<0.05$) in the percentage of body fat, total fat mass as well as body mass in the yoga group after 12 weeks of yoga training when compared to baseline data (0 weeks).

However, there was no significant difference in height, BMI, BSA, and LBM in the yoga group after 12 weeks of training when compared to baseline data. In the control group, no such changes were noticed after 12 weeks of study. Further, the control group had significantly ($P<0.05$) higher body fat, total fat mass, and body mass when compared to the yoga group after 12 weeks of study (Table 2).

Table-2: Body composition variables of yoga and control group subjects				
Groups	**Yoga Group**		**Control Group**	
Parameters	0 Week	12 Weeks	0 Week	12 Weeks
Height (cm)	168.1 ± 5.1	168.1^{NS} ± 5.1	167.2 ± 3.9	167.2^{NS} ± 3.9
Body mass (kg)	61.1 ± 3.4	$58.2^{*\#}$ ± 3.2	61.2^{NS} ± 3.5	62.9^{NS} ± 3.7
BMI (kg m^{-2})	21.27 ± 1.63	20.7^{NS} ± 1.58	21.89^{NS} ± 1.52	22.5^{NS} ± 1.61
BSA (m^2)	1.68 ± 0.15	1.66^{NS} ± 0.14	1.69 ± 0.13	1.71^{NS} ± 0.14
Body Fat (%)	$16.4^{\#}$ ± 2.5	$12.7^{*\#}$ ± 2.4	17.8 ± 2.3	18.6^{NS} ± 2.7
Fat mass (kg)	$9.9^{\#}$ ± 1.7	$7.4^{*\#}$ ± 1.6	10.9 ± 1.6	11.7^{NS} ± 1.5
LBM (kg)	50.2^{NS} ± 4.5	51.1^{NS} ± 4.1	50.3 ± 4.3	51.2^{NS} ± 4.2

[All the data were expressed as mean ± SD; ANOVA with repeated measured followed by multiple comparison (*post hoc*) tests were performed; n= 30. When compared to baseline data (0 weeks) *P<0.05; when compared to control group # P<0.05; NS= not significant, BMI= body mass index, BSA= body surface area, LBM= lean body mass, ANOVA= analysis of variance, SD= standard deviation.]

Effect of short term yoga training on cardiovascular functions: A significant reduction (P<0.05) in systolic blood pressure (SBP) and resting heart rate (RHR) were noted in the yoga group after 12 weeks of yoga training when compared to baseline data (0 weeks). However, there was no significant change in diastolic blood pressure (DBP) in the yoga group after 12 weeks of training when compared to baseline data. In the control group, no such changes were noticed after 12 weeks of study. Further, the control group had significantly (P<0.05) higher SBP and RHR when compared to the yoga group after 12 weeks of study (Table 3).

Table-3: Blood pressure and heart rate response of yoga and control group subjects				
Groups	**Yoga Group**		**Control Group**	
Parameters	**0 Week**	**12 Weeks**	**0 Week**	**12 Weeks**
SBP (mmHg)	121.6^{NS} ± 5.2	$118.4^{*\#}$ ± 5.3	122.3 ± 5.1	122.1^{NS} ± 5.2
DBP (mmHg)	79.5^{NS} ± 4.1	78.3^{NS} ± 4.2	79.7 ± 4.7	80.1^{NS} ± 4.4
Resting HR (beats/min)	79.6^{NS} ± 4.3	$75.7^{*\#}$ ± 4.4	80.9 ± 4.7	80.2^{NS} ± 4.5

[All the data were expressed as mean ± SD; ANOVA with repeated measured followed by multiple comparison (*post hoc*) tests were performed; n= 30. When compared to baseline data (0 weeks) *P<0.05; when compared to control group # P<0.05; NS= not significant, SBP= systolic blood pressure, DBP= diastolic blood pressure, HR= heart rate, ANOVA= analysis of variance, SD= standard deviation.]

Effect of short term yoga training on pulmonary functions: It was noted that there was a significant increase (P<0.05) in FVC, FEV1, PEFR, MVV and BHT among the yoga group subjects after 12 weeks of yoga training when compared to baseline data (0 weeks). However, there was a significant reduction (P<0.05) in RR among the yoga group subjects after 12 weeks of yoga training when compared to baseline data. In the control group, no such changes were noticed after 12 weeks of study. Further, the control group had significantly (P<0.05) lower FVC, FEV1, PEFR, MVV and BHT; and higher (P<0.05) RR when compared to yoga group subjects after 12 weeks of study (Table 4).

Table-4: Pulmonary functions of yoga and control group subjects

Groups	Yoga Group		Control Group	
Parameters	0 Week	12 Weeks	0 Week	12 Weeks
FVC (L)	$3.14^{NS} \pm 0.86$	$3.86^{*\#} \pm 0.81$	3.04 ± 0.67	$3.09^{NS} \pm 0.74$
FEV1 %	$82.56^{NS} \pm 4.56$	$93.54^{*\#} \pm 4.41$	81.32 ± 4.64	$81.71^{NS} \pm 4.47$
PEFR (L/Sec.)	$4.33^{NS} \pm 1.14$	$5.61^{*\#} \pm 1.16$	4.19 ± 1.17	$4.24^{NS} \pm 1.15$
MVV (L/min)	$100.18^{NS} \pm 8.41$	$112.14^{*\#} \pm 9.72$	100.24 ± 8.97	$102.64^{NS} \pm 7.94$
BHT (sec.)	$26.12^{NS} \pm 4.32$	$32.64^{*\#} \pm 4.42$	25.47 ± 4.37	$26.84^{NS} \pm 4.48$
RR (breath/min)	$18.4^{NS} \pm 2.1$	$14.8^{*\#} \pm 2.2$	18.6 ± 2.4	$18.1^{NS} \pm 2.1$

[All the data were expressed as mean ± SD; ANOVA with repeated measured followed by multiple comparison (*post hoc*) tests were performed; n= 30. When compared to baseline data (0 weeks) *P<0.05; when compared to control group # P<0.05; NS= not significant, FVC= Forced vital capacity, FEV1 = Forced expiratory volume during the 1st second, PEFR= Peak expiratory flow rate. MVV= Maximum Ventilatory Volume, BHT= Breath Holding Time, RR= Respiratory rate, ANOVA= analysis of variance, SD= standard deviation.]

Discussion

Yoga has a role in maintaining good health and physical fitness. In the present study, a significant reduction in body fat was noted after 12 weeks of yoga exercise. The reduction in body fat might be because the volunteers underwent a high level of yogic exercise over a period, which resulted in the lowering of body fat percentage. Yoga involves deep nostril breathing, the flexibility of limbs and stretching of different body parts, which might be the cause of reduction of body fat of the volunteers practicing yoga. The reduction of body fat might influence the body mass and hence in the present study significant reduction of body mass was noted among the volunteers practicing yoga. Similar observations were noted by many authors where a reduction in body fat was noted after yoga training [11].

On the other hand, no significant difference was observed in LBM among the subjects after 12 weeks of the yoga training program. This might be due to improper optimization of the training load and/or short duration of the yoga training. An increase in body fat can elevate the risk factors for obesity, cardiovascular disease, diabetes and many other complications [11]. Regular yoga practice may reduce body fat, which is essential for a disease-free life.

Heart rate and blood pressure are essential for assessing cardiovascular fitness. The cardiovascular response in yoga was studied in the present experiment and it has been seen that there was a significant reduction in systolic blood pressure and resting heart rate among the yoga group after 12 weeks of yoga training when compared to baseline data. However, there was no significant change in diastolic blood pressure among the experimental group after yoga training. Similar observations were noted by many researchers where the reduction in blood pressure and heart rate was noted after yoga training [1, 3].

It can be stated that yoga involves deep nostril breathing, the flexibility of limbs and stretching of different body parts which might be the cause of reduction of systolic blood pressure and heart rate of the subjects. Reduction in heart rate and blood pressure indicate a shift in the balancing components of the autonomic nervous system towards the parasympathetic activity [3]. This modulation of autonomic nervous system activity might have been brought about through the conditioning effect of yoga on autonomic functions and mediated through the limbic system and higher areas of the central nervous system [4].

Regular follow of yoga will increase the baroreflex sensitivity and reduces the sympathetic tone; thereby restoring pressure level to traditional levels in patients of hypertension [4]. Meditation by modifying the state of tension reduces stress-induced sympathetic activity thereby decreasing blood vessel tone and peripheral resistance, and leading to remittent pulse pressure level and pulse, this ensures better peripheral circulation [3] and blood flow to the tissues [3]. Elevation in heart rate and blood pressure variables indicate the risk factors for cardiovascular disease. Regular yoga practice may restore normal heart rate and blood pressure which are essential to maintain disease-free life.

Pulmonary functions are essential for assessing the respiratory status of the subject. The pulmonary functions in response to yoga were studied in the present experiment and it has been seen that there was a significant increase in FVC, FEV1, PEFR, MVV, and BHT and a significant reduction in RR among the yoga group subjects after 12 weeks of yoga training when compared to baseline data.

It can be stated that yoga involves Asana (posture- physical exercise), Pranayama (breathing exercise) and meditation (an approach to training the mind or focusing mind on a particular object) which might be the cause of increase in FVC, FEV1, PEFR, MVV and BHT and reduction in RR after yoga training. Yoga exercise and postures involve isometric contraction which might increase the strength of respiratory muscles including the diaphragm, intercostals muscles, and abdominal muscles and hence the increase in FVC, FEV1, PEFR, MVV and BHT and reduction in RR was observed after yoga training. Similar observations have been reported by many researchers [5].

An earlier study reported that regular Yoga practice resulted in a decrease in resting respiratory rate [12], improvement in BHT and MVV [13]. Kapalbhati in which forceful exhalation was performed by contracting the abdominal muscles, without any undue movements in the chest and shoulder region and the inhalation is passive. This produces short powerful strokes of exhalation in quick succession with contraction of abdominal and diaphragm muscles which trains the subject to make full use of the diaphragm and abdominal muscles in breathing [5].

Thus yoga training might improve the strength of respiratory muscles performance which may, in turn, increased FEV1 in yoga group subjects. Anulom-vilom (Nadi Shodhan) alternate nostril breathing technique a part of pranayama increases the resistance of respiratory muscles which may increase peak expiratory flow rates and FEV1 due to the strengthening of resistance of respiratory muscles which may increase peak expiratory flow rates and FEV1 due to the strengthening of respiratory muscles in yoga group subjects. During yoga practice, different breathing techniques may cause the respiratory apparatus to empty and fill quickly, completely and efficiently which may intern increased forced vital capacity (FVC) [14].

During pranayama, all the maneuvers i.e. deep inspiration up to TLC and prolonged expiration up to residual volume, are done through nostrils which offer resistance through decreased cross-sectional area and turbulence. Yoga with its calming effect on the mind can reduce and release emotional stresses, as a result of this withdrawing the broncho-constrictor effect [13].

By practicing pranayama, the various reflex mechanisms that control respiratory center in bulbopontine areas may be altered or modified by producing a strong cortical force thereby increasing the breath-holding time or decreasing the resting respiratory rate [13-14]. Thus regular yoga practice may improve the pulmonary functions which are essential to maintain a disease-free lifestyle.

Conclusions

Regular practice of yoga helps to maintain a normal healthy lifestyle and physical fitness which is indicated by improving body composition, cardiovascular and pulmonary functions. The findings of the study demonstrate the efficacy of yoga exercise on body composition, cardiovascular and pulmonary functions in healthy subjects.

The findings of the present study suggest that yoga can be used as an effective lifestyle modality to reduce the chance of CVD and pulmonary diseases. Thus the regular practice of yoga may be helpful to reduce stress and maintain a disease-free lifestyle. As young people are the working force of the country, thus the regular practice of yoga may increase the number of working days, productivity and reduce the expenditure towards medication by maintaining the disease-free lifestyle.

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