RESEARCH ARTICLE

Study on the effects of short-term yoga practice on body composition, physical fitness, physiological variables, nutritional and mental health status of school children

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ABSTRACT

Background: Physical inactivity may cause poor physical fitness, obesity, cardio-respiratory and mental illness. Yoga may be adopted as a method for maintaining physical fitness. The present study has been designed to investigate the effects of short-term yoga practice on body composition, physical, and physiological parameters, and nutritional and mental health status of children of 10 to 12 years. *Materials and Methods*: For the present study 120 volunteers (60 healthy female and 60 healthy male) within the age group of 10–12 years were screened randomly and were divided into: (a) Yoga Group (n = 60) and (b) Control Group (n = 60). Both these groups were sub-divided into (i) Male (n = 30) and (ii) Female (n = 30) volunteers. The volunteers of yoga group followed a yoga practice schedule of 1hr/day, 6 days/week for 6 weeks, with no yoga practice in the control group. Body composition, physical fitness, physiological variables, nutrition and mental status were measured before (0 week) and after (6 weeks) training. *Results*: A significant increase ($p \leq 0.05$) in strength, flexibility, anaerobic power, VO_{2max}, FVC, FEV1, PEFR; and a decrease ($p \leq 0.05$) in resting heart rate, blood pressure, depression, anxiety and stress scores were observed in both male and female volunteers after six weeks of yoga practice. *Conclusion*: Regular practice of yogic asana, pranayama, and meditation improves body composition, cardiovascular, respiratory, and physical fitness, and reduces stress level.

Keywords: Yoga, Body fat, Flexibility, VO_{2max}, Lung function, Mental health.

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Introduction

Regular physical activity has many health benefits. Being physically fit and active helps in strengthen bones and muscles, and improves the ability to perform everyday activities.[1] Physically fit individuals can able to manage weight and have reduce risk of cardiovascular disease, type 2 diabetes, metabolic syndrome, infectious diseases and some cancers in later life.[1] In the childhood and adolescent stage of life physical activities is very important, as it helps in improving academic performance by improving attention and memory, reducing risk of depression, causing stronger bones, improve muscle endurance, improving cardiovascular and respiratory functions, managing body weight and reduce body fat, keep blood sugar at normal levels, reduces risk of including type 2 diabetes and obesity etc.[2,3] Physical fitness can also be improved by various methods such as yoga. Yoga originated in India as a way of life. Yoga is a holistic practice of controlling body and mind by practicing physical postures (asanas), rhythmic breathing (pranayama) and meditation. Yoga helps in gaining a strong and flexible body, optimal physiological function, and acceleration of growth, balanced autonomic nervous system and calm mind.[4] Asanas comprises of several postures involving muscle contraction and stretching in standing, sitting, supine and prone positions, which helps in increased blood circulation, muscle strength and flexibility.[5] Pranayama is controlling breathing to control physiological processes such as blood pressure, and heart rate.[6] Pranayama has shown benefits in treating asthma.[7] Dhyana or meditation is the practice of deep relaxation of mind and spirit which helps to attain calm and stress-free mind.[8] Yoga improves on physical fitness, cognitive performance, and self-esteem.[9-11] Practicing yoga from early stages of life may result in overall physical and mental development.

In the present time children and adolescents spent more time on academic activities, computers, watching TV, cell phones which reduces time for physical activities and thus lowers physical fitness. Physical activities may cause obesity, asthma, and hypertension, mental illness among children and adolescent.[12,13] It has been observed that school students

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suffer from pre-hypertension and bronchial asthma which may cause major health issues later in life.[14] There is a need to improve the physical fitness of children and adolescents. Yoga has a holistic approach which may improve physical fitness and mental status. The present study has been designed to investigate the effects of shortterm of yoga practice on body composition, physical, and physiological parameters, and nutritional and mental health status of school children of 10 to 12 years.

Material And Methods

Subjects: For the present study 120 volunteers (60 healthy female and 60 healthy male) within the age group of 10–12 years were screened randomly from the Midnapore District, West Bengal, India. All the volunteers were included in this study following medical examinations by the physicians. Based on their decision subjects without any history of illness, and not involved in any type of strenuous physical exercise for last 2 years were considered eligible for this study. The volunteers with history of chronic illness, fracture, or surgery for at least 03 months prior to the commencement of the study were excluded. The volunteers were grouped as: (a) Control Group (n = 60) and (b) Yoga Group (n = 60), both the groups comprised of (i) male (n = 30) and (ii) female (n = 30) volunteers.

Ethical considerations: The purpose and possible complications of the investigation were explained to all participants, parents, legal guardians and school authorities; and written consent was obtained. Yoga group participants were forbidden to perform any form of strenuous physical activity other than the prescribed yoga routine. The volunteers of the control group were engaged in recreational activities. All volunteers were asked to maintain their traditional diet and stay away from fast food, and carbonated cold drinks. Approval was taken from the Institutional Ethical Committee (Human Studies) for this study.

Experimental Design: The yoga group volunteers were acclimatized 15 days prior to the yoga practice. Only yoga group volunteers practiced yoga 1-hour/day, 6 days/week for 6 weeks under the guidance of a well-trained yoga instructor. The study of socio-economic, nutritional, mental health status, body composition, physical fitness and physiological variables were evaluated at the beginning (0 week) and after 6 weeks of yoga training (Figure 1).

Yoga Practice Schedule: The yoga training was followed including the three basic elements of yoga: (a) physical postures (asana), (b) breathing exercises (pranayama), and (c) meditation. The participants were advised to perform prayer followed by Om chanting and reciting Gaytri mantra to concentrate their mind. Then the participants performed free hand warm-up exercises (Yogic Sukshm Vyayam) for 10 min to prepare the body for the yogic asanas and pranayama. The volunteers then performed Surya Namaskar, other asanas, pranayama and meditation. At the end of the yoga schedule, the participants performed Ajapa Jap and Shanti Mantra. The volunteers performed yoga in yoga training centre under the guidance of qualified yoga instructors. The yoga practice schedule was followed for 1hr/day, 6 days/week for 6 weeks (Table 1 and Figure 2).[11]

Assessment of Socio-Economy Status: The socio-economic status of the participants was evaluated by questionnaire method using the Modified Kuppuswamy socioeconomic scale updated for the year 2021.[15]

Assessment of Mental Health Status: The mental health status of the subjects was evaluated by questionnaire method using Depression Anxiety Stress Scale-21 (DASS21).[16]

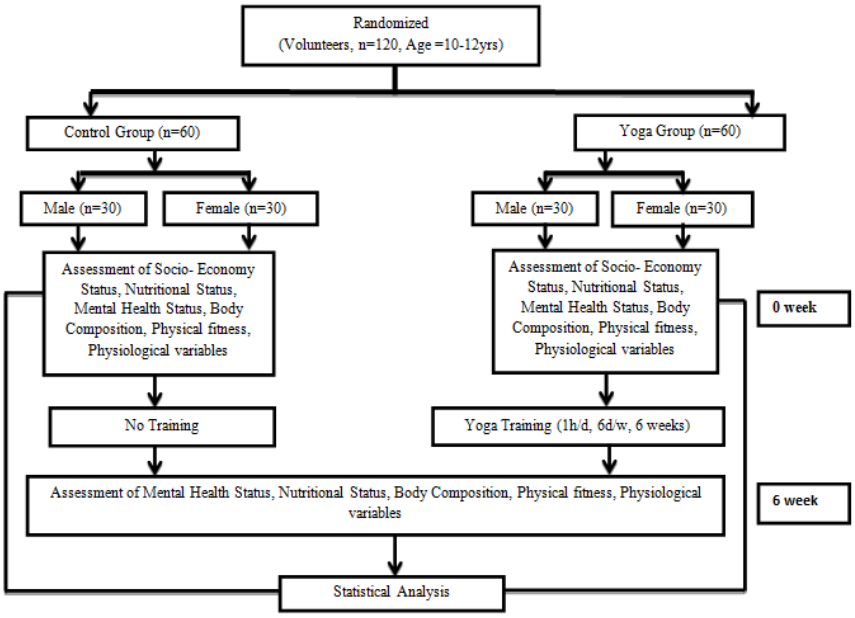

Figure 1: Experimental design

Table 1: Yoga training schedule

Yogic training schedule	*Duration of each session (min)*
Prayer	2
Om chanting	2
Gayatri Mantra	2
Yogic SukshmVyayam	10
Surya Namaskar	12
Yogasana	
Trikonasan (triangle pose)	10
Tadasan (palm tree pose)	
Paschimottanasan (seated forward bend)	
Vakrasan (Half spinal twist)	
Bhujangasan (cobra pose)	
Dhanurasan (bow pose)	
Pavanmuktasan (wind releasing pose)	
Setubandhasan (bridge pose)	
Shavasan (corpse pose)	
Pranayama	
Kapal bhati	15
Mahabandh	
Laybadh Shvas Prashwas	
Nadi Shodhan Pranayama	
Ujjayi and Bhramari Pranayama	
Meditation	
Ajapa Jap	5
Shanti Mantra	2
Total	60

Assessment of Nutritional Status: The nutritional status of the participants was assessed indirectly by 24-hour recall method.[17]

Determination of Body Composition variables

Measurement of height and weight

The height (stature) was measured in centimeters by the stadiometer (Seca220, UK), having accuracy recorded to the nearest 0.5 cm.[18] The body mass was measured using standard electronic weighing machine (Seca Alpha 770, UK), having accuracy recorded to the nearest 50 g (gm).[18]

Determination of BMI and BSA

Body mass index (BMI) and body surface area (BSA) were derived from the following equation using body mass and stature.[18]

$BMI = \text{weight (kg)}/\text{height (m}^2\text{)}$

$BSA\ (m^2) = \text{body mass (kg)}^{0.425} \times \text{height (cm)}^{0.725} \times 71.84/10{,}000$

Determination of body fat

A skin fold calliper (Cescorf, USA) was used to assess the body fat percentage following standard methodology.[19] The skin fold thickness at the site of biceps, triceps, subscapular, and suprailiac was used to calculate the body density. Computation of body density and percent body fat, fat mass and lean body mass was derived using the standard equations.

$BD = 1.1369 - 0.0598 \times \log (\text{Biceps} + \text{Triceps} + \text{Subscapular} + \text{Suprailliac})$ for females.

$BD = 1.1533 - 0.0643 \times \log (\text{Biceps} + \text{Triceps} + \text{Subscapular} + \text{Suprailliac})$ for males.

Body fat (%) = (495/BD) −450

Fat mass (FM) (Kg) = Body Mass x (% Body Fat/100)

Lean Body Mass (LBM) (kg) = body mass (kg) − FM (kg)

Determination of Waist hip ratio

The waist and hip circumference of the subject was measured using a non-stretchable steel tape having an accuracy of 0.5 cm following standard procedure.[18] The waist-hip ratio was derived by the following formula:

Waist hip ratio = Waist Circumference (cm)/ Hip Circumference (cm)

Measurement of Mid-upper arm circumference

Mid-upper arm circumference was measured by a non-stretchable still tape placed at the maximum extension of the subject's upper arm while the subject's arm hangs loosely by the side.[18]

Assessment of Physical Fitness Variables

Handgrip and Back Strength

Hand grip strength was measured by hand dynamometer (Baseline, USA), recorded in kg with accuracy up to 0.01 kg following standard protocol.[20] The back muscle strength was measure by back dynamometer (Baseline, USA), recorded in kg with accuracy nearest to the 500 gm.[21]

Assessment of Flexibility

Flexibility of the participants was measured by modified sit and reach test using sit and reach box (Baseline, USA). Flexibility was recorded in cm with accuracy up to 0.5 cm.[22]

Measurement of Anaerobic Power

Running-based Anaerobic Sprint Test (RAST) was used to assess the anaerobic power of the participants.[23] A 35 meter of running surface was marked by the cones at two ends. Two testers were involved in performing the test, one person was involved in taking time for each 35-meter run, the other person was involved in taking 10 seconds recovery time. Following the warm-up for 15 minutes, the subject was asked to stands at one end of the 35-meter track, and start sprinting as fast as possible on the command 'go'. After 10 seconds, the next sprint was started from the other end of the 35 m track. The test was repeated for six times. The anaerobic power was determined by the following equation.

Figure 2: Different postures for the yoga and meditation

Peak Power Output (PPO) (watt) = Body mass × Distance ^{2} ÷ Time ^{3}
Maximum power ($Power_{min}$) (watt) = the highest value
Minimum power ($Power_{max}$) (watt) = the lowest value
Average power (watt) = sum 6 Power Output ÷ 6
Fatigue Index (FI) = ($Power_{max}$ – $Power_{min}$) ÷ Time taken for six 35 meters run
Anaerobic Capacity (Watt) = Sum of all six sprint PPOs.

Assessment of Physical Fitness Index (PFI)

The physical fitness of both male and female participants will be assayed by a modified Harvard step test following standard protocol. The fitness index will be measured by the standard formula:
Fitness index = [Duration of exercise (sec) × 100] / 2 × [sum of 3 recovery heart rates].[24]

Assessment of Physiological Variables

Assessment of cardiovascular functions

The heart rate and the blood pressure of the participants were measured by digital b*lood Pressure* Monitor (*Omron, Japan*) in seating position after taking 15 minutes rest.[25]

Assessment of maximum aerobic capacity

The maximum aerobic capacity (VO_{2max}) of the participants was measured by Queen's College Step Test on a 41.3 cm stool. The participant performed the step test for a duration of 3 minutes and the rate of up-down was set at 22 cycles/min. The recovery heart rate was taken in between 5 sec to 20 sec for 15 sec duration. The VO_{2max} was determined by using standard formula.[26]

For male: VO_{2max} (ml/kg/min) = 111.33 - (0.42 x heart rate (bpm))
For female: VO_{2max} (ml/kg/min) =65.81-(0.185 x heart rate (bpm))

Assessment of pulmonary functions

Participants' lung function test was performed by portable digital spirometer (Care Fusion, Japan). Force vital capacity (FVC), forced expiratory volume in 1st second (FEV_1) and peak expiratory flow rate (PEFR) was recorded following standard protocol.[27]

Statistical Analysis

All the data collected were analysed by a standard statistical software package IBM SSPSS Statistics for Windows, Version 28.0.1 (IBM Corp., Armonk, NY: USA). The mean and standard deviation were computed; paired sample t-test was used to find out the differences among the within-group and between-group variables. The correlation coefficient was performed to find the relationship among the variables.[28] The alpha was considered at $p \leq 0.05$.

Results

Assessment of Socio-Economic, Nutritional and Mental Health Status

Distribution of Socio-Economic Score of male and female praticipants: Upper- 7% and 3%, Upper Middle- 56% and 70%, Lower Middle- 37% and 27% respectively. In the present study, no difference was observed in socio-economic status, macronutrient and micronutrient intake of yoga group and control group participants. It was noted that male participants had significantly higher (p <0.05) protein and fat intake than

Table 2: Nutritional status of control group and yoga group

Parameters	*Control Male*		*Yoga Male*		*Control Female*		*Yoga Female*	
	0 week	*6 week*	*0 week*	*6 week*	*0 week*	*6 week*	*0 week*	*6 week*
Carbohydrate (gm)	292.8 ± 26.2	296.3 ± 24.3	298.2 ± 23.4	305.2 ± 25.8	296.4 ± 22.2	297.3 ± 26.5	289.9 ± 25.4	290.6 ± 22.2
Protein (gm)	64.8 ± 8.8	62.4 ± 9.1	62.2 ± 8.9	65.3 ± 8.5	55.7$^{\$}$ ± 7.8	54.7$^{\$}$ ± 7.5	62.5 ± 9.4	65.3 ± 9.7
Fat (gm)	37.5 ± 6.9	35.2 ± 6.7	39.2 ± 6.7	40.2 ± 7.2	28.5$^{\$}$ ± 6.6	30.1$^{\$}$ ± 6.3	26.7$^{\$}$ ± 7.2	26.9$^{\$}$ ± 7.1
Energy (kcal)	1767.8 ± 57.5	1751.9 ± 53.2	1794.3 ± 55.4	1843.5 ± 58.2	1665.3 ± 48.7	1679.3 ± 53.3	1650.1 ± 54.8	1665.7 ± 51.2
Calcium (mg)	687.6 ± 55.4	685.3 ± 55.0	690.9 ± 57.0	694.3 ± 54.3	682.5 ± 46.4	687.1 ± 41.4	685.7 ± 38.2	690.2 ± 42.2
Phosphorus (mg)	1227.6 ± 96.3	1234.2 ± 92.2	1231.2 ± 94.3	1247.3 ± 90.2	1189.7 ± 78.5	1201.3 ± 81.5	1200.1 ± 79.7	1196.2 ± 81.3
Iron (mg)	16.3 ± 4.3	14.3 ± 4.1	17.6 ± 4.6	18.3 ± 4.7	14.5 ± 4.1	15.2 ± 4.3	16.5 ± 4.6	16.5 ± 4.5
Sodium (mg)	254.2 ± 20.2	261.3 ± 21.4	257.9 ± 18.3	264.3 ± 19.6	248.5 ± 16.9	250.3 ± 16.5	250.9 ± 16.7	256.2 ± 16.3
Magnesium (mg)	314.8 ± 34.2	320.8 ± 33.6	310.2 ± 36.9	308.2 ± 34.3	304.2 ± 26.2	302.2 ± 28.3	304.3 ± 25.9	310.5 ± 24.2
Potassium (mg)	978.3 ± 86.3	984.3 ± 84.5	982.9 ± 84.2	992.1 ± 83.3	997.6 ± 85.3	1012.3 ± 83.5	985.9 ± 89.7	983.6 ± 90.2
Chlorine (mg)	40.2 ± 7.7	43.1 ± 8.7	43.8 ± 8.4	45.4 ± 8.2	36.2 ± 7.1	36.4 ± 7.3	39.1 ± 8.6	38.9 ± 7.3
Zinc (mg)	7.5 ± 2.2	7.3 ± 2.0	7.6 ± 2.4	7.7 ± 2.7	7.2 ± 2.0	7.3 ± 2.1	7.2 ± 2.6	7.3 ± 2.1
Carotene (µg)	526.3 ± 61.3	531.5 ± 60.9	532.5 ± 56.8	540.3 ± 59.1	534.1 ± 54.4	541.3 ± 51.4	530.2 ± 51.7	534.2 ± 54.2
Thiamin (mg)	1.5 ± 0.5	1.5 ± 0.4	1.6 ± 0.5	1.6 ± 0.6	1.4 ± 0.3	1.6 ± 0.4	1.5 ± 0.3	1.5 ± 0.4
Riboflavin (mg)	1.8 ± 0.4	1.8 ± 0.2	2.0 ± 0.5	2.1 ± 0.4	2.1 ± 0.6	2.2 ± 0.6	2.0 ± 0.7	2.3 ± 0.5
Niacin (mg)	15.6 ± 4.2	14.3 ± 4.1	16.5 ± 4.7	18.9 ± 5.1	15.9 ± 4.5	16.4 ± 4.6	16.0 ± 4.6	17.3 ± 4.9
Folic acid (µg)	130.3 ± 19.1	134.5 ± 18.2	126.0 ± 18.2	132.2 ± 17.6	127.5 ± 16.9	132.5 ± 15.5	123.6 ± 16.9	130.2 ± 17.3
Vitamin C (mg)	42.1 ± 7.3	46.3 ± 8.0	47.5 ± 9.2	52.4 ± 8.9	41.4 ± 7.1	41.5 ± 7.6.2	44.2 ± 7.4	42.1 ± 8.2
Retinol (µg)	112.3 ± 23.8	115.4 ± 23.9	110.5 ± 24.9	114.4 ± 22.2	106.3 ± 21.1	112.4 ± 23.5	108.8 ± 20.0	112.3 ± 26.9
Tochopherol (µg)	5.1 ± 0.8	5.2 ± 0.7	5.1 ± 0.7	5.8 ± 0.6	5.2 ± 0.5	5.2 ± 0.5	5.4 ± 0.6	5.5 ± 0.6
Vitamin K (µg)	56.2 ± 11.0	55.4 ± 10.9	51.4 ± 11.0	56.8 ± 10.6	48.1 ± 9.3	46.3 ± 10.3	49.2 ± 11.1	46.4 ± 10.2
Vitamin D (µg)	32.1 ± 8.6	31.3 ± 8.7	28.6 ± 7.6	32.1 ± 8.2	26.4 ± 7.5	31.5 ± 7.2	28.1 ± 7.9	30.3 ± 7.7

All the data were expressed as mean ± Standard Deviation; paired sample t-test was performed, n=30. When compared to 0 week and 6 week *P<0.05; when compared to control group and yoga group $^{\#}P$<0.05; when compared to male and female $^{\$}P$<0.05.

Table 3: Mental health status of control group and yoga group

Parameters	*Control male*		*Yoga male*		*Control female*		*Yoga female*	
	0 Week	*6 Week*	*0 Week*	*6 Week*	*0 Week*	*6 Week*	*0 Week*	*6 Week*
Depression Score	8.6 ± 1.2	8.4 ± 1.2	8.4 ± 1.4	$3.5^{*\#}$ ± 1.5	$6.4^{\$}$ ± 1.3	6.0 ± 1.4	$6.8^{\$}$ ± 1.4	$3.2^{*\#}$ ± 1.4
Anxiety Score	9.6 ± 1.4	9.2 ± 1.3	9.1 ± 1.6	$4.5^{*\#}$ ± 1.2	9.2 ± 1.2	9.6 ± 1.2	8.8 ± 1.1	$4.7^{*\#}$ ± 1.5
Stress Score	10.6 ± 1.5	10.6 ± 1.6	10.4 ± 1.5	$6.1^{*\#}$ ± 1.4	10.2 ± 1.3	11.2 ± 1.6	10.8 ± 1.5	$5.6^{*\#}$ ± 1.6

All the data were expressed as mean ± Standard Deviation; paired sample t-test was performed, *n*=30. When compared to 0 week and 6 week *P<0.05; when compared to control group and yoga group $^{\#}P$<0.05; when compared to male and female $^{\$}P$<0.05.

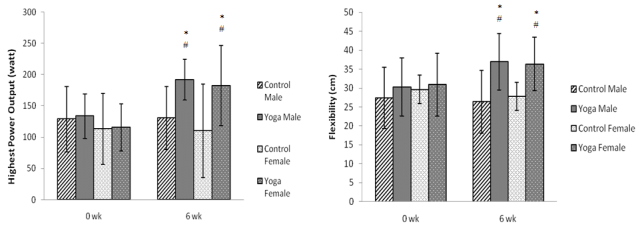

Figure: 3a Figure: 3b

All the data were expressed as mean ± SD; paired sample t-test was performed, n=30. When compared to 0 week and 6 week *P<0.05; when compared to control group and yoga group #P<0.05; when compared to male and female $P<0.05. NS= Not significant, SD= Standard deviation.

Figure 3: Assessment of flexibility and Highest Power Output of control and yoga group

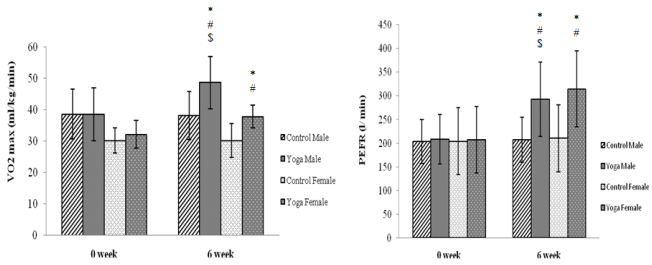

Figure 4a Figure 4b

All the data were expressed as mean ± SD; paired sample t-test was performed, n=30. When compared to 0 week and 6 week *P<0.05; when compared to control group and yoga group #P<0.05; when compared to male and female $P<0.05. NS= Not significant, SD= Standard deviation, VO_{2max} = maximum aerobic capacity, PEFR= Peak Expiratory Flow Rate.

Figure 4: Assessment of VO_{2max} and PEFR of control and yoga group.

female participants (Table 2). No difference was observed in the DASS scores of yoga and control group participants at the beginning of the study. However, a significant decrease (p <0.05) in depression, anxiety and stress scores was noted in both male and female participants after six weeks of yoga. The male had significantly (p<0.05) higher depression scores than female participants (Table 3).

Assessments of Body Composition Variables

There was no significant difference in baseline body composition variables of the yoga group and control group participants. No significant change in body composition variables was noted after six weeks of yoga practice on in both male and female participants. Females had significantly higher (p <0.05) body fat percentage and fat mass than males both in the control and yoga group (Table 4).

Assessment of Physical Fitness Variables

There was a significant increase (p <0.05) in highest power output, lowest power output, average power output, physical fitness index, flexibility, fatigue index and grip strength right in female participants due to six weeks of yoga training. However, no significant change was observed in back muscle strength and grip strength left in female participants due to six weeks of yoga training. On the other hand, a significant increase (p <0.05) in highest power output, lowest power output, average power output, physical fitness index, flexibility, fatigue index and grip and back strength was noted in male participants due to six weeks of yoga training. Further, the male participants had significantly higher (p <0.05) grip and back muscle strength, lowest power output than female participants after six weeks of study. The control male volunteers had significantly higher (p <0.05) grip strength and anaerobic power than the control female volunteers (Table 5 and Figure 3).

Assessment of Physiological Variables

A significant decrease (p <0.05) in systolic blood pressure, diastolic blood pressure, mean pressure, resting heart rate; and increase (p <0.05) in VO_{2max}, FEV1, FVC, PEFR was observed in both male and female participants after six weeks of yoga training. The male participants had significantly higher (p <0.05) systolic blood pressure, diastolic blood pressure, mean pressure resting heart rate and VO_{2max} than the female participants in both the yoga group and the control group (Table 6 and Figure 4). The present study showed a significant positive correlation between resting systolic blood pressure and body fat percentage (r = +0.45, p <0.05); lean body mass and right-hand grip strength (r = +0.65, p <0.05); lean body mass and anaerobic capacity (r = +0.72, p <0.05); a significant negative correlation between VO_{2max} and body fat percentage (r = -056, p <0.05) (Figure 5).

Discussion

Yoga originated in ancient India is a way of life that may improve life by a holistic approach. Yoga practice involves specific techniques such as asanas (postures), breathing

Table 4: Body composition variables of control group and yoga group.

Parameters	*Control Male*		*Yoga Male*		*Control Female*		*Yoga Female*	
	0 week	*6 week*	*0 week*	*6 week*	*0 week*	*6 week*	*0 week*	*6 week*
Height (cm)	138.5 ± 7.5	138.6 ± 7.4	137.4 ± 6.3	137.5 ± 6.1	138.3 ± 7.6	138.4 ± 7.5	141.4 ± 8.9	141.5 ± 8.0
Body mass (kg)	36.7 ± 5.1	37.9 ± 5.2	36.5 ± 5.0	33.8 ± 5.2	37.5 ± 5.4	37.8 ± 5.6	38.6 ± 5.1	37.9 ± 5.3
BMI (kg/m^2)	19.0 ± 4.3	19.3 ± 4.2	18.9 ± 4.0	17.5 ± 3.7	19.4 ± 3.6	19.5 ± 3.5	18.7 ± 3.5	18.7 ± 3.4
BSA (m^2)	1.2 ± 0.3	1.2 ± 0.3	1.2 ± 0.2	1.1 ± 0.2	1.2 ± 0.2	1.2 ± 0.2	1.2 ± 0.2	1.2 ± 0.2
Body fat (%)	14.5 ± 3.4	14.6 ± 3.0	14.5 ± 3.1	13.2 ± 3.9	$18.5^{\$}$ ± 3.7	$19.2^{\$}$ ± 3.8	$18.9^{\$}$ ± 3.6	$18.4^{\$}$ ± 3.4
Fat mass (kg)	5.3 ± 1.1	5.4 ± 1.0	5.2 ± 1.8	4.9 ± 1.2	6.9 ± 3.1	$7.3^{\$}$ ± 3.2	$7.3^{\$}$ ± 3.3	$7.2^{\$}$ ± 3.1
LBM (kg)	31.2 ± 4.3	31.7 ± 4.2	31.0 ± 4.1	29.1 ± 4.8	30.4 ± 4.4	30.5 ± 4.4	30.9 ± 4.2	30.7 ± 4.1
WC (cm)	70.2 ± 11.3	70.7 ± 11.2	70.1 ± 11.3	70.1 ± 11.3	68.5 ± 10.6	69.4 ± 11.2	66.6 ± 10.4	66.5 ± 10.1
HC (cm)	76.2 ± 10.8	76.2 ± 10.8	76.6 ± 10.8	76.5 ± 10.7	76.8 ± 10.7	78.7 ± 10.6	75.9 ± 10.9	75.7 ± 10.9
WHR	0.9 ± 0.1	0.9 ± 0.1	0.9 ± 0.04	0.9 ± 0.04	0.9 ± 0.1	0.9 ± 0.1	0.9 ± 0.04	0.9 ± 0.04
MUAC (cm)	21.4 ± 3.1	21.5 ± 3.2	21.4 ± 3.6	21.6 ± 3.6	21.5 ± 3.6	21.6 ± 4.0	20.9 ± 3.3	21.0 ± 3.1

All the data were expressed as mean ± Standard Deviation; paired sample t-test was performed, *n*=30. When compared to 0 week and 6 week $^{*}P<0.05$; when compared to control group and yoga group $^{\#}P<0.05$; when compared to male and female $^{\$}P<0.05$. BMI= body mass index, BSA= body surface area, LBM= lean body mass, WC= waist circumference, HC= hip circumference, WHR = waist hip ratio, MUAC= mid upper arm circumference.

Table 5: Physical fitness variables of control group and yoga group

Parameters	*Control male*		*Yoga male*		*Control female*		*Yoga female*	
	0 Week	*6 Week*	*0 Week*	*6 Week*	*0 Week*	*6 Week*	*0 Week*	*6 Week*
GSTR (kg)	14.8 ± 3.1	14.9 ± 3.2	15.0 ± 3.5	$18.4^{*\#}$ ± 3.0	12.9 ± 3.2	$12.9^{\$}$ ± 3.3	12.8 ± 3.7	$15.2^{*\#\$}$ ± 4.0
GSTL (kg)	14.9 ± 3.9	15.0 ± 3.7	15.1 ± 4.0	$18.2^{*\#}$ ± 3.9	12.7 ± 3.2	13.3 ± 3.2	12.9 ± 3.8	$14.1^{\$}$ ± 4.1
Back strength (kg)	32.6 ± 4.8	34.3 ± 4.3	38.9 ± 4.0	$45.2^{*\#}$ ± 4.7	30.5 ± 4.5	30.6 ± 4.3	32.8 ± 4.7	$36.9^{\$}$ ± 4.1
LPO (watt)	76.6 ± 14.6	81.7 ± 13.9	79.5 ± 16.0	$156.6^{*\#}$ ± 16.4	70.4 ± 15.3	70.6 ± 13.3	70.3 ± 16.2	$111.9^{*\#\$}$ ± 15.6
APO (watt)	102.3 ± 21.4	104.6 ± 18.8	104.1 ± 18.9	$171.6^{*\#}$ ± 20.4	85.9 ± 21.7	$82.3^{\$}$ ± 20.6	89.5 ± 21.4	$142.0^{*\#}$ ± 20.4
AC (watt)	613.7 ± 55.9	627.8 ± 50.4	624.8 ± 51.2	$1029.5^{*\#}$ ± 76.2	515.5 ± 50.6	$493.6^{\$}$ ± 49.5	537.3 ± 50.2	$852.2^{*\#}$ ± 63.6
Fatigue index (watt/sec)	1.1 ± 0.4	1.2 ± 0.4	1.2 ± 0.3	1.4 ± 0.4	0.95 ± 0.5	0.98 ± 0.6	0.93 ± 0.5	$1.7^{*\#}$ ± 0.3
PFI	46.9 ± 3.8	46.8 ± 3.7	48.0 ± 4.2	$55.9^{*\#}$ ± 4.0	48.2 ± 4.4	48.3 ± 4.4	49.7 ± 4.1	$54.8^{*\#}$ ± 4.3

All the data were expressed as mean ± SD; paired sample t-test was performed, *n*=30. When compared to 0 week and 6 week $^{*}p<0.05$; when compared to control group and yoga group $^{\#}p<0.05$; when compared to male and female $^{\$}p<0.05$. NS= Not significant, SD= Standard deviation, GSTR = Grip Strength Right Hand, GSTL = Grip Strength Left Hand, LPO = Lowest Power Output, APO = Average Power Output, AC=Anaerobic capacity, PFI = Physical Fitness Index.

practices (pranayamas), deep relaxation of mind and spirit (dhyana or meditation), yogic diet and sleep (yogic nidra).[10] Thus, yoga helps to attain the highest level of consciousness. Practicing yoga helps to reduce the risk of many diseases such as obesity, diabetes, CVD, mental disorders etc.

In the present study, an attempt was made to find out the effects of short-term yoga practice on body composition, physical, and physiological parameters, and nutritional and mental health status of 10 to 12 years of children. It was noted that male participants had significantly higher protein and fat intake than female participants. However, no difference was observed in socio-economic status, macronutrient and micronutrient intake of yoga group and control group participants. In this study, no difference was observed in

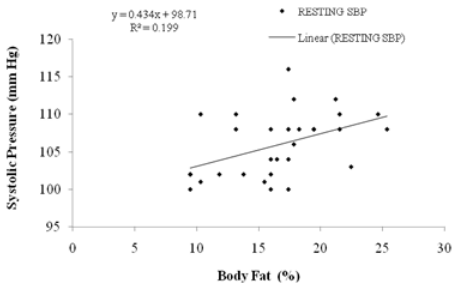

Figure 5a

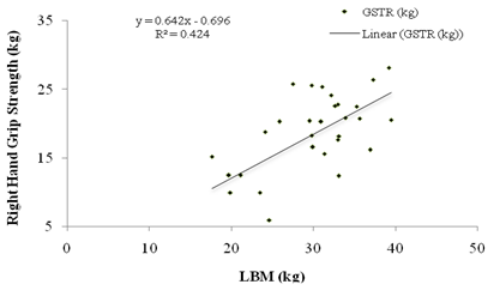

Figure 5b

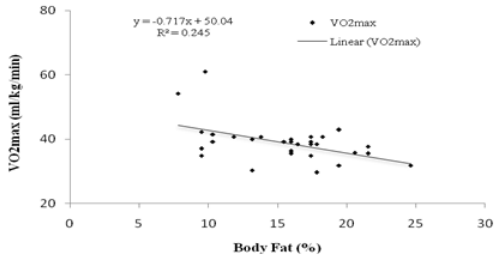

Figure 5c

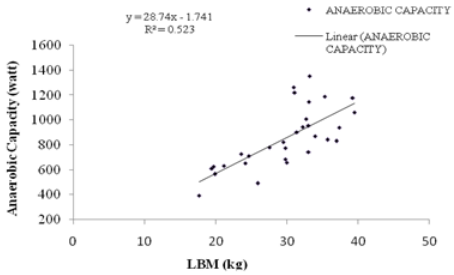

Figure 5d

Figure 5: Correlation of percentage body fat with systolic pressure and VO_{2max}; LBM with anaerobic capacity and grip strength

Table 6: Physiological variables of control group and yoga group

Parameters	*Control male*		*Yoga male*		*Control female*		*Yoga female*	
	0 Week	*6 Week*	*0 Week*	*6 Week*	*0 Week*	*6 Week*	*0 Week*	*6 Week*
Systolic pressure (mm/Hg)	119.3 ± 8.3	120.2 ± 8.3	119.1 ± 8.5	106.4$^{*\#}$ ± 6.8	116.5 ± 6.3	118.3 ± 7.5	113.6$^{\$}$ ± 6.9	105.9$^{*\#}$ ± 5.3
Diastolic pressure (mm/Hg)	72.4 ± 6.9	74.3 ± 5.9	71.3 ± 6.0	64.8$^{*\#}$ ± 5.8	74.7 ± 5.6	75.4 ± 6.2	71.0 ± 5.3	64.1$^{*\#}$ ± 5.0
Pulse pressure (mm/Hg)	46.9 ± 4.7	45.9 ± 4.9	48.0 ± 5.0	41.6$^{*\#}$ ± 5.1	41.9 ± 4.8	42.9 ± 4.7	42.6$^{\$}$ ± 5.0	41.8 ± 5.3
Mean pressure (mm/Hg)	88.0 ± 7.5	89.6 ± 7.4	87.1 ± 7.2	78.7$^{*\#}$ ± 6.9	88.6 ± 7.6	89.7 ± 7.5	85.2 ± 7.5	78.0$^{*\#}$ ± 6.9
RHR (beats/min)	82.6 ± 5.2	80.8 ± 6.1	82.8 ± 6.2	69.6$^{*\#}$ ± 5.8	90.2$^{\$}$ ± 7.5	87.4$^{\$}$ ± 6.4	93.2$^{\$}$ ± 8.8	76.3$^{*\#\$}$ ± 6.8
FEV_1(l)	1.9 ± 0.5	1.9 ± 0.5	1.9 ± 0.5	2.6$^{*\#}$ ± 0.6	1.7 ± 0.5	1.9 ± 0.6	1.9 ± 0.5	2.6$^{*\#}$ ± 0.6
FVC (l)	1.9 ± 0.5	1.9 ± 0.6	2.0 ± 0.6	2.6$^{*\#}$ ± 0.6	1.9 ± 0.6	1.9 ± 0.6	1.9 ± 0.6	2.7$^{*\#}$ ± 0.6
FEV1/FVC	96.2 ± 5.3	98.0 ± 5.2	95.6 ± 5.3	99.1* ± 5.8	96.5 ± 4.5	96.4 ± 4.5	96.8 ± 4.6	96.2$^{\$}$ ± 3.8

All the data were expressed as mean ± Standard Deviation; paired sample t-test was performed, *n*=30. When compared to 0 week and 6 week *p <0.05; when compared to control group and yoga group $^{\#}P$<0.05; when compared to male and female $^{\$}p$ <0.05, RHR= resting heart rate, FEV1= Forced Expiratory Volume in 1st second, FVC= Forced Vital Capacity.

DASS scores of yoga and control group participants at the beginning of the study. However, a significant decrease in depression, anxiety and stress scores was noted in both male and female participants after six weeks of yoga practice. The male had significantly higher depression scores than female participants. Practicing yoga might increase the amount of GABA neurotransmitters in the brain and stimulate the vagal nerve, which creates parasympathetic dominance in the body. This helps in controlling the activity of the hypothalamic-pituitary axis (HPA) and decreases the release of the stress hormone cortisol.[29-31] The six weeks of yoga practice did not show any effect on body composition

variables. This was probably due to the limited period time of for yoga practice. Female poses more body fat percentage then male; this might be due to their secondary reproductive characteristics.

The present study showed that six weeks of yoga practice had a positive impact on physical fitness variables in both male and female participants. A significant increase in hand grip strength and flexibility was noted after six weeks of yoga practice in both male and female participants. It can be stated that these changes might be due to the practice of different asanas which involve stretching, postural changes and bending of body parts. However, no significant change in back muscle strength was observed after six weeks of yoga practice among the female volunteers. This was probably due to the limited period time of yoga practice. This result correlates with the findings of other research group[32]. As the female participants had more body fat than male, this might be the cause that the female had reduced gain in muscle strength, as increased body fat reduces physical fitness.[32] However, long-duration yoga practice may increase the strength of the female participants.[32] In addition, six weeks of yoga practice increased anaerobic power in both the male and female participants. The male participants had significantly higher anaerobic capacity than females after yoga practice. As the female participants had more body fat than male, this might be the cause that the female had reduced gain in muscle power, as increased body fat reduces physical fitness.[32] Similar findings were also reported by another research group.[33,34]

In the present study, it was observed that the short-term yoga practice had some beneficial effects on physiological functions. The systolic pressure, diastolic blood pressure and resting heart rate significantly decreased after six weeks of yoga training in both male and female participants. This might be due to parasympathetic nervous system dominance. It can be stated that yoga practice improved parasympathetic activities. These results correlate with the findings of research group who worked on the healthy male volunteers.[11] The male participants had higher systolic blood pressure, diastolic blood pressure, mean pressure and resting heart rate than the female participants in both yoga group and the control group. This might be due to the fact that the male participant practicing has more sympathetic activations than their female counterpart. Lung functions as indicated by FEV1, FVC and PEFR were increased after yoga practice in both male and female participants. It can be stated that Pranayama (breathing practice) help to improve the functions of respiratory muscles and thus improves lung functions.[11] Therefore, regular yoga practice improves the oxygen supply to tissue. Similar observations have been reported by other research groups.[32] A significant increase in VO_{2max} was observed in after yoga practice in both male and female participants. This might be due to the fact that the decreased vascular tone due to yoga practice increases vasodilation time, therefore oxygen reaches to muscles for a longer time and due to increased lung volume, the concentration of oxygen also increases in the blood thus improving $VO_{2max.}$[32-35] Females have significantly lower VO_{2max} than their male counterparts. This might be due to lower blood volume, low muscle mass and low hemoglobin level in females than in males. Similar observations have been reported in other studies.[32-35] In the present study body fat percentages showed a significant positive correlation with resting systolic blood pressure; and a significant negative correlation with VO_{2max}. This indicated that an increase in body fat might elevate systolic blood pressure and negate VO_{2max} of the participants. Further, lean body mass showed a significant positive correlation with hand grip strength and anaerobic capacity. Thus increase in muscle mass has positive impact on the strength and power of the participants.

Conclusion

In the present study increase in strength, flexibility, anaerobic power, VO_{2max}, FVC, FEV1, PEFR; and a decrease in resting heart rate, blood pressure, depression, anxiety and stress scores were observed in both male and female volunteers after six weeks of yoga practice. However, no significant change was noted in body composition variables. This was probably due to the limited period time of yoga practice. However, long-term yoga practice may be beneficial for maintaining body mass, body fat; improving flexibility, strength and power, and cardio-respiratory variables. The findings of the present study were limited to 10-12 years male and female volunteers. Similar observations may be noted in adolescents and adult individuals. In the present time children and adolescents spend less time in physical activities which may lead to increased risk of various diseases including obesity, cardiovascular diseases, diabetes, asthma, mental illness etc. Yoga may be helpful in preventing these health issues at any stage of life. Practicing yoga in school days may help the students to lead a disease-free lifestyle. Yoga practice may be adopted in school as a mode of physical activity. The government should take the initiative to introduce yoga in school curricula, and health programs in order to improve the well-being of children.

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PEER-REVIEWED CERTIFICATION

During the review of this manuscript, a double-blind peer-review policy has been followed. The author(s) of this manuscript received review comments from a minimum of two peer-reviewers. Author(s) submitted revised manuscript as per the comments of the assigned reviewers. On the basis of revision(s) done by the author(s) and compliance to the Reviewers' comments on the manuscript, Editor(s) has approved the revised manuscript for final publication.