IMPACT OF 24 WEEKS OF YOGA PRACTICE ON BODY COMPOSITION, PHYSICAL FITNESS AND CARDIO-RESPIRATORY VARIABLES OF HEALTHY ADOLESCENT FEMALE PARTICIPANTS

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Abstract
Back grounds: Yoga practice may improve health, fitness and reduces the risk of many diseases. This work aimed to observe whether practice of yoga asana can improve the body fat, strength, flexibility, and cardio-respiratory variables of female volunteers. Methods: One hundred fifty one adolescent female participants (age: 13–15 yrs) were screened randomly, thirty one were excluded, rest one hundred twenty participants were grouped : (i) Yoga asana Practice Group (YPG: n = 60) and (ii) Sedentary Control Group (SCG: n = 60). The YG followed a yoga asana practice schedule of 1 hr/d, 5 d/wk for 24 wks was followed by the participants of YPG, and no such protocol was given to SCG. Body fat, strength, flexibility, and cardio-respiratory variables was assessed at the beginning (0 wk) and after yoga training (12 wks and 24 wks). Results: Yoga practice reduced (p≤0.05) body weight, BMI, body fat, LBM, reaction time, SBP, heart rate during rest, exercise and recovery; and increased (p ≤0.05) strength, flexibility, PFI, VO_{2max}, FVC, FEV1 and PEFR among the volunteers of YPG after yoga training. The SCG volunteers had higher (p ≤0.05) body fat, WHR, reaction time, SBP, heart rate during rest and recovery,; and lower (p <0.05) MUAC, strength, flexibility, PFI, VO_{2max}, FVC and PEFR than the YPG. Conclusion: Yoga practice reduces body fat, blood pressure, heart rate; and increase strength, flexibility, PFI, VO_{2max}, lung functions. Thus yoga improves physical and cardio- respiratory fitness which is essential for good health.

Keywords - Yoga, body fat, blood pressure, heart rate, VO_{2max}, FEV1, FVC

1.0 INTRODUCTION
Becoming physically active person is one of the important criteria in children and adolescents health. Optimum level of physical activity energizes the individual at the same time reduce the onset of fatigue [(1)]. It has been reported that in young aged people improvement in physical functions helps them to accomplish the daily tasks with less difficulties. In addition, improved physical activity may increase cognitive functions among youths, these includes memory, attention, executive function, and academic performance [(2)]. Studies also showed that physical activity have many health benefits including- improvement in strength, flexibility, cardio-respiratory variables which reduce the onset of various health problems [(1, 2)]. It also decreases depression and anxiety and injury risk etc [(3)]. Thus improve physical activity improve the life span of the person. In the present era due to lack of space or play ground it is becomes difficult of the young children to perform physical activities. Further, the facilities such as gymnasium,

swimming pool etc is not affordable by all. On the other hand, increase use of computer, mobile phone, TV etc. keeps the children away from the play ground. Thus, most of the children are way from the play ground, which may reduce their physical fitness. In such a condition, yoga may be applied as an alternative exercise mode. Yoga can be

performed in home, without using any equipment facilities.

Yoga practice unit the soul with the body, thus yoga is related to body, mind and spirit. Yoga includes practice of asana, pranayama and meditation, which are also used as therapy for improving physical and mental wellness [3]. Yoga improves physical fitness, brain functions, mental health etc [4]. Yoga reduces body fat by utilising the lipid for metabolism [5]. The stress level also reduces by practicing the yoga [6]. Studies showed that regular practice of yoga decreases oxidative stress and increases the levels of antioxidants, and thus enhances bodies defence mechanism [6]. The heart rate, blood pressure, respiratory functions are indicators of health; they also predict the risk of cardio-respiratory diseases [2, 5]. Studies indicated that yoga practice have beneficial effects on cardiovascular and respiratory functions of the individuals [5, 7].

The work related stress and low level of activity may elevate risks for various diseases. School children spend a considerable time of day in the school. In addition, they are also involving in various types of academic and co-curricular activities. Further, the children are also exposed to computer/ tab and /or cell phone during the study hours. So they are exposed to different levels of

stress which include long hours of school, academic load, co-curricular activities and mental pressure due to competition etc. Thus the children find less times for physical activities. School has a role to promote physical activities among the children. School may use yoga as a mode of exercise for children for promotion of health, mental status and encouraging children to be active. This work aimed to observe whether practice of yoga asana can improve the body fat, strength, flexibility, and cardio-respiratory variables of female volunteers.

2.0 MATERIALS AND METHODS

Participants:

One hundred and fifty one (n = 151) female participants (age: 13–15 yrs) did not performed yogic asana in last one year and having no previous disease or ill health condition were included from the Midnapore, W. B., India. They were examined by the medical doctors. Thirty one [n = 31 (unable to meet the criteria, n = 06; left the study in mid way, n = 08; not able to do yogic asana, n = 09; and did not maintain the schedule, n = 08)] participants were removed, the rest one hundred twenty (n=120) were grouped into (i) Sedentary Control Group (SCG: n = 60) and (ii) Yogic Exercise Group (YEG: n = 60).

Table 1: Protocol for practice of yogic asana

Protocol	Time (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	05
(i) Ajpa Jap (ii) Shanti Mantra	02
Total	60

Experimental Design: Yogic exercise group performed a yogic exercise programme for 1 hr/d, 05 d/wk for 24 wks following a standard protocol [8] (Table 1). The sedentary control group partipicants did not performed the yogic exercises. The body fat, strength, flexibility, and cardio-respiratory variables were determined at the beginning, after 12 and 24 weeks. The detail of the experimental design is shown in Figure- 1.

Ethics: The aims and objectives, methods and possible complication of the investigation were explained to the participants and they gave consent. This investigation was recorded and given approval by the Institutional Research Committee.

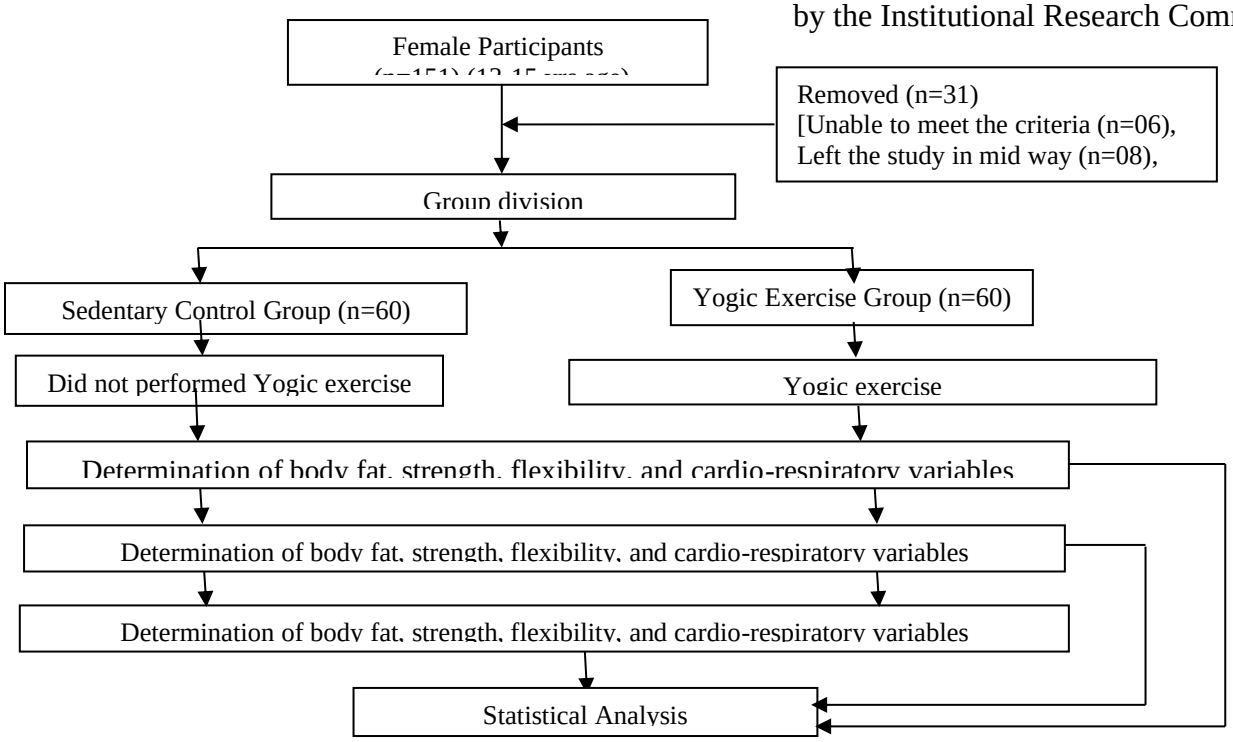

Fig 1: Consort flow chart

Measurement of Body Composition Variables

The height (stature) and body weight of the participants were measured by the standard procedure [9]. The body mass index (BMI) and body surface area (BSA) were determined [9]. A skin fold calliper (Cescorf, USA) was used to measure the skin fold thickness for determination of body density and body fat [9, 10]. The total fat mass and lean body mass (LBM) were obtained [9]. The waist hip ratio (WHR) of the participants was determined from waist circumference (WC) and hip circumference (HC) [9]. Mid-upper arm circumference (MUAC) of the participant was measured by non-stretchable steel tape [9].

Measurement of Physical Fitness Variables

Strength of the hand grip of right hand and left hand (GSTR and GSTL) were determined by hand dynamometer (Baseline, USA) [11]. The modified sit and reach test was employed for assessment of flexibility of the participants [12].The reaction time of left and right hand (LHRT and RHRT) were determined by Ruler Drop Test [13]. The physical fitness index (PFI) of the participants was assayed by modified Harvard step test following standard protocol [14].

Measurement of Cardio-respiratory Variables

Te resting systolic and diastolic blood pressure (SBP and DBP) was determined by digital sphygmomanometer (Omron HEM 7120, Japan) [15]. Heart rate was measure during rest (HR_{rest}), maximum exercise (HR_{max}) and recovery (HR_{rec1-3}) by standard procedure [15]. Maximum aerobic capacity (VO_{2max}) of the participants was measured by Queen's College Step Test using standard procedure [16]. Lung functions like FEV1, FVC and PEFR were assessed by Portable digital spirometer (MIR, USA) following standard protocol [17].

Statistics:

The data obtained from the present investigation was treated by statistical programme SPSS 20. Describe statistics including mean and standard deviation were shown. Repeated measure analysis of variance (ANOVA) followed by multiple comparison (*post hoc*) tests was applied to observe intergroup and intra group differences [18]. The alpha was fixed at $p \leq 0.05$.

3.0 RESULTS

3.1 Impact of 24 weeks of Yoga practice on Body Composition Variables of Healthy adolescent Female Participants: In the present investigation practice of yogic asana showed decline ($p \leq 0.05$) in weight, BMI, body fat, LBM among the participants of yogic exercise group at the end of the analysis. On the other hand, sedentary control group participant exhibited greater ($p \leq 0.05$) weight, BMI, BSA, body fat, fat mass, LBM, WHR; and less ($p \leq 0.05$) MUAC than the volunteers of yogic exercise group.

3.2 Impact of 24 weeks of Yoga practice on Physical Fitness Variables of Healthy adolescent Female Participants: In this investigation an improvement ($p \leq 0.05$) in strength, flexibility, PFI; and decline ($p \leq 0.05$) in reaction time of the participants of yogic exercise group was observed at the end of the research work. Further, the sedentary control group participant had shown reduced ($p < 0.05$) in strength, flexibility and PFI; and elevated ($p \leq 0.05$) reaction time when compare to the volunteers of yogic exercise group.

Table 2: Impact of 24 weeks of Yoga practice on Body Composition Variables of Healthy adolescent Female Participants

Parameters	Control Group (n= 60)			Yoga Group (n= 60)		
	0 Wk	12 Wk	24 Wk	0 Wk	12 Wk	24 Wk
Stature (cm)	152.6 ± 5.1	152.6^{NS} ± 5.1	152.6^{NS} ± 5.1	153.3 ^{NS} ± 5.5	153.5 ^{NS} ± 5.8	153.6 ^{NS} ± 5.6
Body Weight (kg)	46.1 ± 4.6	46.5^{NS} ± 3.8	47.2^{NS} ± 3.0	45.9 ^{NS} ± 3.9	43.7$^{*\$}$ ± 3.3	41.3$^{*\#\$}$ ± 3.7
BMI (kg/m^2)	20.0 ± 2.4	20.5^{NS} ± 2.1	20.9^{NS} ± 2.0	19.6 ^{NS} ± 2.6	18.7 $^{\$}$ ± 2.2	17.6$^{*\$}$ ± 1.9
BSA (m^2)	1.40 ± 0.07	1.40^{NS} ± 0.06	1.40 ^{NS} ± 0.05	1.38 ^{NS} ± 0.08	1.37 ^{NS} ± 0.07	1.36 ^{NS} ± 0.05
Body fat (%)	21.4 ± 2.4	21.7^{NS} ± 2.5	22.1 ^{NS} ± 2.2	19.6$^{\$}$ ± 2.6	17.8$^{*\$}$ ± 2.3	16.7$^{*\$}$ ± 2.6
Fat mass (kg)	10.0 ± 1.8	10.6^{NS} ± 1.7	11.1* ± 1.5	9.1$^{\$}$ ± 1.6	7.9$^{*\$}$ ± 1.9	6.7$^{*\#\$}$ ± 1.2
LBM (kg)	36.3 ± 3.2	36.6^{NS} ± 2.6	37.2^{NS} ± 2.7	36.8 ^{NS} ± 2.6	35.8 ^{NS} ± 2.7	34.1$^{*\#\$}$ ± 2.8
WC (cm)	78.4 ± 7.8	79.5^{NS} ± 8.1	80.2$^{*\#}$ ± 7.8	72.7$^{\$}$ ± 7.7	70.9$^{\$}$ ± 7.5	69.1$^{\$}$ ± 7.6
HC (cm)	87.0 ± 7.3	87.0^{NS} ± 7.3	87.9^{NS} ± 7.7	87.0 ^{NS} ± 7.2	85.8 ^{NS} ± 7.4	85.1 ^{NS} ± 7.6
WHR	0.90 ± 0.10	0.91^{NS} ± 0.10	0.91^{NS} ± 0.11	0.83$^{\$}$ ± 0.07	0.82$^{\$}$ ± 0.07	0.81$^{\$}$ ± 0.09
MUAC (cm)	19.7 ± 1.4	20.0^{NS} ± 1.7	20.1^{NS} ± 1.6	21.7$^{\$}$ ± 2.0	22.3$^{\$}$ ± 2.1	22.7$^{\$}$ ± 2.2

[When compared to 0 week- *P≤0.05; when compared to 12 week- $^{\#}$P≤0.05; when compared to control group- $^{\$}$P≤0.05.]

Table 3: Impact of 24 weeks of Yoga practice on Physical Fitness Variables of Healthy adolescent Female Participants

Parameters	Control Group (n= 60)			Yoga Group (n= 60)		
	0 Wk	12 Wk	24 Wk	0 Wk	12 Wk	24 Wk
GSTR (kg)	20.7 ± 3.1	21.5 ^{NS} ± 3.1	22.1^{NS} ± 3.2	22.3 ^{NS} ± 3.1	24.1$^{*\$}$ ± 3.0	26.0$^{*\#\$}$ ± 3.1
GSTL (kg)	19.8 ± 2.7	20.1^{NS} ± 2.8	20.9 ^{NS} ± 2.7	21.9$^{\$}$ ± 2.7	23.8$^{*\$}$ ± 2.6	25.7$^{*\#\$}$ ± 2.8
Flexibility (cm)	30.0 ± 3.2	30.7^{NS} ± 3.1	31.2^{NS} ± 3.2	32.4$^{\$}$ ± 3.4	35.9$^{*\$}$ ± 3.5	36.7$^{*\$}$ ± 3.1
LHRT (Sec)	0.24 ± 0.02	0.23 ^{NS} ± 0.02	0.24 ^{NS} ± 0.02	0.22$^{\$}$ ± 0.02	0.21$^{*\$}$ ± 0.02	0.20$^{*\#\$}$ ± 0.01
RHRT (Sec)	0.23 ± 0.02	0.23^{NS} ± 0.02	0.23^{NS} ± 0.02	0.23^{NS} ± 0.02	0.22^{NS} ± 0.02	0.21$^{*\$}$ ± 0.02
PFI	50.4 ± 3.4	50.9^{NS} ± 3.5	51.5^{NS} ± 3.4	51.6^{NS} ± 3.3	55.3$^{*\$}$ ± 3.2	57.4$^{*\#\$}$ ± 3.3

[When compared to 0 week- *P≤0.05; when compared to 12 week- $^{\#}$P≤0.05; when compared to control group- $^{\$}$P≤0.05.]

Table 4: Impact of 24 weeks of Yoga practice on Cardio-respiratory Variables of Healthy adolescent Female Participants

Parameters	Control Group (n= 60)			Yoga Group (n= 60)		
	0 Wk	12 Wk	24 Wk	0 Wk	12 Wk	24 Wk
RSBP (mm Hg)	120.8 ± 6.0	120.3^{NS} ± 5.8	119.8^{NS} ± 5.8	117.0$^{\$}$ ± 5.1	114.2$^{*\$}$ ± 5.1	112.5$^{*\$}$ ± 5.2
RDBP (mm Hg)	77.8 ± 5.6	75.2^{NS} ± 5.4	73.5^{NS} ± 5.3	75.9^{NS} ± 5.1	74.7 ^{NS} ± 6.1	73.7 ^{NS} ± 5.4
HR_{rest} (bpm)	86.1 ± 5.4	85.2^{NS} ± 5.7	83.4^{NS} ± 5.7	85.7^{NS} ± 5.7	81.9$^{*\$}$ ± 5.8	73.4$^{*\#\$}$ ± 5.4
HR_{max} (bpm)	189.7 ± 6.7	188.9^{NS} ± 6.6	187.1^{NS} ± 6.5	191.5^{NS} ± 6.2	188.1* ± 6.6	186.1* ± 6.3
HR_{rec1} (bpm)	166.6 ± 5.3	165.4^{NS} ± 5.4	164.2^{NS} ± 5.2	166.4^{NS} ± 5.3	161.1$^{*\$}$ ± 5.2	152.8$^{*\#\$}$ ± 5.4
HR_{rec2} (bpm)	147.8 ± 4.9	146.8^{NS} ± 4.9	145.8^{NS} ± 4.9	146.5^{NS} ± 4.3	142.0$^{*\$}$ ± 4.9	140.8$^{*\$}$ ± 4.7
HR_{rec3} (bpm)	133.1 ± 4.7	132.3^{NS} ± 5.0	131.4^{NS} ± 5.1	126.8$^{\$}$ ± 4.5	124.9$^{\$}$ ± 4.7	122.2$^{*\#\$}$ ± 4.8
$VO_{2\ max}$ (ml/kg/min)	33.0 ± 3.2	33.3^{NS} ± 3.0	33.7^{NS} ± 3.1	33.6^{NS} ± 3.0	35.9$^{*\$}$ ± 3.2	37.7$^{*\#\$}$ ± 3.2
FEV1 (l)	2.0 ± 0.4	2.1^{NS} ± 0.4	2.2^{NS} ± 0.4	2.1^{NS} ± 0.4	2.3$^{*\$}$ ± 0.3	2.4* ± 0.4
FVC (l)	2.0 ± 0.4	2.1^{NS} ± 0.3	2.1^{NS} ± 0.4	2.1^{NS} ± 0.4	2.3$^{*\$}$ ± 0.3	2.4$^{*\$}$ ± 0.4
FEV1/FVC (%)	99.8 ± 8.5	98.7^{NS} ± 8.3	97.8^{NS} ± 8.9	97.9 ^{NS} ± 8.1	97.9 ^{NS} ± 9.4	98.4 ^{NS} ± 9.1
PEFR (l/min)	234.1 ± 29.9	236.3^{NS} ± 30.1	241.8^{NS} ± 27.3	249.7$^{\$}$ ± 30.4	268.4$^{*\$}$ ± 28.9	282.8$^{*\$}$ ± 29.7

[When compared to 0 week- $^{*}P\leq0.05$; when compared to 12 week- $^{\#}P\leq0.05$; when compared to control group- $^{\$}P\leq0.05$]

3.3 Impact of 24 weeks of Yoga practice on Cardio-respiratory Variables of Healthy adolescent Female Participants: In this investigation, systolic blood pressure, resting heart rate, maximal heart rate recovery heart rate was found lowered ($p\leq0.05$); with an elevation ($p\leq0.05$) in VO_{2max}, FVC, FEV1 and PEFR among the participants of yogic exercise group at the end of the intervention. The sedentary control group participant had control group with yoga group, it was found that control group volunteers had significantly increased ($p<0.05$) blood pressure, heart rate during rest and recovery; and reduced ($p\leq0.05$) VO_{2max}, FVC and PEFR when compare to the volunteers of yogic exercise group.

4.0 DISCUSSION

Yoga is beneficial for keeping health and physical fitness. In the present investigation practice of yogic asana showed decline in weight, BMI, body fat, LBM among the participants of yogic exercise group at the end of the analysis. On the other hand, sedentary control group participant exhibited greater weight, BMI, BSA, body fat, fat mass, LBM, WHR; and less MUAC than the volunteers of yogic exercise group. It can be suggested that the practice of yogic asana for long period of time (24 wks) might be responsible for the decline in weight, BMI, body fat. The yogic asana incorporate change in posture, bending in different directions and movement of limbs which might cause increase muscle activities which might be related to the changes observed in this study. Research findings in this direction also noted that similar observations [6, 19-21]. It can be stated that a reduction of body fat is beneficial for health, and reduces the risk for many

diseases like obesity, cardiovascular disease, diabetes etc. [6, 19-21].

Yoga is considered as mode of physical exercise. In this investigation an improvement in strength, flexibility, PFI; and decline in reaction time of the participants of yogic exercise group was observed at the end of the research work. Further, the sedentary control group participant had shown reduced in strength, flexibility and PFI; and elevated reaction time when compare to the volunteers of yogic exercise group. Yoga asana involves movements of different limbs, change in posters and bending ether in forwards or backwards direction. These might be the probable cause of increase in grip strength, flexibility and physical fitness index; and reduction in reaction time after yoga training. Research findings in this area reported that yoga practice might improve strength and flexibility of the volunteers [22, 2].

The cardiovascular and respiratory variables are used for determination of health status; these are also used as indicators of risk factors for several diseases. In this investigation, systolic blood pressure, resting heart rate, maximal heart rate recovery heart rate was found lowered; with an elevation in VO_{2max}, FVC, FEV1 and PEFR among the participants of yogic exercise group at the end of the intervention. The sedentary control group participant had control group with yoga group, it was found that control group volunteers had significantly increased blood pressure, heart rate during rest and recovery; and reduced VO_{2max}, FVC and PEFR when compare to the volunteers of yogic exercise group.

Other research finding reported that yogic asana practice have positive impact on cardiovascular activities as represented by heart rate and blood pressure [24, 25]. Yoga practice involves asana, pranayama and meditation. During yoga asana practice there were movements of different limbs, change in posters and bending ether in forwards or backwards direction which might be helpful to improve the cardio-respiratory variables. Pranayama involves deep and slow breathing; uni-nostril breathing, alternate nostril breathing, breathing holding etc. this probably have positive impact on the autonomic nervous system. The parasympathetic division of the autonomic nervous system is responsible for the lowering of heart rate and blood pressure [24, 25]. Regular yogic asana practice might increase the parasympathetic activation as well as reduce the sympathetic activation, which might be considered as cause of lower heart rate and blood pressure following yoga exercise [25]. Meditation activates parasympathetic nervous system and reduces anxiety, stress – and lowers arterial tone and peripheral resistance, which might cause lower heart rate and blood pressure [24]. Pranayama and meditation both might improve the parasympathetic activation which might be considered as cause of heart rate and blood pressure following yoga training [24]. The VO_{2max}, FVC, FEV1 and PEFR represent the status of the lung respiratory status. It can be stated that yoga asana involves movements of different limbs, change in posters and bending ether in forwards or backwards direction. Pranayama involves deep and slow breathing, uni-nostril breathing, alternate nostril breathing, breathing holding etc which might be the cause of increase in VO_{2max}, FVC, FEV1 and PEFR after yoga training [26-29]. Pranayama and meditation together might increase the ventilation perfusion ratio which is responsible for improvement of cardio-respiratory status [26-29]. Similar observations have been reported by many researchers [27-29]. Increase in respiratory functions and maximal aerobic capacity enhances the health status and reduces the risk for pulmonary disease. Practice of

yogic asana might be beneficial for improve health, which may reduce the risk for many diseases.

5.0 CONCLUSIONS

Yogic asana practice helps to improve morphological, physical fitness and cardio-respiratory variables. School may adopt the yoga regime as an alternate mode of exercise for school children. Practice of yogic asana improve the life style and thus reduces the risk of many diseases later in life.

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