



## Research article

### EFFECT OF RESIDENTIAL INTEGRATED YOGA ON PHYSICAL FITNESS OF ADOLESCENTS USING EUROFIT BATTERY

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#### Abstract

*Decrease in physical activity and sedentary behavior in adolescents is very prevalent today. These factors can constitute risks in physical and mental health. It is important to promote physical fitness in adolescence to prevent health problems and to minimize sedentary life style in adulthood. Yoga, which includes asana, pranayama, yogic diet and relaxation, is considered an important intervention that provides the right dose of activities to promote physical fitness. To evaluate the effectiveness of short term residential integrated yoga intervention on physical fitness among adolescents. A single group pre-post yoga interventional study was carried out in three independent cohorts, batches 1, 2, and 3, in a residential setting. Sample comprised of 145 (41.38% girls), 166 (27.11% girls) and 194 (38.14% girls) respectively. A 7-day holistic integrated yoga program was given as an intervention. Physical fitness tasks such as body mass index (BMI), plate-taping test (PLT), sit and reach (SAR), standing broad jump (SBJ), sit-ups (SUP) and 10x5m Shuttle run (10x5mR) were assessed using Eurofit battery and relevant analyses were carried out. Significant ( $p$  value < 0.05) positive changes were observed in BMI, SBJ, SAR and SUP in all the cohorts. The study concludes that even a short term residential yoga intervention is an effective tool to enhance physical fitness in adolescents.*

**Keywords:** Yoga; adolescents; Physical fitness; Residential

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## **INTRODUCTION**

There is steady decline in physical activity in children and adolescents as they spend majority of their time in classrooms (indoor) and less time for activity (physical education) (Ahn & Fedewa, 2011; Brodersen, Steptoe, Boniface, Wardle, & Hillsdon, 2007). The amount of physical activity is further reduced by limited use of active means of transport (i.e., biking, walking) and outdoor play due to perceived safety risks, distance, child's age, and parents' travel mode (Merom, Tudor-Locke, Bauman, & Rissel, 2006; Stevens, To, Stenvenson, & Lochbaum, 2008). Easily available technology has given rise to opportunities to watch TV, play video games or browse the Internet during and after school hours, resulting in more sedentary lifestyle (Atkin, Gorely, Biddle, Marshall, & Cameron, 2008). Physical inactivity is a leading cause of juvenile obesity (Leech, McNaughton, & Timperio, 2014) as well as in increasing public health costs across all age groups (An, Xiang, Yang, & Yan, 2016; Kohl et al., 2012; World Health Organization, 2010). Reduced physical activity among adolescence not only troubling the implications related to health but also their academic performance (Stevens et al., 2008) and mental health (Ahn & Fedewa, 2011). The risk for adult inactivity was significantly lower for those who were physically active in adolescence (Huotari,

Nupponen, Mikkelsson, Laakso, & Kujala, 2011).

Physical fitness is an important factor that influences daily routine activities and sportive productivity of an individual (Erİkođlu, Güzel, & Pense, 2015; Houwen, Visscher, Hartman, & Lemmink, 2006). Physical fitness refers to the full range of physical qualities, i.e. muscular strength, flexibility, coordination, speed, agility and cardiorespiratory fitness (Ruiz et al., 2006). Physical fitness assessments for each child help to get information about their physical status (Erİkođlu et al., 2015). Development of a positive attitude towards their bodies and physical fitness may help children to improve positive re-appraisal and thereby several psychological constructs. EUROFIT (European Test of Physical Fitness) battery is helpful tool to measure and evaluate the physical fitness of school age children and to motivate them to enjoy taking regular exercise and promote the importance of children's sport and fitness (Council of Europe. Committee for the Development of Sport.; Committee of Experts on Sports Research., 1988).

Effective intervention programs, along with nutritional education are found effectively helpful in promoting physical fitness in children and adolescents (Poitras et al., 2016). Physical fitness can be achieved through right nourishment, exercise and rest (de Groot &

Fagerström, 2011; Malina, 2010). Physical fitness is closely associated with health and skills. It is also very closely linked to mind state or mental health (Lang et al., 2018; University of Tsukuba, 2015). Corroborating this concept, review studies recommend multi-component intervention programs for improving physical fitness among children and adolescents (Camacho-Minano, LaVoi, & Barr-Anderson, 2011) (Kriemler et al., 2011).

Any physical activity could be considered an exercise, usually when one does it deliberately for fitness or training, rather than something that's part of daily routine. Similarly any physical activity or an exercise is considered as yoga when the body, breath and mind are synchronized with it in a harmonious way.

Yoga, which is a holistic multi-component program that includes asana, pranayama, yogic diet and relaxation, is considered as an effective intervention that provides perfect combination of activities for promoting physical fitness. Review studies suggest that yoga is generally effective in improving physical and mental health in children and adolescents (Birdee et al., 2009) (Greenberg & Harris, 2012) (J. Davidson et al., 2012). Yoga promotes psychological fitness in adolescents (Choukse, Ram, & Nagendra, 2018), cardiopulmonary fitness (Bhutkar, Bhutkar, Taware, & Surdi, 2011) (Chen, Mao, Lai, Li, & Kuo, 2009) and weight

loss in obese children (Benavides & Caballero, 2009). Yoga is found effective in improving posture among children with physical malformations (Savić, Pfau, Skorić, Pfau, & Spasojević, 1990) and many behavioral issues (Harrison, Manocha, & Rubia, 2004). Yoga is beneficial for improving the fitness among children with visual impairment (Telles & Srinivas, 1998) and to increase their exercise capacity (Jain et al., 1991). Yoga as a therapy is effective in alleviating many disease conditions in adolescents and children (Kuttner et al., 2006), (Kaley-Isley, Peterson, Fischer, & Peterson, 2010). Studies on yoga and adolescents are generally conducted in school setting, with yoga as part of curriculum, or before / after school hours on homogeneous sample.

An important research question in this field relates to whether yoga offers any positive effects on physical fitness of children in a different setting other than school. Thus, the present study was done to explore the efficacy of short term integrated residential yoga intervention on physical fitness of adolescents. This study is part of bigger study done on overall fitness of adolescents registered in the Clinical Trials Registry of India bearing the trail number CTRI/2018/02/011709.

## **METHODS AND MATERIALS**

The aim of this study was to examine the effects of an integrated yoga intervention on physical fitness

parameters in adolescents, and across different age groups within adolescence.

### **Experimental Design**

This pre-post residential yoga interventional study was done during the summer holidays at the campus of Yoga University, Bengaluru, India. Three independent cohorts of adolescents underwent similar yoga intervention program with same guidelines. The consecutive studies were conducted in the month of April between 1<sup>st</sup> and 10<sup>th</sup> (batch 1), 11<sup>th</sup> and 20<sup>th</sup> (batch 2) and 21<sup>st</sup> and 30<sup>th</sup> of April (batch 3) in the year 2016. The duration of the intervention was 7 days with 8 hours of yoga based sessions per day. All the components were similar and consistent as far as possible like living conditions, teachers, daily routine and dietary plan.

### **Participants**

The sample of the study comprised of healthy adolescents, between the age of 9 and 16 years, studying in English Medium schools, who registered for the yoga camp. The participants were divided into three batches as per the registration and selected time slot. And they were grouped into juniors (9-12years) and seniors (13-16years) to evaluate changes, as the age range 9-16 is wide considering the rapid changes during adolescents. Sample were 145 (91 juniors and 54 seniors), 166 (90 juniors and 76 seniors) and 194 (111 juniors and 83 seniors) in batch 1, 2 and 3 respectively.

For easier implementation of the intervention, participants were further randomly divided into smaller groups of 12-15. Each smaller group was under supervision of two teachers for better monitoring. Teachers were trained on the implementation of the intervention to ensure uniformity and all of them possessed bachelor degree in yoga.

Sample was heterogeneous in nature, with subjects from different socio-economic strata, cultures, ethnicity and different academic status, as the study was conducted in a residential yoga camp. Subjects with single parents, acute or chronic health problems, on medication, those who attended any yoga program in the last three months were excluded.

Ethical approval was obtained from the Institutional Ethical Committee with reference number RES/IEC-SVYASA/64/2015. After explaining the study, written informed consent from parents, and informed assent from all participants, were obtained prior to screening.

### **INTERVENTION**

The intervention was a 7-day residential yoga program, with sessions running from 5.00 am till 9.30 pm each day, based on multilevel approach of yoga. The contents of this holistic integrated yoga intervention program were based on concept of Pancha kosha model (five layers of existence) as explained in Taitairya Upanishad. The specially designed and modified version

of Integrated Yoga Module had multiple components of yoga to ensure its effectiveness at all the five koshas (Gross body – Annamaya Kosha, Energy body – Pranamaya Kosha, Emotional Body – Manomaya Kosha, Intellectual Body – Vijnanamaya Kosha and Bliss body – Anandamaya Kosha). The yoga module was customized to the target age group, interactive and children friendly, referring to various yogic texts on yoga for children. Further the module was reviewed by yoga experts. The yoga module included Asana, Pranayama, Relaxation, Meditation and also Jnana Yoga (Yama Niyama Concepts) and Bhakti Yoga. The yogic techniques

/activities were designed to inculcate/drive the Yama-Niyama concepts. Jnana yoga sessions included lectures, creativity - like role-playing, parables, journal/diary writing etc., while bhakti yoga sessions included chanting and singing. Yogic games (Krida yoga) were played in free time. Several friendly competitions and events were arranged during the study between groups to encourage the participation and team cohesiveness. They were spread over the day with mixing of events to make the program interesting. Daily schedule is given in table 1. Details of asana and pranayama practice sessions are provided in table 2.

**TABLE-I  
DAILY SCHEDULE OF INTEGRATED YOGA INTERVENTION**

Time	Session	Details
5am		Wake Up
5:30am to 5:45am	Session 1	Morning Prayer
5:45am to 6:45am	Session 2	Asana practice (Physical postures)
6:45am to 7:30am	Session 3	Meditation ( Om meditation, Cyclic meditation )
7:30am to 8:15am		Breakfast
8:15am to 9.00am	Session 4	Social works (altruistic group activities)
9.00am to 10:00 am		Bath & Wash
10:00am to 11:00am	Session 5	Lectures on concepts of Yoga ( Yama Niyama concepts)
11:00am to 12:00pm	Session 6	Pranayama practice
12:00pm to 1:00pm		Lunch
1:00pm to 2:00pm	Session 7	Relaxation (IRT,QRT, DRT)
2:00pm to 3:30pm	Session 8	Indoor activities (parables, creativity, chanting)
3:30pm to 4:30pm	Session 9	Asana practice
4:30pm to 5.00pm		Evening Tea, Snacks
5.00pm to 6:15pm		Free time

6:15pm to 7:15pm		Dinner
7:15pm to 8:30pm	Session 10	Happy assembly (Cultural programs)
8:30pm to 9.00pm	Session 11	Tranquilling Pranayama and Meditation
9.00pm to 9.15pm		Milk, Snacks
9.15pm to 9:30pm	Session 12	Diary Writing
9:30pm		Good Night Sleep

**TABLE-II**  
**CONTENT OF ASANA AND PRANAYAMA SESSIONS**

<b>Component</b>	<b>Content details</b>	
Prayer	Opening and closing prayer (Taitairya Upanishad 2.1 Shanti Mantra)	
Warm up and loosening practices	Warm up	Jogging, jumping, forward & backward bending, Side bends, Twisting
	Anga-sanchalana	Loosening for toes, ankle, knee, hips, fingers, wrist, elbow and neck
	Stretching with breathing	Hands stretch, Ankle stretch, Back stretch, Tiger stretch, Lumber stretch
	Shakti-chalana	Cycling, Rowing, Rocking and rolling
Asana	Standing postures	Half wheel posture ( <i>Ardhacakrasana</i> )
		Foot palm posture ( <i>Padahastasana</i> )
		Half waist rotation posture ( <i>Ardhaticakrasana</i> )
		Triangle posture ( <i>Trikonasana</i> )
		Tree posture ( <i>Vrkshasana</i> )
	Sitting postures	Bolt posture ( <i>Vajrasana</i> )
	Rabbit posture ( <i>Shashankasana</i> )	

		Spinal twist posture ( <i>Vakrasana / Ardhamatsyendrasana</i> )
		Camel posture ( <i>Ustrasana</i> )
		Posterior stretch ( <i>Paschimottanasana</i> )
	Prone postures	Cobra posture ( <i>Bhujangasana</i> )
		Grasshopper posture ( <i>Salabhasana</i> )
		Bow posture ( <i>Dhanurasana</i> )
	Inverted postures	Shoulder stand ( <i>Sarvangasana</i> )
		Plough posture ( <i>Halasana</i> )
		Variation of head stand ( <i>Viparitamakarni</i> )
	Supine postures	Boat posture ( <i>Naukasana</i> )
		Fish posture ( <i>Matsyasana</i> )
Surya Namaskara	Each round of 12 Steps	1 <sup>st</sup> round with mantra, rest 11 rounds without mantra
Breathing practices	Conscious breathing	Awareness of natural breathing pattern
	Sectional breathing	Separately Abdominal, Thoracic and Clavicular breathing
	full yogic breathing	Combination of Abdominal, Thoracic and Clavicular breathing
Kriya	Kapalbhati	Alternate and both nostril (Active exhalation)
Pranayama	Dynamic pranayama	Bhastrika (Breathing with rapid inhalation & exhalation)
	Balancing pranayama	Anulom-vilom (Slow & rhythmic alternate nostril breathing)
	Cooling pranayama	Shitli (Inhalation through mouth- beak of the tongue)

Tranquilising pranayama	Bhramari (Exhalation, with a honey bee sound)
Mudra	Jnana mudra
Relaxation	IRT (Instant Relaxation Technique), QRT (Quick Relaxation Technique), DRT (Deep Relaxation Technique)

## ASSESSMENTS

The assessments for measuring physical fitness were done using Eurofit physical fitness testing battery. This battery of tests, designed by the European Council (Council of Europe. Committee for the Development of Sport.; Committee of Experts on Sports Research., 1988), is a standardized set of tasks evaluating physical speed, strength, flexibility, balance, and agility. Reliability of Eurofit physical fitness parameters for adolescent males ranged from 0.84 to 0.94 (Donncha, Watson, McSweeney, & O'Donovan, 1999). Participants were instructed and familiarized with each of the tests prior to administration. The procedure for selected tests were detailed below.

**Anthropometry:** Height and weight was measured using standard measuring device. Body mass index (BMI) was calculated by using formula  $BMI = \frac{\text{Weight in kg}}{(\text{height in m})^2}$ .

**Plate-Taping Test (PLT):** On the table two discs were placed 60 cm apart with a rectangle in the centre. Keeping the non-preferred hand on the rectangle,

participants moved the preferred hand back and forth between the discs as quickly as possible. The time taken to complete 25 cycles ((50 taps) is recorded using a stopwatch. The process was done twice and best result was recorded.

**Sit-and-Reach Test (SAR):** Trunk flexibility was measured with participant seated on the floor with legs extended to front with knee locked. The soles of the feet were placed flat against the sit and reach box. Participants were asked to reach forward along the measuring line as far as possible by keeping hands side by side with palms facing downwards. After some practice reaches, the maximum distance was recorded to the nearest centimeter.

**Standing Broad Jump (SBJ):** The starting line was marked on a sturdy mat. The participants were told to stand behind the starting line, to jump forward by swinging arms and slightly bending their knees and land on both feet. The distance from the starting line to the back of their heels was measured. This process was done three times and the best attempt was recorded.

**Sit-Ups Test (SUP):** This test was done by lying down in supine position with bent knees at right angle, feet on the floor kept hold down by trainer and hand crossed over chest with palms on opposite shoulders. Lifting upper body to a vertical position and then returned to the supine position was counted as one sit-up. Number of sit-ups in 30 seconds was recorded.

**10x5m Shuttle run (10x5mR):** Two lines were made 10 meters apart and the participants were told to stand behind the starting line with preferred leg forward. At the whistle participant started running to the other line, crossed it and then ran back to the starting line. Time taken to complete five round-trips at maximum speed between the two lines was recorded in seconds.

**Socio-demography measures:** A short demographic questionnaire and screening sheets were completed by adolescents and parents. Variables included are gender, age, handedness, sibling hierarchy, family background, mother's age, father's age etc.

Data collection was done on the first day (pre-data) and on the ninth day (post-data) of the 10 day camp. Small station set up was done for each performance test by investigators. Three trained researchers were available on each station for data collection. Out of three, one was supervising the test process, one with measuring instrument and third was recording the result and signing the sheets

for confirmation of test completion. Each participant was provided with individual excel sheet table with all details. When the participant came to station, he/she handed over the sheet to the researcher (who filled the result column). As the subject finished each test, his/her sheet was signed off and moved on to the next station. After finishing all tests, participant handed over the sheet to one senior researcher, who checked the sheet and signed it and put it in the collection box. Calibrated stop watches, standard measuring and test materials were used to conduct the tests and record the data.

#### **DATA ANALYSIS**

To maintain confidentiality, data sheets were coded and all personal identifiers along with name were omitted. Data analysis was done with SPSS (Version 19). Paired samples t-test was used to evaluate change over time. The results of the tests were deemed to be significant if probability values were less than 0.05 whereas trends ( $p < 0.1$ ) were also highlighted.

#### **RESULTS**

The three cohorts comprised of 145 (41.38% girls) (62.76% Juniors), 166 (27.11% girls) (59.64% Juniors) and 194 (38.14% girls) (57.22% Juniors), with a mean age of  $11.84 \pm 1.77$ ,  $12.22 \pm 1.82$  and  $12.06 \pm 1.82$  respectively. All individual cohorts were evaluated for the effects of a 7-day holistic integrated yoga intervention program on weight and BMI

(Anthropometry), speed of limb movement (PLT), explosive leg power (SBJ), trunk strength and endurance (SUP), running speed and agility

(10x5mR) and flexibility (SAR) using European Test of Physical Fitness (EUROFIT) battery by a single arm pre-post study.

**TABLE-III**  
**COMPARISON OF PRE-POST DATA OF THREE COHORTS**

Measures	Batch 1 (n=145)			Batch 2 (n=166)			Batch 3 (n=194)		
	Pre Mean (±SD)	Post Mean (±SD)	p value	Pre Mean (±SD)	Post Mean (±SD)	p value	Pre Mean (±SD)	Post Mean (±SD)	p value
Weight (kg)	43.42 ±13.20	42.32 ±13.15	< 0.001*	41.33 ±12.24	40.47 ±12.08	< 0.001*	44.04 ±12.38	42.75 ±12.41	< 0.001*
BMI (kg/m <sup>2</sup> )	19.34 ±3.80	18.84 ±3.80	< 0.001*	18.24 ±3.95	17.85 ±3.86	< 0.001*	19.28 ±4.98	18.68 ±4.93	< 0.001*
10x5mR (sec)	15.81 ±1.63	15.79 ±1.73	0.888	15.91 ±1.69	15.82 ±1.66	0.301	16.27 ±1.59	16.11 ±1.77	0.020*
SBJ (cm)	126.44 ±27.87	131.35 ±27.36	0.001*	128.34 ±25.82	136.71 ±25.44	< 0.001*	131.48 ±24.35	133.70 ±26.96	0.061
PLT (sec)	11.85 ±1.44	10.81 ±2.22	< 0.001*	12.01 ±2.07	12.95 ±2.55	< 0.001*	13.09 ±2.00	12.32 ±1.81	< 0.001*
SUP (freq./30s)	13.87 ±6.44	14.90 ±6.23	0.003*	15.93 ±6.35	17.33 ±6.37	< 0.001*	15.13 ±5.76	17.98 ±6.45	< 0.001*

SAR	31.78	33.22	<	31.11	32.45	<	31.12	31.69	0.069
(cm)	±6.31	±7.29	0.001*	±6.21	±6.21	0.001*	±7.21	±7.06	

BMI (Body mass index); 10x5mR (Shuttle run); SBJ (Standing board jump); PLT (Plate tapping); SUP (Sit-ups); SAR (Sit and reach); SD (Standard deviation); \*indicates p < 0.05.

As seen in Table 3, comparing pre and post data for each of the cohorts, there was significant (p < 0.001) decrease in scores of weight and BMI in all the three cohorts. Time taken in 10x5mR has not shown significant change in batch 1 and batch 2 but significant change is seen in batch 3 (p = 0.020). Scores of SBJ in batch 1 (p = 0.001) and batch 2 (p < 0.001) increased significantly and positive trend is observed in batch 3 (p = 0.061). Time taken for PLT was significantly decreased in batch 1 (p < 0.001) and batch 3 (p < 0.001), but significant increase is observed in batch 2. SUP scores were significantly increased in batch 1 (p = 0.003), batch 2 (p < 0.001) and batch 3 (p < 0.001). Scores of SAR in batch 1 (p < 0.001) and batch 2 (p < 0.001) increased significantly and positive trend is observed in batch 3 (p = 0.069).

**TABLE-IV**  
**COMPARISON OF PRE-POST DATA OF THREE COHORTS OF JUNIORS**

Measure	Batch 1 (n=91)			Batch 2 (n=90)			Batch 3 (n=111)		
	Pre Mean (±SD)	Post Mean (±SD)	p value	Pre Mean (±SD)	Post Mean (±SD)	p value	Pre Mean (±SD)	Post Mean (±SD)	p value
Weight (kg)	37.26 ±10.28	36.01 ±10.04	< 0.001*	36.03 ±10.72	35.03 ±10.31	< 0.001*	38.27 ±9.99	36.74 ±9.98	< 0.001*
BMI (kg/m <sup>2</sup> )	18.32 ±3.55	17.70 ±3.52	< 0.001*	17.62 ±4.14	17.14 ±3.98	< 0.001*	18.35 ±3.58	17.59 ±3.58	< 0.001*
10x5mR (sec)	16.12 ±1.61	15.99 ±1.68	0.438	16.75 ±1.31	16.38 ±1.42	0.001*	16.57 ±1.52	16.60 ±1.70	0.752

SBJ (cm)	121.5 7 ±26.5 2	126.5 4 ±26.0 5	0.012*	119.6 9 ±23.1 3	127.9 7 ±20.0 8	< 0.001*	129.8 5 ±21.3 4	128.5 0 ±21.8 6	0.272
PLT (sec)	11.86 ±1.15	11.39 ±2.30	0.026*	12.21 ±2.42	14.72 ±2.02	< 0.001*	13.47 ±2.06	13.04 ±1.56	0.018*
SUP (freq./30 s)	13.11 ±6.67	14.30 ±6.18	0.011*	13.76 ±6.55	15.20 ±6.67	0.001*	14.27 ±5.91	15.52 ±6.64	0.001*
SAR (cm)	32.18 ±5.50	34.52 ±6.63	< 0.001*	30.97 ±5.60	32.11 ±5.48	< 0.001*	30.62 ±6.41	31.25 ±6.40	0.121

BMI (Body mass index); 10x5mR (Shuttle run); SBJ (Standing board jump); PLT (Plate tapping); SUP (Sit-ups); SAR (Sit and reach); SD (Standard deviation); \*indicates  $p < 0.05$ .

Analysis of the junior subgroup, as presented in Table 4, showed significant decrease in scores of Weight ( $p < 0.001$ ) and BMI ( $p < 0.001$ ) in all three cohorts. Time taken in 10x5mR has not shown significant change in batch 1 and batch 3 but significant decrease is seen in batch 2. Scores of SBJ in batch 1 ( $p = 0.012$ ) and batch 2 ( $p < 0.001$ ) increased significantly and slight decrease is observed in batch 3 but non-significant ( $p = 0.272$ ). Time

taken for PLT is significantly decreased in batch 1 ( $p = 0.026$ ) and batch 3 ( $p = 0.018$ ) respectively, but significant increase is observed in batch 2. SUP scores were significantly increased ( $p = 0.011$ ), ( $p = 0.001$ ) and ( $p = 0.001$ ) in batch 1, 2 and 3 respectively. Scores of SAR in batch 1 and batch 2 increased significantly ( $p < 0.001$ ) and no significant change was seen in batch 3 ( $p = 0.121$ ).

**TABLE-V**  
**COMPARISON OF PRE-POST DATA OF THREE COHORTS OF SENIORS**

Measure	Batch 1 (n=54)			Batch 2 (n=76)			Batch 2 (n=83)		
	Pre Mean (±SD)	Post Mean (±SD)	p value	Pre Mean (±SD)	Post Mean (±SD)	p value	Pre Mean (±SD)	Post Mean (±SD)	p value
Weight (kg)	53.81 ±10.9 1	52.96 ±10.7 1	< 0.001*	47.60 ±10.9 5	46.91 ±10.8 2	< 0.001*	51.77 ±11.0 3	50.80 ±10.6 9	< 0.001*
BMI (kg/m <sup>2</sup> )	21.10 ±3.58	20.78 ±3.49	< 0.001*	18.96 ±3.60	18.69 ±3.56	< 0.001*	20.52 ±6.20	20.13 ±6.03	< 0.001*
10x5mR (sec*)	15.23 ±1.53	15.42 ±1.78	0.262	14.94 ±1.57	15.17 ±1.69	0.067	15.88 ±1.60	15.47 ±1.66	< 0.001*
SBJ (cm)	135.0 ±28.3 8 5	139.8 ±27.8 5 1	0.015*	138.7 ±25.1 2 8	147.2 ±27.3 0 1	< 0.001*	133.6 ±27.8 6 5	140.6 ±31.3 6 6	0.001*
PLT (sec*)	11.83 ±1.84	9.80 ±1.65	< 0.001*	11.79 ±1.56	10.95 ±1.31	< 0.001*	12.59 ±1.81	11.37 ±1.68	< 0.001*
SUP (freq./30 s)	15.10 ±5.92	15.88 ±6.24	0.143	18.50 ±5.03	19.84 ±4.96	0.001*	16.28 ±5.39	21.28 ±4.41	< 0.001*
SAR (cm)	31.10 ±7.49	31.04 ±7.88	0.883	31.29 ±6.89	32.86 ±7.00	< 0.001*	31.78 ±8.15	32.29 ±7.85	0.319

BMI (Body mass index); 10x5mR (Shuttle run); SBJ (Standing board jump); PLT (Plate tapping); SUP (Sit-ups); SAR (Sit and reach); SD (Standard deviation); \*indicates p < 0.05.

Analysis of the senior subgroup, as presented in Table 5, showed significant decrease in scores of weight and BMI in all three cohorts. Time taken in 10x5mR was increased but not significant in batch 1 and batch 2 but significant decrease was seen in batch 3 ( $p < 0.001$ ). Scores of SBJ increased significantly with ( $p = 0.015$ ), ( $p < 0.001$ ) and ( $p = 0.001$ ) in batch 1, 2 and 3 respectively. Time taken for PLT is significantly decreased with  $p < 0.001$ ,  $p < 0.001$  and  $p < 0.001$  in batch 1, 2 and 3 respectively. SUP scores were significantly increased in batch 2 ( $p = 0.001$ ) and 3 ( $p < 0.001$ ) but not in batch 1 ( $p = 0.143$ ). Scores of SAR increased significantly ( $p < 0.001$ ) in batch 2 but not in batch 1 and 3.

## **DISCUSSION**

The current study has examined the effect of short term residential integrated yoga intervention on physical fitness among adolescents in residential setting in summer holidays. In present study, significant weight loss and decrease in BMI were observed which is in line with previous study done on adults with 6-day residential program (Telles, Visweswaraiyah, Balkrishna, & Kumar, 2009) and in contrast with another study where weight loss was not seen (Telles, Singh, Bhardwaj, Kumar, & Balkrishna, 2013), which may be due to variation in time duration and yoga intervention. As the present study was carried out in a residential setting, the weight loss across all batches could be attributed to the

holistic approach which included yogic practices, disciplined life style and balanced diet. Reduction in time taken in 10x5mR has shown improvement in agility and speed. Direction of positive change is similar in all three batches although significant in batch 3. Distance covered in SBJ has shown improvement in explosive leg strength which was significantly seen across the batches. This might be due to stretch and strengthening of the muscles by asana and Suryanamaskara practices. Reduction in time shows improvement in PLT which measures upper body reaction and coordination. The results of the batch 1 and 3 has shown significant positive change in alignment with the previous study (Telles, Sharma, Yadav, Singh, & Balkrishna, 2014). The increase in reaction and coordination could be attributed to improved concentration and attention due to calming down the mind by practicing bhakti yoga and jnana yoga. Significant increase in SUP across the batches has shown improvement in abdominal strength and muscular endurance which is aligned with earlier study in children (Telles et al., 2013). Significant increase in SAR across the batches has shown improvement in flexibility. Results aligned with the study done among children (Chen et al., 2009) and young adults (Bal B.S., 2009) following yoga. This improved flexibility might be due to different loosening practices and yoga postures included in this study. However, any physical

activity, mainly asana, pranayama etc. involve concentration, mindfulness, psychological steadfastness, a relaxed and calm mind. This could be achieved through Jnana yoga, Bhakti yoga and Karma yoga practices.

All three batches have shown significant changes in weight, BMI, SBJ, SUP and SAR. Junior group has shown significant changes in Weight, BMI, SUP and SAR across all three batches. PLT has shown negative change in juniors of batch 2 which could be contributed to the negative change in PLT results of batch 2. Senior group has shown similar significant changes in Weight, BMI, SBJ and PLT. Trend of change was in same direction and similar in all three batches. Time taken for 10x5mR did not change significantly overall. Long intervention may be required to improve agility and speed.

In present study, significant results across three independent cohorts corroborate the benefits of short term integrated yoga towards improvement in weight loss, flexibility, endurance and strength in adolescents in residential setting. The positive outcomes of the present study also corroborates the finding of earlier studies on yoga and physical fitness among children (Bal B.S., 2009; Benavides & Caballero, 2009; Bhavanani, Udupa, Madanmohan, & Ravindra, 2011; Bhutkar et al., 2011; Chen et al., 2009; D'souza & Avadhany, 2014; Donahoe-Fillmore, Brahler, Fisher, & Beasley, 2010). The findings suggested

that the integrated yoga module specially designed for yoga camp recognized as a tool to establish physical fitness in adolescents. Children found the program captivating and inspiring. Parents also acknowledged that the program was beneficial. The subjective feedback received from children at the end of the program showed that they benefited from a number of positive takeaways in terms of discipline, engaging in good physical activity etc.

This integrated approach to yoga acts on multiple layers of existence (pancha koshas) which comprises of asana, pranayama, meditation, relaxation and knowledge imparted via interactive discussions, lectures, activities, games and friendly competitions. The multi-component nature of yoga and intervening effect of each technique on various koshas, makes it complicated to precisely assign the particular effect to any parameter. Asana practice leads to expansion of mind and ceasing of dualities, according to sage Patanjali (Swami Satyananda Saraswati, 1976). Practice of pranayama, relaxation and meditation works on cellular activities and gives better clarity of thoughts. Jnana yoga sharpens the mind while Bhakti yoga calms down the mind. A healthy mind has impact and influence on physical fitness especially in speed, agility, endurance, perseverance etc. A prospective study recommended considering cognitive factors while developing exercise intervention

programs targeting physical fitness among adolescents (Lang et al., 2018). The school-based application of multicomponent intervention strategies was the most consistent promising intervention strategy for improving physical fitness among children and adolescence (Dobbins, Husson, DeCorby, & LaRocca, 2013).

Not having a control group has had limitations on the study. Having a control group was a practical challenge as this was a residential program and the sample was heterogeneous in nature. This limitation was addressed by having three independent cohorts where large and matched sample size were subjected to have same intervention to observe the repeatability and consistency of the effect, which helped to prove the effect of intervention. As there was no follow up, sustainability of the improvements was not known, which could have been considered for future studies. As uniformity has been maintained in the execution of the intervention, and in conducting the program across three independent cohorts, this acts as a replication of the study. Results from all

the three cohorts indicate consistent and similar trends, which confirm the positive effect of the integrated yoga module in adolescents.

## **CONCLUSION**

Successful repeatability with independent cohorts provide evidence for promoting residential short term yoga camps as a powerful tool to establish physical fitness among adolescents. The results of the study show that yoga is an effective tool to enhance physiological functioning in adolescents. Another aspect of the study exhibits that yoga is one of the sportive components which helps to improve fitness in a holistic way.

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