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Original Article

The impact of yoga on stress, metabolic parameters, and cognition of Indian adolescents: Cluster randomized controlled trial

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ABSTRACT

Background: This project aimed to assess the impact of yoga on stress, metabolic parameters and cognition (attention & concentration) in adolescents, aged 13–15 years from public and private schools in two cities (Chennai and New Delhi) in India.

Methods: The study recruited 2000 adolescents from 24 schools in a cluster randomized controlled trial design. The yoga group participants underwent 17 yoga sessions, which included: pranayama, basic asanas, meditation and relaxation exercises. Yoga sessions, were held in the school premises once a week. A total of five awareness talks on healthy lifestyle were delivered once a month to the education group. ADOlescence Stress Scale (ADOSS), salivary cortisol, metabolic and clinical parameters and Letter Cancellation Test (LCT) score were measured at baseline and post-intervention (5–6 months).

Results: The yoga group showed statistically significant differences in the mean ADOSS score, metabolic parameters, salivary cortisol, and LCT scores compared to the education group. In the intention- to- treat analysis, a significant reduction [5.11, 95% CI (4.78, 5.36), $p = 0.001$] in ADOSS score was seen in the yoga group compared to education.

Conclusion: Implementation of a 17-week standardized yoga program at the school level significantly decreased stress, improved attention and concentration, metabolic and clinical parameters in Indian adolescents.

Trial registration: Clinical Trials Registry, India (CTRI/2017/08/009203).

1. Introduction

Adolescence is one of the most critical periods of transition between childhood and young adulthood during which young people experience physiological, cognitive and social changes.[1] Difficulty in adjusting and coping with these direct and indirect changes leads to stress that affects psychological and physiological wellbeing of adolescents.[2] Globally, it is estimated that 1 in 7 (14%) of 10–19-year-olds experience some mental health conditions.[3] Earlier studies report that the prevalence of stress among Indian adolescents varied between 13% and 45%.[4]

Yoga is an ancient discipline which originated from India and is designed to bring balance and health to the physical, mental, emotional, and spiritual dimensions of an individual.[5] As yoga include practices that are specifically focused on calming the nervous system, it is ideally suited to prevent or alleviate psychological stress affecting (attention and concentration) and physiological stress (resulting in metabolic abnormalities) that are encountered during adolescence. It is thus hypothesized to bring about improvements in an adolescent's physical and mental health.[6] A NIH/CDC Complementary and Alternative Medicine (CAM) therapy survey revealed that 2.1% of participants under age of 18 practice yoga and that 4.8% of child/adolescent CAM users were specifically targeting anxiety and stress.[7]

A review by Khalsa and Butzer. ,[8] revealed that most school-based studies testing yoga as an intervention were carried out in small samples. They mostly used self-reported subjective measures, usually did not include control groups and only a handful employed randomized controlled trial designs. Some research studies suggest that providing yoga within the school curriculum may be an effective and feasible way

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to help youth develop stress management skills.[9] In a recent study of yoga in adolescents with obesity, there was an average of 2-kg weight loss.[10] after the yoga.

Targeting novel methods to improve metabolic parameters and cognitive levels in adolescents and youth is an urgent need. This study aimed to assess the impact of yoga on stress, metabolic parameters and cognition (attention & concentration) in adolescents aged 13–15 years from public and private schools in two cities in India.

2. Methods

2.1. Study type & design

This prospective study was a cluster randomized controlled trial (cRCT). Participants in grades VIII-X (age group of 13–15 years) from public and private schools across two cities (Chennai and New Delhi (NCR) were enrolled into the study in the year 2018–2019 (Supplementary Table 1).

2.1.1. Protocol registration

The protocol was registered with the Clinical Trials Registry, India after which the first participant was enrolled (CTRI/2017/08/009203)[11]

2.1.2. Ethical statement

The study was approved by Madras Diabetes Research Foundation Institutional Ethics Committee (IEC) (Ref No: ECR/194/Inst/TN/2013), All India Institute of Medical Sciences Institutional Ethics Committee (Ref. No. IEC-424//04.08.2017, RP-08/2017) and Center for Chronic Disease Control Independent Ethics Committee (CCDC_IEC_06_2018). Written informed consent and assent were obtained from parents and participants respectively.

2.2. Randomization, masking and participant selection

The study teams at both sites, Chennai and Delhi approached their respective state government education offices and requested formal approval to conduct this study across public and private schools in each city. Next, the study team randomly approached schools from different parts of the city and explained the study protocol. Schools were selected only after they provided a letter from the head of the school confirming their participation. In each city this process was followed until 12 schools were reached (6 public and 6 private). Study coordinators at each site, namely, Chennai and Delhi sent the list of consented schools to the data manager in Chennai who created sequence random numbers of the schools in either city. Thus, the school names were blinded before being sent to the project coordinator who then randomized the schools into yoga or education group using an online randomization grid. Each site study coordinator then received the allocation details in a sealed envelope. After baseline testing, the envelope was opened and schools were informed about their group allocation.

The school (and all participants of the selected grade in that school) was cluster randomized into the yoga or education group to avoid any cross contamination. To maintain uniformity across cities and also in the type of schools getting randomized, we assigned the yoga to three private schools and three public schools spread across Chennai and Delhi. The rest of the schools were in the education group.

A total of 2000 students were selected (1000 each in Chennai and New Delhi, Supplementary Fig. 1). In each city, six private and six public schools were randomly selected. In each school one grade from VIII to X (age group of 13–15 years), including all its sections and comprising of a total of 60–130 students (average 70–80), was randomly selected by the research team and adolescents who underwent recent surgery, had a serious illness, or were irregular at school were excluded from the study due to safety and monitoring issues.

2.3. Sample size calculation

Postulating that our yoga can help achieve a 5% difference in ADOSS score between the yoga and education groups (primary objective), the trial needed 979 adolescents in each group to achieve the primary objective with 80% power after accounting for 25% loss to follow up. This led to a total sample size of 1957 participants which was rounded off to 2000. A design effect of 1.5 was included in the sample size calculation to account for the clustering effect. Once the participants were recruited, the Intracluster Correlation Coefficient (ICC) was calculated to check for clustering effect. We found an ICC of less than 0.4 post-recruitment. Hence, sample size was deemed sufficient to achieve the primary objective.

2.4. Yoga

In the yoga schools, the yoga-based intervention emphasized the four key elements of yoga: 1) Pranayama or deep breathing exercises (~10 mins); 2) basic yoga postures (asanas) thought to alleviate stress, such as back bends, standing poses, and inversions (~15 mins); 3) Dhyana or meditation (~5 mins) and 4) relaxation exercises (~5 mins) aimed at relaxing the mind and improve attention and concentration. The program also incorporated theme-based discussions at the beginning and end of each session with the intention of engaging the participants in learning, through self-inquiry in a reflective environment (~10 mins). Yoga sessions were held once a week for 4 months and the final refresher session was held in the 5th month (total 17 sessions) in the school premises for around 45 min (one period/class) and taught by a trained yoga teacher. As part of the intervention delivery, yoga teachers /PT teachers and class leaders/monitors from each of the yoga schools were invited to a one-day training workshop that was held at Madras Diabetes Research Foundation (MDRF), Chennai and All India Institute of Medical Sciences (AIIMS), Delhi, respectively, on different days. They were trained by the respective research teams on the yoga modules. During intervention delivery, the class leader's and yoga /PT teachers helped in the demonstration of yoga postures along with the yoga teacher. They also helped to correct the student's postures during practice sessions. The student leaders helped build peer support. The idea of involving the school teachers and peers as part of intervention delivery was to ensure long term sustainability of the yoga program in the schools.

In the education schools, a healthy lifestyle lecture was delivered once in a month for 5 months, in which the participants, actively participated and cleared their doubts. The program was a 45-minute session on healthy living (which included 10 min on healthy eating, 10 min on increasing physical activity, 10 min on sleep, stress, & good habits, 5 min of simple stretching exercises and the remaining time for questions and answers).

2.5. Outcome measures

2.5.1. Primary outcome

2.5.1.1. ADOSS. The ADOlescence Stress Scale (ADOSS) is a 20 items self-reported scale which has been validated in adolescents aged 10 to 17 years. The ADOSS asked respondents about their thoughts and feelings over the last two weeks. ADOSS has been validated against salivary cortisol with higher score indicating more stress.[12] Hence, ADOSS was used for the subjective assessment of stress in the present study.

2.5.2. Secondary outcomes

2.5.2.1. Metabolic parameters. Anthropometric measurements including height, weight, body fat, and waist circumference were obtained using standardised techniques in all adolescents. Height was measured (SECA Model 213, SecaGmbh Co, Hamburg, Germany) to the nearest centimeter (cm) using a stadiometer with the children standing erect without shoes. Weight was measured using a portable weighing scale

(Tanita BC-601). Body fat percent was measured by bioimpedance technique using a standardized body fat analyzer (Tanita). Body mass index (BMI) was calculated as the weight in kilograms divided by height in meters squared (Standard formula). Waist circumference was calculated as the mean of two measures of the shortest horizontal girth between the costal margins and the iliac crests at moderate breathing using a non-stretchable tape. Blood pressure was measured in the sitting posture in the right arm to the nearest 1 mm Hg using an automated OMRON system (Omron Corporation, Tokyo, Japan). Two measurements were taken five minutes apart, and the mean of the two was used to calculate blood pressure. All the parameters were measured at baseline and post intervention.

2.5.2.2. Salivary cortisol. Salivary cortisol levels were assessed as an objective indicator of stress. After the completion of baseline screening camp in the study schools, participants were recruited for salivary cortisol test. Among the selected classes, participant recruitment for cortisol collection was calculated based on the total number of participants in the particular section and an equal ratio of both sexes was ensured. Saliva samples were collected one-hour after breakfast and before the mid-morning break. Research staff and lab technicians ensured that the participants did not have any food items between breakfast and the mid-morning break. All instructions were given to the selected participants in advance. Participants were made to gargle water 10–15 min before collecting the saliva to increase the saliva flow and they were also advised to chew a cotton roll (salivette) gently for a minute to collect 0.5–1.0 ml sample. The design included taking salivary cortisol samples for 600 participants (300/site) and (300 in each arm). At the end of the study, we had the pre and post salivary cortisol samples of only 561 participants. The cortisol levels were estimated by the Electro Chemiluminescence Immunoassay (ECLIA) method.[13]

2.5.2.3. Psychometric test (specific to measure attention & concentration). A validated psychometric cognitive test called the Letter Cancellation Test (LCT) was used to assess the attention & concentration of the adolescents. The scoring scale was straight forward as no Likert scale was used. Higher scores indicated better attention and concentration.

2.5.2.4. Data management and monitoring. All questionnaires were administered by pen and paper. Password-protected interview data was encrypted and transferred in real time using cloud computing resources. The coordinating center (MDRF) managed electronic data on-site and backed it up remotely. Compact discs containing backed-up data is being kept locked in storage for a duration of 10 years after study completion.

2.6. Statistical analysis

Data analysis was done using the Statistical Package for Social Sciences (SPSS Inc, release 17.0, Chicago, IL). A p-value of <0.05 was considered statistically significant. Missing data was quality checked in the following manner; a) At data collection level: Data that was missing due to equipment error or abnormal values was collected the next day, this missing data error was at <0.5%; b) At participant level: Absentees from post intervention screening camps were followed up, and data was collected on another day (<0.3%); c) At data entry level: A double data entry quality check was done for every randomly selected 10th form. The data manager checked the backend data at regular intervals, and if any data was missing in entry, he would check the questionnaire and update the data in the entry tool (<0.4%); d) During data analysis, data with higher standard deviation from the baseline were highlighted and again cross- checked with the raw data and updated (0.2%). For the primary and secondary outcomes missing data due to lost to follow up ($n = 193$) was imputed by regression-based Multiple Imputation Generalized Estimating Equations (MI-GEE) method.

Intention-to-treat (ITT) analysis was attempted for the all outcomes. Study population characteristics such as their demographic profile, risk factors, exposures, and outcome measures were analysed and presented using Chi-square, ANOVA and t-tests. A paired *t*-test was applied to determine the pre and post changes in anthropometric, clinical and biochemical variables. A Variance Inflation Factor (VIF) was used to diagnose the co-linearity among the variables: 1= no correlation, 1–5= moderate correlation, and greater than 5= high correlation. A linear regression analysis was used to explore the associations between risk factors and outcome measures. As a final step, variables that were significantly different between the two groups at baseline (age, weight, BMI, waist circumference and diastolic BP) were adjusted for in the multivariable models.

3. Results

3.1. Breakdown of the study participants

The data collected from 2000 participants who enrolled in the study at both sites were analyzed (Supplementary Table 2). A similar percentage of participant's were recruited from both study sites, study groups, school type and standard. The study had a 9.6% ($n = 193$) dropout rate, and the main reasons were transfer of students to another school after baseline testing, a low response rate in 10th grade, and also some religious restrictions (e.g., not allowed to chant OM) (Fig. 1).

3.2. Baseline characteristics

Those in the yoga group were significantly younger and had lower body weight, BMI, and waist circumference but high diastolic BP as compared to the education group. In contrast, the mean ADOSS score, body fat, systolic BP, salivary cortisol, LCT scores were not significantly different between groups (Supplementary Table 3).

3.3. Effect of yoga on the primary outcome (ADOSS scores)

The Intention- to treat (ITT) analysis showed that there was a significant decrease in ADOSS scores [5.11, 95% CI (4.78, 5.36)] in the yoga group as compared to education. The results remained the same when analyzed by site, school type, standard and sex (Table 1). On additional analysis, reduction in ADOSS score by ≥5% was observed in 61.5% ($n = 613$) participants in the yoga group compared to 18.4% ($n = 185$) in the education group.

3.4. Effect of yoga on secondary outcomes

Table 1 shows that there was a significant reduction in body weight, fat, waist circumference, BMI, systolic and diastolic blood pressures, and salivary cortisol in the yoga group participants while these parameters increased in the education group. The results of the yoga showed the impressive results in mean LCT scores with a statistically significant ($p<0.05$) increase in the yoga group (18%) as compared to the education (7%) group. All these changes persisted when analyzed by sex, school type and site (Supplementary Tables 4–6).

3.5. Regression analysis on primary outcome

ADOSS score was further adjusted for the confounding variables (as shown in models) in Table 2. Co-linearity analysis showed that VIF for age, bodyweight, BMI, waist circumference and diastolic BP was 1.22, 7.72, 6.37, 4.31 and 1.35 respectively. This indicated that body weight and BMI were highly correlated ($r = 0.72$). Co-linearity diagnosis performed without BMI showed the VIF for age, body weight, waist circumference and diastolic BP were 1.12, 3.54, 4.19 and 1.35 respectively. Thus, based on the VIF value it was decided to exclude BMI from the regression models. All adjusted models showed that the yoga had a significant effect on primary outcome ($p<0.05$).

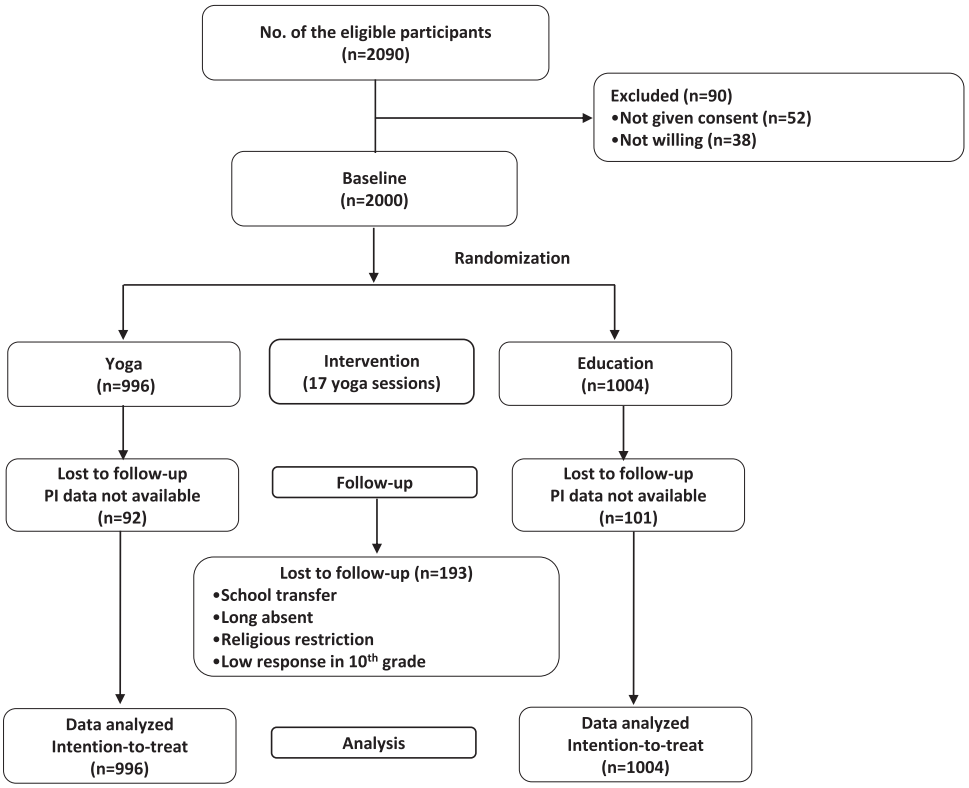

Fig. 1. Consort flowchart.

Table 1
Impact of yoga and education on primary and secondary outcomes.

	Yoga (n = 996)			Education (n = 1004)			D education - Dyoga (95% CI)
	Baseline	Post	Dyoga	Baseline	Post	D education	
Primary outcomes (ADOSS score)							
Overall	16.6 ± 8.9	13.4 ± 7.4	−3.2 ± 0.1†	16.5 ± 9.9	18.4 ± 11.8	1.9 ± 0.1†	5.11 (4.78, 5.36) ‡
Site							
Chennai	18.0 ± 9.6	13.9 ± 7.4	−4.1 ± 0.5†	15.5 ± 10.1	16.5 ± 10.8	1.0 ± 0.1†	5.02 (4.63, 5.48) ‡
Delhi	15.1 ± 7.8	12.8 ± 7.6	−2.3 ± 0.4†	17.6 ± 9.6	20.4 ± 11.4	2.8 ± 0.1†	5.06 (4.71, 5.48) ‡
Type							
Public	16.9 ± 8.9	13.2 ± 7.5	−3.7 ± 0.1†	17.0 ± 9.6	19.5 ± 11.2	2.5 ± 0.2†	6.14 (5.76, 6.59) ‡
Private	16.3 ± 8.8	13.5 ± 7.5	−2.8 ± 0.1†	16.1 ± 10.1	17.4 ± 12.2	1.3 ± 0.1†	3.94(3.57, 4.36) ‡
Standard							
8th	16.5 ± 8.7	13.9 ± 8.0	−2.6 ± 0.5†	16.1 ± 9.3	16.6 ± 10.7	0.5 ± 0.1†	2.98 (2.53, 3.49) ‡
9th	17.3 ± 9.9	13.1 ± 7.3	−4.2 ± 0.3†	16.2 ± 9.4	19.1 ± 12.5	2.9 ± 0.2†	7.07 (6.54, 7.65) ‡
10th	16.1 ± 8.1	13.0 ± 6.7	−3.1 ± 0.3†	17.4 ± 10.9	19.3 ± 11.5	1.9 ± 0.2†	5.00 (4.57, 5.48) ‡
Sex							
Boys	16.6 ± 9.0	13.0 ± 7.3	−3.6 ± 0.5†	16.9 ± 10.5	19.0 ± 12.0	2.1 ± 0.1†	5.72 (5.35, 6.13) ‡
Girls	16.5 ± 8.7	13.9 ± 7.4	−2.6 ± 0.5†	16.0 ± 8.9	17.6 ± 11.3	1.6 ± 0.2†	4.20 (3.81, 4.66) ‡
Secondary outcomes							
Weight (kg)	46.2 ± 13.7	45.2 ± 12.6	−1.0 ± 0.03†	51.5 ± 12.5*	53.9 ± 13.4	2.4 ± 0.05†	3.39 (2.97, 3.81) ‡
Body fat (%)	21.3 ± 10.5	19.7 ± 9.0	−1.6 ± 0.06†	21.4 ± 9.3	22.8 ± 10.0	1.4 ± 0.05†	3.01 (2.47, 3.56) ‡
Waist circumference (cm)	66.1 ± 14.5	63.3 ± 12.2	−2.8 ± 0.08†	75.8 ± 12.0*	77.9 ± 13.3	2.1 ± 0.05†	4.85 (4.22, 5.48) ‡
BMI (kg/m^2)	18.7 ± 4.5	18.4 ± 4.2	−0.3 ± 0.01†	20.7 ± 4.1*	21.6 ± 4.4	0.9 ± 0.02†	1.31 (1.13, 1.49) ‡
Systolic (mmHg)	109±11	91±12	−18±2†	109±12	133±13	24±4†	41.7 (40.4, 42.9) ‡
Diastolic (mmHg)	78±10	69±12	−9 ± 2†	70±9*	83±12	13±4†	22.2 (20.9, 23.4) ‡
Salivary cortisol (ng/dL)	1.9 ± 0.1	1.2 ± 0.1	−0.7 ± 0.02†	2.1 ± 0.1	2.8 ± 0.2	0.7 ± 0.03†	0.4 (0.2, 0.7) ‡
LCT score (%)	96±34	114±36	18±2†	94±36	101±35	7 ± 2†	10.8 (7.28, 14.3) ‡

* p<0.001, baseline comparison yoga vs. education.
† p<0.001: baseline vs. post; D: Post-baseline;.
‡ p<0.001, D education vs. Dyoga; ADOSS, ADOlescence Stress Scale.

4. Discussion

This RCT of a 17-week yoga delivered to adolescent girls and boys aged 13 –15 years from public and private schools in Chennai and Delhi was effective in significantly reducing stress levels, bodyweight, body fat, waist circumference, BMI, blood pressure and improving attention and concentration of the yoga group compared to the education group.

The present study showed a significantly high (5%) difference in stress scores between the yoga and education groups. Supportive studies show that 21 days of Hath yoga reduced 4.3% of perceived stress scores in intervened participants.[14] Another study conducted in 60 adolescents aged 12–17 years showed reduced stress scores by 17.2% in experimental group as compared to control (2.9%) due to practice of 'pranayama'.[15] A study conducted in 10th grade students reported that

Table 2
Linear regression models showing association of the yoga with ADOSS score (n = 2000).

Models	ADOSS Score* β Coefficients (CI) (p-value)
Unadjusted	−5.04 (−5.29, −4.80) 0.001
Adjusted for age	−4.95 (−5.20, −4.71) 0.001
Adjusted for Body weight	−5.01 (−5.27, −4.75) 0.001
Adjusted for waist circumference	−5.08 (−5.36, −4.80) 0.001
Adjusted for diastolic BP	−5.43 (−5.71, −5.15) 0.001
Adjusted for age, body weight, waist circumference and diastolic BP	−5.61 (−6.65, −4.56) 0.001

* ADOSS, ADOlescence Stress Scale.

adolescents who practiced 'Yoga Nidra' for 21 days reduced stress scores from moderate to low.[16] In the present study, it was found that boys reported higher stress scores than girls. Whereas another study showed that girls reported a three times higher perceived stress scores than boys.[17] Sociocultural factors, including gender disparities and discrimination could contribute to the differential stress experiences between sexes. Among girls pubertal related hormonal changes also add to stress.

Various forms of pranayama such as Nadishuddi Pranayama (Alternate nostril breathing), Kapalabathi Kriya (cleansing breath), Sitali Pranayama, and Sitkari Pranayama have been shows to decrease blood pressure.[18] We observed that the mean systolic and diastolic blood pressure were reduced significantly in the yoga group participants at post intervention. Supportive results were reported by Barnes et al.[19] wherein the yoga decreased systolic (4 mmHg) and diastolic (2 mmHg) blood pressure in school participants.

Yoga have been known to reduce cortisol concentrations in adults.[20] Very little research exists on the effects of yoga on the cortisol concentrations in the young. Moreover, inadequate reporting and methodological limitations of current yoga research, limits the interpretation and comparisons of previous yoga-based studies. Also limited data that is available from yoga-based studies have been conducted on adults.[21] Our study is one of the first to show that in children the mean salivary cortisol significantly decreased in the yoga group compared to the education group. A study by Maheshkumar[22] et al. reported that six months pranayama intervention decreased salivary cortisol in adolescents.[4] An elementary school yoga program found that 10 weeks of classroom yoga decreased salivary cortisol of second and third grade participants.[9] In contrast, findings of some studies have not found any correlation between salivary cortisol and perceived stress scores[23,24] and anxiety scores.[25]

Our results showed that participants who were exposed to regular yoga practice exhibited better attention and concentration than those who were not exposed to yoga. Das and colleagues[26] analyzed the effects of a 10-week intensive yoga camp on adolescent's self-efficacy and cognitive task performance and found that the yoga group showed higher self-efficacy and improved performance after 10 days of yoga. In another study, in India with two-hundred school participants were randomly allocated to either a yoga or a physical- activity group. No significant differences were found in cognitive performance between the two study groups (yoga versus physical activity) at post intervention, after controlling for grade levels.[27]

The strength of our study is that our simple yoga could be delivered by training and co-opting the yoga and physical training (PT) teacher's availability in the schools, and also the class leaders (all existing resources) as peer support. This was a way to ensure the long-term sustainability of the project. A few participating schools thus decided to make this a permanent program for all the classes in their school. The main limitation is that the study was conducted only in two urban cities and hence cannot be extrapolated to rural areas of the country, but as stress/ NCDs are increasing rapidly in urban areas, such studies are the need of the hour. Moreover, there is no reason to believe that this intervention will not work in rural children or adolescents. Data on stress was self-reported, since the participants were in the adolescent stage there was always the risk of recall and over/under reporting bias. Another study limitation was that salivary cortisol was not measured in all participants. Furthermore, family and school backgrounds can affect one's stress score.

4.1. Conclusion

Our study showed that a simple 17-week yoga delivered in schools using a train the trainer model, ably assisted by peers, was effective in bringing down stress levels, metabolic parameters and improving the attention and concentration, in the adolescents aged (13–15 years). Implementation of this yoga at the school level has the potential to significantly decrease stress levels, enhance attention and concentration and improve metabolic outcomes in the young population.

Author contributions

HR and RMA conceived the study, drafted the proposal for funding with inputs from VM, NT and YG. NJ and TR coordinated the field study in Chennai and Delhi respectively. RV helped in the yoga components and JV with the scales used in the study. HR and RMA over seen the execution of the project and stand guarantor for the work undertaken.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical statement

The study was approved by Madras Diabetes Research Foundation Institutional Ethics Committee (IEC) (2013), All India Institute of Medical Sciences Institutional Ethics Committee (2017) and Center for Chronic Disease Control Independent Ethics Committee (2018).

Data availability

The data will be made available by the corresponding author upon responsible request.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.imr.2023.100979.

Supplementary Table 1. Study schedule

Supplementary Table 2. Breakdown of the study participants

Supplementary Table 3. The baseline characteristics of the yoga and education groups

Supplementary Table 4. Impact of yoga on secondary outcomes by sex

Supplementary Table 5. Impact of yoga on secondary outcomes by school type

Supplementary Table 6. Impact of yoga on secondary outcomes across the two sites

Supplementary Figure 1. Study recruitment flowchart

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