



## Assessment Of Neuropsychological And Behavioral functions With Yoga Intervention In Early Adolescent Obesity

Ruchira R. Joshi<sup>1</sup>, Sunanda S. Rath<sup>2</sup>

1. Academic and Research Head, Chiranjiv Foundation

2. Director , Chiranjiv Foundation

Yoga Initiative Centre, Chiranjiv foundation ,404, Pinnacle pride, Sadashiv Peth, Tilak road, Pune ,India – 411030.

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Corresponding author- --  
 Dr. Ruchira R. Joshi, Academic and Research Head, Chiranjiv Foundation , Pune. Mail Id- [Joshiruchira19@gmail.com](mailto:Joshiruchira19@gmail.com)

### Abstract-

**Background:** -Adolescent Obesity is causing serious public health concern and in many countries threatening the viability of basic health care delivery. Apart from physical problems there are issues which affect neuropsychological and behavioral well-being of the obese child. Yoga is found to have effective solutions for neuropsychological and behavioral problems in adolescent obesity if practiced in early age.

**Aim:**-To asses effect of Yoga intervention on neuropsychological and behavioral assessments in early adolescent Obesity.

**Method :-**Randomized Controlled Trial ( Yoga n = 30 and Control n = 30 ) was conducted on 60 obese early

adolescents with average age of 11.32 yrs ( ± 1.43 ) and average weight of 61.43 Kg( ± 10.42 )

for 40 days. Neuropsychological and behavioral parameters like Body Awareness Questionnaire (BAQ), Rosenberg Self-esteem Scale (RSES) and Child Eating Behavior Questionnaire (CEBQ), Six Letter Cancellation Test (SLCT) and Digit Letter Substitution test (DLST) were assessed before and after intervention for both the groups.

**Results :-** Significant results were observed in improvement of self-esteem, neuropsychological functions and eating behavior with Yoga group. SLCT of Yoga group improved better as compared to Control group. Yoga group showed better performance than Control group in other parameters but without significance.

**Conclusion :-** Yoga intervention is witnessed to have affirmative impact on neuropsychological and behavioral functions in early adolescent obesity.

**Keywords :-** Obesity; Early adolescence; Yoga, Neuropsychological and behavioral functions.

## **Introduction**

Obesity can be described as a “New World Syndrome” causing an enormous socioeconomic and public health burden in developed, developing countries of the world. Overeating, energy-dense nutrient-poor foods and a sedentary lifestyle have led to an epidemic of obesity and type 2 diabetes all over the world<sup>(1)</sup>. In the developed world, it is one of the major health issues and results in poor outcomes in the form of higher mortality and morbidity in obesity has been in the past thirty years. The growing problem of obesity is associated with multiple morbidities, including increased risk of diabetes, hypertension, heart disease, sleep apnea and cancer. Diet and exercise focused strategies are not effective in preventing obesity and maintaining weight loss.<sup>(2)</sup> Apart from

physical problems there are issues which affect psychological well-being of an individual. Depression is the most common psychological co-morbidity of obesity. A wide range of treatment options are available but balanced nutrition diet and regular physical activity are considered to be the safest and the easiest option<sup>(3)</sup>.

Adolescence is the period of transition between childhood and adulthood. It includes some big changes to the body, and to the way a young person relates to the world. The many physical, sexual, cognitive, social, and emotional changes that happen during this time can bring anticipation and anxiety for both children and their families. During early adolescence, children often start to grow more quickly. They usually start a year or two earlier in girls than boys, and it can be normal for some changes to

start as early as age 8 for females and age 9 for males. Early adolescents have concrete, black-and-white thinking.<sup>(4)</sup>

The prevalence of over weight and obesity among children and adolescents aged 5-19 years has risen dramatically from just 4% in 1975 to just over 18% in 2016. The rise has occurred similarly among both boy sand girls: in 2016 18% of girls and 19% of boys were overweight.<sup>(5)</sup> Children in low and middle income countries are more prone to in adequate pre-natal, infant and young child nutrition. At the same time, they are exposed to high-fat, high-sugar, high-salt, energy-dense, micronutrient-poor foods. These dietary patterns in conjunction with lower levels of physical activity, result in sharp increases in childhood obesity while under nutrition issues remain unsolved.<sup>(6)</sup>

Obesity in early adolescents have serious influence on neuropsychological and behavioral functions. In comparison to normal weight group children with that of obese; it had a significantly lower performance on tests of reading and mathematics. Study revealed that among children with obesity, % Fat and subcutaneous abdominal adipose tissue were not related to neuropsychological abilities.

The influence of fat distribution, specifically visceral adiposity, on select aspects of achievement and cognitive function remains poorly characterized among preadolescent children<sup>(7)</sup> Neuropsychological investigations of patients with medical diagnoses including hypertension, diabetes, and obstructive sleep apnea have demonstrated deficits across a variety of cognitive domains, including attention, processing speed, memory, and executive functioning. While these medical conditions are often resultant from obesity or excess body weight, recent findings indicate that compromised neurocognition in obese individuals may exist independent of such medical conditions.<sup>(8)</sup> According to one study, elevated BMI is not associated with cognitive function in healthy children and adolescents, though underweight might be a risk factor for reduced memory performance in females.<sup>(9)</sup> Although increased body weight is independently associated with decreased visuospatial organization and general mental ability among children.<sup>(10)</sup> It has been observed that obese individuals show difficulties with decision-making, planning and problem-solving when compared to healthy weight controls, with fewer difficulties reported on tasks examining verbal fluency and learning and memory.

Yoga may help children and young people in managing stress better and so help positively to balance life, well-being, and mental health. They also suggested that Yoga in schools helps students to improve resilience, mood, and self-regulation skills.<sup>(11)</sup>Yoga practices are useful to reduce back pain and reduces stress and improvises attitude of enjoyment of food which helps to reduce food intake.<sup>(12)</sup>Yoga benefits physical and mental health in comparison with the effects of Yoga and exercise on health. Yoga intervention is equally as effective as or more better than exercise for improving health-related outcome measures.<sup>(13)</sup>Present study goals to assess the effect of Yoga based intervention neuropsychological and behavioral functions in early adolescent obesity.

### **Methods**

1400 students including both genders were screened from age of 9 year to 14 year in a secondary school in Pune city of Maharashtra state in India. Height, weight and BMI of all the students were recorded and 100 obese students (Figure 1) with

BMI>95<sup>th</sup>percentiles were screened. 60 obese participants included who were ready to participate in the study with written consent. Participants having any physical disability, any psychosomatic disorder, consuming any medical drugs and exposed to yoga within last 6 months were excluded from the study. All the participants are randomly divided in two groups. Yoga group was containing 30 participants with average weight of 62.95 ( $\pm 15.52$ )Kg and control group was containing 30 participants with average weight of 61.84 ( $\pm 13.87$ ) Kg . These 60 obese adolescents were involved in RCT (Randomized Controlled Trial) for 40 days of intervention. Special Yoga based training Program was conducted for Yoga group. This Yoga intervention was consisting of specially designed Yoga protocol of 60 minutes duration which was validated by 16 SMEs. It was involving a special design and validated pattern of Yoga practices like loosening practices, *Suryanamaskara*, *Asana*, body cleansing practices, *Pranayama*, Breathing practices, Meditation and relaxation practices.

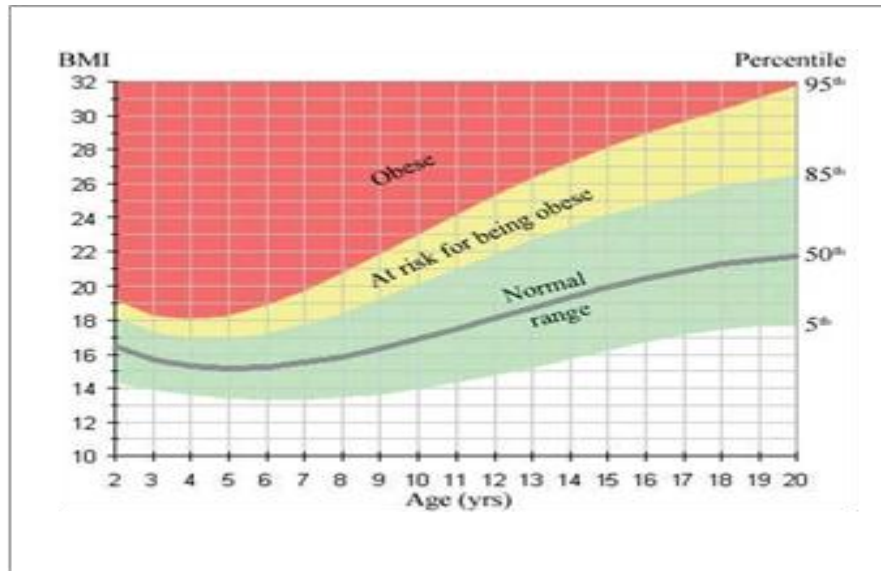


Figure 1: Body Mass Index for age percentile.

This intervention was conducted for 5 days a week for 6 weeks. On every weekends , sessions of *Mantra & Bhajana* chanting, *Karmayoga*, Yoga counseling was also provided. Control group was under observation with normal routine. The diet regulation was observed for both yoga and control group in order to acquire uniform base with respect to diet. Psychological parameters like BAQ (Body Awareness Questionnaire) , RES (RES ( Rosenberg Self-esteem Scale) and CEBQ ( Child Eating Behavior Questionnaire along with cognitive parameters like SLCT ( Six Letter Cancellation Test ) and

DLST (Digit Letter Substitution test ) were assessed before and after intervention for both Yoga and control groups. In Yoga group, there were 5 drop outs and from control group 2 children were absent for post parameter collection. The complete study has been approved by ethical committee of Swami Vivekananda Yoga Anusandhan Samsthana, Bangalore .

The data was evaluated using SPSS software 20 version. Normality test was run on baseline data using Shapiro Wilk test. The paired sample t test was conducted for pre & post

variables which were found normally distributed for both the groups. For not normally distributed variables, Wilcoxon signed ranks test was done.

Between groups analysis was done using independent sample t test for the post values of both the groups.

### **Results**

The baseline demographic data of continuous variable of the yoga and control group is described in Table 1.

NO.	GROUP	YOGA		CONTROL	
		Male ( n=13)	Female ( n=17)	Male ( n=14)	Female ( n=16)
1	Gender				
2	Average Age (years)	11.8 ± 1.24		12.2 ± 1.01	
3	Average Height (cm)	152.43 ± 7.08		151.93 ± 9.35	
4	Average Weight (Kg)	63.89 ± 14.69		61.84 ± 13.87	
5	Average BMI (Kg/m <sup>2</sup> )	27.36 ± 4.77		26.48 ± 3.41	

**Table1: The base line demographic data of continuous variable ( n= 60 ).**

Results of the baseline demographic data of categorical variables are described in Table No. 2.

Parameter	Category	No. of obese students	Percenta ge	BMI	r (coefficient value )
Parent Education	Undergraduate	9	15		0.165 <sup>a</sup>
	Graduate	31	51.6		

	Post Graduate	20	33.3	26.92 ± 4.13	0.254 <sup>a</sup>
Parent Occupation	Student	3	5		
	Unemployed	13	21.6		
	Self Employed	27	45		
	Public Sector		13.3		
	Professional	8			
	Private Sector		15		
Family Structure	Professional	9			0.104 <sup>a</sup>
	Nuclear	32	53.3		
	Extended	28	46.6		0.345 <sup>a</sup>
Family Income	INR 1,00,000 To 5,00,000	18	30		
	INR 5,00,000 To 10,00,000	18	30		
	INR 10,00,000 To 15,00,000	12	20		
	INR 15,00,000 above	12	20		

<sup>a</sup>Eta & cross tab

**Table2: The base line demographic data of categorical variable( n= 60 ).**

Results of within group analysis of Yoga group are given inTable3.

No.	Variable	Mean Pre value	Mean Post value	t value	p value
1	BAQ	62.89 ± 19.48	57.96 ± 17.14	1.491 <sup>b</sup>	0.14
2	RES	14.75 ± 3.83	15.75 ± 2.88	-2.046 <sup>a</sup>	0.04*
3	CEBQ - EF	13.21 ± 3.21	11.82 ± 3.25	2.081 <sup>b</sup>	0.04*
4	CEBQ - EOE	7.82 ± 4.19	6.32 ± 3.74	-1.710 <sup>a</sup>	0.08

5	CEBQ - SR	11.82 ± 3.48	13.60 ± 3.96	-2.212 <sup>b</sup>	0.03*
6	CEBQ - SE	11.28 ± 10.14	3.93 ± 3.18	1.753 <sup>b</sup>	0.09
7	CEBQ - DD	6.21 ± 2.91	4.78 ± 2.20	-2.500 <sup>a</sup>	0.01*
8	CEBQ - FF	16.64 ± 5.25	15 ± 5.01	-2.281 <sup>a</sup>	0.02*
9	CEBQ - EUE	10.60 ± 4.39	8 ± 4.18	-3.712 <sup>a</sup>	0.01*
10	CEBQ - FR	9.78 ± 4.68	7.64 ± 3.34	3.776 <sup>b</sup>	0.001 <sup>∞</sup>
11	DLST	45.67 ± 9.73	90.57 ± 09.37	-4.542 <sup>a</sup>	0.001 <sup>∞</sup>
12	SLCT	27.28 ± 9.37	56.46 ± 9.35	-14.227 <sup>b</sup>	0.001 <sup>∞</sup>

a - Wilcoxon test b - Paired sample t test\* -  $p < 0.05^{\infty}$  -  $p < 0.01$

**Table No. 3 :- Results of within group analysis of Yoga group ( n= 25 ).**

Result of within group analysis of Control group is described in Table No. 4.

No.	Variable	Mean ( Pre )	Mean ( Post )	t / z value	p value
1	BAQ	76.58 ± 19.37	80.29 ± 16.31	-1.073 <sup>b</sup>	0.294
2	RES	16.33 ± 2.83	16.79 ± 2.37	-.926 <sup>a</sup>	0.354
3	CEBQ - EF	14.88 ± 4.15	12.88 ± 3.71	3.176 <sup>b</sup>	0.004*
4	CEBQ - EOE	07.36 ± 3.18	05.83 ± 3.14	-2.611 <sup>a</sup>	0.009*
5	CEBQ - SR	14.28 ± 3.76	12.68 ± 2.98	1.789 <sup>b</sup>	0.086
6	CEBQ - SE	09.60 ± 4.07	09.28 ± 2.90	0.479 <sup>b</sup>	0.636
7	CEBQ - DD	05.04 ± 2.44	04.87 ± 2.69	-0.461 <sup>a</sup>	0.645
8	CEBQ - FF	14.12 ± 5.21	13.62 ± 5.46	-0.891 <sup>a</sup>	0.373
9	CEBQ - EUE	09.32 ± 3.54	8.68 ± 4.31	-0.919 <sup>a</sup>	0.358
10	CEBQ - FR	11.24 ± 5.22	8.12 ± 4.71	4.058 <sup>b</sup>	0.001*
11	DLST	44 ± 8.95	44.04 ± 8.92	-.515 <sup>a</sup>	0.607



12	SLCT	28 ± 12.53	29.20 ± 10.91	.607 <sup>b</sup>	0.371
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a - Wilcox test    b - Paired sample t test    \* - p < 0.05    <sup>∞</sup> - p < 0.01

**Table No. 4 :- Results of within group analysis of Control group ( n= 28 ).**

Result of in between group analysis are evaluated in Table No. 5.

N o.	Variables	Yoga Group ( n= 25 )		Control Group ( n= 28 )		T value	p value
		Pre	Post	Pre	Post		
1	BAQ	62.89 ± 19.48	57.96 ± 17.14	76.58 ± 19.37	80.29 ± 16.31	-1.830 <sup>b</sup>	0.07
2	RES	14.75 ± 3.83	15.75 ± 2.88	16.33 ± 2.83	16.79 ± 2.37	-1.070 <sup>a</sup>	0.28
3	CEBQ - EF	13.21 ± 3.21	11.82 ± 3.25	14.88 ± 4.15	12.88 ± 3.71	0.656 <sup>b</sup>	0.51
4	CEBQ - EOE	7.82 ± 4.19	6.32 ± 3.74	07.36 ± 3.18	05.83 ± 3.14	-.779 <sup>a</sup>	0.43
5	CEBQ - SR	11.82 ± 3.48	13.60 ± 3.96	14.28 ± 3.76	12.68 ± 2.98	2.817 <sup>b</sup>	0.007*
6	CEBQ - SE	11.28 ± 10.14	3.93 ± 3.18	09.60 ± 4.07	09.28 ± 2.90	-0.880 <sup>b</sup>	0.38
7	CEBQ - DD	6.21 ± 2.91	4.78 ± 2.20	05.04 ± 2.44	04.87 ± 2.69	-.047 <sup>a</sup>	0.96
8	CEBQ - FF	16.64 ± 5.25	15 ± 5.01	14.12 ± 5.21	13.62 ± 5.46	-.829 <sup>a</sup>	0.40
9	CEBQ - EUE	10.60 ± 4.39	8 ± 4.18	09.32 ± 3.54	8.68 ± 4.31	-.664 <sup>a</sup>	0.50
10	CEBQ -	9.78 ±	7.64 ±	11.24 ±	8.12 ±	1.037 <sup>b</sup>	0.30

	FR	4.68	3.34	5.22	4.71		
11	DLST	45.67 ± 9.73	90.57 ± 09.37	44 ± 8.95	44.04 ± 8.92	0.517 <sup>a</sup>	0.60
12	SLCT	27.28 ± 9.37	56.46 ± 9.35	28 ± 12.53	29.20 ± 10.91	9.877 <sup>b</sup>	.001*

a Mann-Whitney U test

b Independent samples t-test

**Table No. 5 :- Results of in between group analysis .****Discussion**

Psychological Parameters like BAQ (Body Awareness Questionnaire), Parameters like RES (Rosenberg Self-esteem Scale), CEBQ-EF (Child Eating Behavior Questionnaire - Enjoyment of food), CEBQ-SR (Satiety responsiveness), CEBQ-SE (Slowness in eating), CEBQ-FR (Food responsiveness), CEBQ - EOE( Child Eating Behavior Questionnaire - Emotional over-eating ), CEBQ- DD ( Desire to drink ), CEBQ- FF (Food fussiness) , CEBQ - EUE (Emotional under-eating) were assessed pre and post.

Variables like BAQ ( $p = 0.29$ ) and RES ( $p = 0.35$ ) increased but without significance. According to one study, obese adolescents have lower levels of physical activity, higher inactivity and a larger perception of ideal body size than non-obese adolescents.<sup>(14)</sup> The perception of bodily awareness has been increased with Yoga

group. Yoga group participants became more physically active due to intervention. So Body Awareness Questionnaire scores improved well.

One review published article quotes that early adolescents, female gender exposure to victimization, history of greater parental control on feeding are the factors which make overweight children to possess low self esteem.<sup>(15)</sup> In Yoga group, it has been seen that self esteem has increased when that of control group has been decreased as Yoga intervention has positive impact on will power building leading to increased self esteem. Yoga concepts include another important measure of an evolving personality, which is the knowledge about one's unlimited potential to move towards perfect harmony with Nature.<sup>(16)</sup> Breathing pattern is regularized due to yoga practices, which trains the mechanism to use the abdominal in synchronization with

respiratory muscles and breathing system. Lung capacity is increased which results in to stamina building and developing vital energy.<sup>(17)</sup>The Child Eating Behavior Questionnaire (CEBQ) is a parent-report instrument to assess 'obesogenic' eating behaviors in children with obesity. In this study, associations were examined between three CEBQ scales, Satiety Responsiveness, SR; Food Responsiveness, FR; Enjoyment of Food, EF and four aspects of eating behavior like eating without hunger, caloric compensation, eating rate and energy intake at a meal. An easily-administered measure such as the CEBQ will be valuable in gathering data on the scale required to study the behavioral phenotype associated with obesity risk.<sup>(18)</sup> Obese individuals are more emotionally reactive and more likely to overeat when distressed than are those of normal weight. This study compared the emotional reactivity and emotional eating of normal and overweight female college students in the natural environment. Correlational analyses indicated that emotional distress associated with snacks and emotional eating associated with both snacks and meals were related to subjects' percentage overweight.<sup>(19)</sup>

Study focused primarily on general trends of soft drink consumption may be

linked to weight gain. This study examines how the Child Eating Behavior Questionnaire (CEBQ) construct 'Desire to Drink' (DD) relates to drink consumption, preferences and BMI-SDS. Findings suggest that the construct desire to drink in children is related to a liking for consuming sweetened drinks, and does not appear to simply denote greater thirst or hunger.<sup>(20)</sup> An appetitive profile characterized by more responsiveness to and enjoyment of food, more emotional eating, lower responsiveness to internal satiety and lower fussiness is associated with weight.<sup>(21)</sup> Fussiness could be protective against overeating by reducing the effective choices for a child.<sup>(22)</sup> Yoga being a promote tool to establish deeper satisfaction at mind can promote fussiness. Yoga programs are potentially effective for the reduction of huge eating.<sup>(23)</sup>

Variables like CEBQ-EF ( $p = 0.004$ ), CEBQ-EOE ( $p = 0.009$ ) and CEBQ-FR ( $p = 0.001$ ) decreased with significance. Variables like CEBQ-SR ( $p = 0.08$ ), CEBQ-SE ( $p = 0.63$ ), CEBQ-DD ( $p = 0.64$ ), CEBQ-FF ( $p = 0.37$ ) and CEBQ-EUE ( $p = 0.35$ ) decreased but without significance. Analysis of between Yoga and control group states that BAQ of Yoga group is increased where as that of Control

group is increased but without significance ( $p = 0.07$ ).

Parameters like SLCT were normally distributed which is increased with significance

( $p = 0.00$ ). Parameters like DLST were not normally distributed which also increased with significance ( $p = 0.00$ ). Analysis of in between Yoga and control group states that DLST of Yoga group is increased than that of Control group but without significance ( $p = 0.60$ ). SLCT of Yoga group is increased than that of Control group with significance ( $p = 0.00$ ).

Yoga is associated to improve cognitive functions like perception, quickness of alertness .It can improve cognitive functions such as remote memory, mental balance, attention and concentration, delayed and immediate recall, verbal retention and recognition tests .<sup>(24)</sup>

So SLCT & DLST improved well with Yoga group both tools needs good concentration, memory and attention. Studies measuring mental health outcomes have shown decreases in anxiety, and increases in cognitive performance after yoga interventions. Similar studies have also shown cognitive advantages amongst yoga practitioners versus non-practitioners .<sup>(25)</sup>Yoga intervention practices like dynamic

suryanamaskara, asana, loosening practices are focused to reduced abdominal adipose tissue. According to one RCT, Yoga intervention had moderately strong positive effects on anthropometric variables in women with abdominal obesity. Yoga is safe in women and can be recommended as a technique for combating abdominal obesity in women. Our study provides efficacy of Yoga in same concern in adolescent population. Yoga improves emotional wellbeing in children. Yoga had been reported to have shown the beneficial effects on different psycho-physiological variables .<sup>(26)</sup>The mechanisms underlying these benefits have not been clearly worked out and may involve complex neuro-chemical changes and modified functioning of brain areas within the limbic circuit.

### Conclusion

Significant results are detected in improvement of self esteem , neuropsychological functions and eating behavior with Yoga group. Yoga group showed better performance than Control group in other parameters. Yoga based intervention is witnessed to have positive impact on neuropsychological and behavioral functions in early adolescent

obesity.

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