



## Obesity and Memory

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### ABSTRACT

**Background:** *New research suggests that ill effects of obesity may not stop with physical health, mental health may be affected leading to long standing impact like low self esteem, depression, other psychological problems and difficulties in learning and memory. Short term memory plays important role in daily life for remembering telephone numbers, remembering directions, persons and names and short list of items. Short term memory also helps in answering questions in the viva, interviews, and doing calculations.*

**Aim and Objectives:** *To find out the short term memory status by visual tasks in obese and non obese children of urban areas. Materials and methods; 80 subjects in the age group of 9 to 15 yrs were taken from the various schools in Kurnool. Among them 40 subjects are obese (as cases) and 40 subjects are non obese children (as controls) for this study. The following tests of Short term memory were conducted which are sub tests of TOMAL (Test of memory and learning) and Weschler's intelligence scales for children. Visual tasks include the following tests; 1. Alphabetical (Letter span) test 2. Numerical (Digit span) test 3. Word memorization test 4. Object recall test.*

**Results:** *Non obese children are having better overall short term memory than the obese children and also performed better in all the individual visual tasks memory tests.*

**Conclusion:** *Obesity affects short term memory in children.*

**Keywords:** *Obesity, short term memory, alphabetical test, numerical test,*

### Introduction

Incidence of childhood obesity have risen dramatically over the past few decades. It causes not only physical consequences but mental health is affected leading to memory problems. Memory is important to have better quality of life.

Normally memory impairment starts physiologically as age progresses but because of obesity, memory impairment starts early in life. Although obesity has been linked to poorer neurocognitive functioning in adults, much less is known about

this relationship in children and adolescents. Therefore this study was taken to examine the relationship between childhood obesity and memory.

### Aim and Objectives

1. To find out the short term memory status by visual tasks in obese and non obese children of urban areas. To see the impact of obesity on short term memory status in children.

2. To formulate the message to the children, parents, teachers and government based on the results.

### Materials and Methods

80 subjects in the age group of 9 to 15 yrs were taken from the various schools in Kurnool. Among them 40 subjects are obese (as cases) and 40 subjects are non obese children (as controls) for this study. A brief history, general examination, and systemic examination was performed and healthy subjects were recruited or taken based on the inclusion and exclusion criteria.

**Inclusion criteria:** According to inclusion criteria subjects are taken in the age group of 9-15 yrs, obese children and non obese children (normal weight), including both males and females.

**Exclusion criteria:** Children with apparent visual defects and illness related to neurological and psychiatric disorders, Diabetes mellitus, Hypertension, history of head injury, Family history of Psychiatric illness, past or current history of drug dependence, antidepressants and other disorders which could affect short term memory.

The selected subjects were tested in the morning hours of school after having their breakfast, anthropometric measurements like height, weight are taken and BMI was calculated.

$BMI = \text{weight in kg} / \text{height in metre}^2$

Based on the BMI values the subjects are divided in to Obese children, non obese children (normal weight) according to their age and gender in accordance with centre for disease control percentiles of children. Later, the following tests of Short term memory were conducted which are sub tests of TOMAL (Test of memory and learning) and Weschler's intelligence scales for children.<sup>[1]</sup>

Visual tasks include the following tests

1. Alphabetical (Letter span test)
2. Numerical (Digit span test)
3. Word memorization test
4. Object recall test

### 1) Alphabetical test (Letter span test):

In this test 5 trials were given. Each trial contained, sets of alphabets i.e. in first trial 2, second trial 4, third trial 6, fourth trial 8 and fifth trial 10 alphabets, like (U,M), ( T, Z, L, D ) etc. Alphabets were flashed for 3 seconds in each trial and subjects were asked to write the alphabets immediately on the paper provided, whatever they remembered.

### 2) Numerical test (digit span test):

In this test 5 trials were given. Each trial contained, sets of numbers i.e. in first trial 2, second trial 4, third trial 6, fourth trial 8 and fifth trial 10 alphabets, like (4,9) (2,7,4,1) etc. numbers were flashed for 3 seconds in each trial and subjects were asked to write the numbers immediately on the paper provided, whatever they remembered.

### 3) Words memorization test:

Subjects were given 30 seconds to look at a list of 15 words which were used commonly in daily life, like eggs, apple, chair etc. Then the subjects were asked to recall all the words or whatever they remembered and ask them to write on a paper given immediately.

### 4) Object recall test:

A tray containing 15 commonly used objects, like lock & key, flower, pen, etc was shown to the subjects for 30 seconds. The tray was covered with cloth and then the subjects were asked to write the names of the objects whatever they remember on a paper provided immediately

### Statistical Analysis

Mean and Standard deviation were calculated for all the memory tests using SPSS 22.0.

Student 't' test was carried out using the formula;

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

P value less than 0.05 indicates significance.

**Results**

**Table No 1:** Comparison of alphabetical test (Letter span test), numerical test (Digit span test), word memorization test, object recall test in 9 to 15 yrs age group in obese and non obese children

	Alphabetical test or letter span test		Numerical test or digit span test		Word Memorize test		Object Recall	
	Obese	Non obese	Obese	Non obese	Obese	Non obese	Obese	Non obese
Mean	72.1916	83.6958	76.7666	85.525	46.8333	63.3333	46.3333	62.5
SD	13.7603	9.99058	13.1243	10.8113	16.6401	15.9057	17.1436	16.0261
t value	4.27874		3.25763		4.53338		4.35689	
P value	0.00001 S		0.00166 S		0.00001 S		0.00003 S	

**Table No 2:** Age wise comparison of Alphabetical test (Letter span test) in obese and non obese children.

	Age in yrs	Obese		Non Obese		t value	P value
		Mean	SD	Mean	SD		
Trial 1	9-12	100	0	100	0	NS	NS
	13-15	100	0	100	0	NS	NS
Trial 2	9-12	86.8421	26.8333	100	0	2.07884	0.045026 S
	13-15	82.1428	32.7326	97.7272	10.6600	2.05548	0.046401 S
Trial 3	9-12	77.1929	28.4423	87.0370	21.8099	1.17654	0.247318 NS
	13-15	80.1587	37.4977	97.7272	10.6600	2.11109	0.04090 S
Trial 4	9-12	52.6315	30.4990	75	32.0844	2.174167	0.036540 S
	13-15	55.9523	31.7753	86.9318	18.2888	2.048839	0.047077 S
Trial 5	9-12	35.7894	25.6722	46.6666	27.6533	1.240751	0.222950 NS
	13-15	39.5238	27.1064	44.0909	23.4336	0.591894	0.557171 NS

**Table No 3:** Age wise comparison of Numerical test (Digit span test) in obese and non obese children.

	Age	Obese		Non Obese		t value	P value
		Mean	SD	Mean	SD		
Trial 1	9-12	100	0	100	0	NS	NS
	13-15	97.61904	10.9108	100	0	1.02412	0.31177 NS
Trial 2	9-12	97.36842	11.4707	95.83333	12.86239	0.38359	0.70359 NS
	13-15	100	0	100	0	NS	NS
Trial 3	9-12	86.84210	28.6415	94.44444	14.00280	1.01639	0.31641 NS
	13-15	88.88888	23.7658	97.72727	10.66003	1.58586	0.12045 NS
Trial 4	9-12	46.05263	36.0970	67.36111	35.90707	1.79929	0.08059 NS
	13-15	64.28571	38.7874	76.70454	37.85456	1.06249	0.29422 NS
Trial 5	9-12	33.68421	22.4129	58.33333	28.33621	2.94313	0.00573 S
	13-15	51.90476	25.6162	62.72727	24.53021	1.41524	0.16454 NS

**Table No 4:** Age wise comparison of Word memorization test in obese and non obese children.

Age	Obese		Non Obese		t value	P value
	Mean	SD	Mean	SD		
9-12	45.26315	18.13242	60.74074	13.69869	2.916969	0.006134 S
13-15	45.39682	15.72246	65.45454	17.53440	3.942744	0.000307 S

**Table No 5:** Age wise comparison of Object recall test in obese and non obese children.

Age	Obese		Non Obese		t value	P value
	Mean	SD	Mean	SD		
9-12	41.403508	12.87718	54.07407	13.31152	2.942863	0.005738 S
13-15	50.476190	20.50164	69.39393	14.92968	3.47076	0.001235 S

## Discussion

Results of the present study were correlating with the earlier studies<sup>[2,3]</sup> where obese children have less scores in letter span test compare to non obese children. All the subjects showed a progressive decrease in short term memory status from 3rd trial onwards. This may be due to an increase in number of alphabets in each trial. Normal individual can hold 7 + 2 bits of information in working memory where these bits can be manipulated and other discontinued or retained as a more permanent memory store. The number of items a person can remember from a single glance at a visual display is quite small usually 5- 7 items. This amount called the span of apprehension is limited because people can only remember as many items as they can identify and store in memory while the visual display is available. In 2<sup>nd</sup> trial, 3<sup>rd</sup> trial, 4<sup>th</sup> trial and 5<sup>th</sup> trail, memory status was low in obese female children compared to non obese female children as there is difference in mean value ,and the difference is statistically significant in trial 2 and trial 4 as p value <0.05. Results are also correlating with the earlier studies<sup>[4-7]</sup> where obese children scores were less in digit span test compare to non obese children. Contradicting results were found in some other studies<sup>[8-10]</sup> in their respective studies there is no difference in memory status in obese and non obese children. All the subjects showed a progressive decrease in short term memory status from 3rd trial on wards in numerical test or digit span test. This may be due to an increase in number of numerical in each trial. The cause for the progressive decrease in memory status for numerical test remains same as that for Alphabetical test.

Results are also correlating with the earlier studies<sup>[11-13]</sup> where obese children scored less in word memorization test compare to non obese children. The decrease in memory status for words test when compared to 4th trial (of 8 letters/numbers) or 5th trial (of 10 letters/ numbers) of alphabetical/ numerical tests may be due to several factors. The word recall will depend on its position in the list. If subjects attempt to

recall the words immediately; they remember first few words and the last few words. The better recall of the first items on the list is called a primacy effect, of the final items is called recency effect.<sup>[14]</sup> Reading demands good eye sight, of course but also comprehension. It is a form of visual attentiveness to both the shape and sense of the words. Whatever the shape of the letters, one's attention is focused primarily on the meaning of the text rather than the typographic elements or correct spelling and it is because a text makes sense that one can remember it.

On the other hand, when one sees a text in a language one is unfamiliar with, one can pay attention only to the appearance of the words, to their shape. One cannot really call this reading, and it would be impossible to remember the text. In this study, 15 words with least of three letters to maximum of seven letters were displayed in the visual task. When words are displayed the visual image persists for less than 1.0 sec. The memory system used to hold this image has been called iconic memory.<sup>[15]</sup> George Miller argued that human short term memory has a forward memory span of approximately seven items or more accurately within the information theoretic single digit or letter, while an item can indeed be a single digit or letter, it can also be a whole number, word or abstract concept.<sup>[16]</sup>

J.L. Tzeng also found an instance where the recency effect in free recall did not seem to result from the function of a short-term memory store. Subjects were presented with four study-test periods of 10 word lists, with a continual distractor task (20-second period of counting-backward). At the end of each list, participants had to free recall as many words from the list as possible. After free-recall of the fourth list, participants were asked to free recall items from all four lists. Both the initial free recall and the final free recall showed a recency effect. These results went against the predictions of a short-term memory model, where no recency effect would be expected in either initial or final free recall.<sup>[17]</sup>

Female obese children have better scores in word memorization test compared to male obese and the

results are in line with some of the earlier studies.  
[18-20]

Some contradicting results were also reported by other studies.<sup>[21,22]</sup> This difference may be hypothesized that abilities to hold and manipulate information over short periods of time under goes substantial changes through the childhood years, with estimates of maximum capacity almost increases in the period between the pre-school years and early adolescence. Age-related changes in phonological short-term memory appear to reflect increased efficiency in a whole range of processes including the storage of item and order of information, rehearsal, retrieval and reconstruction of memory traces. Changes during childhood memory, on the other hand, have been attributed both to gains in the efficiency of processing and to increased attentional capacity in older children.<sup>[23]</sup> Results are correlating with earlier studies where non obese children have better memory for object recall test compare to obese children.<sup>[24]</sup> This better memory status for object test may be due to several factors. Sight enriches one's relation with the world around. Through sight one can register millions of facts. Memories of the faces, colors and objects around exemplify the capacity of one's visual memory. Some people are more dependants on this method of recall. This type of memory is also linked to one's own areas of interest. Some people remember the faces more easily, where as others remember colors or landscapes. Some time we prefer to look at something that is a source of pleasure, curiosity, novelty or fear.<sup>[25]</sup> Female obese children have better memory status for objects compared to male obese children and male non obese children have better memory status than female non obese children. Some researchers are also reported that female children have better memory for object recall test than males.<sup>[26,27]</sup> In the present study female children tend to score higher than male children in all tests except in few trials of alphabetical test and numerical test, because they pay more attention to specific details and the nearer surroundings, while males focus on the specific task that they were asked to complete.

Gender differences may be due to females paying more attention to selected aspects of the environment. Females have been found to be more compliant than males in many testing situation. It is hypothesized that females may be more engaged in recall tasks or spend more time trying to remember objects and object locations than males.<sup>[28]</sup>

In addition to the apparent involvement of short term memory in arithmetic processing and language comprehension across the life span, adult studies have established links between short term memory capacity and many intellectual abilities, like following directions, note-taking, writing, reasoning and complex learning. Given the range of important everyday cognitive activities that appear to be constrained by short term memory, it seems reasonable to suppose that children with severely compromised short term memory capacities will be educationally disadvantaged at school, experiencing a range of learning difficulties. Obesity affects some vital parts of the brain like pre frontal cortex (responsible for short term memory), hippocampus (responsible for long term memory) frontal and temporal lobes (required for planning and memory) it damages the tissues of the brain to such an extent that a very less proportion of brain is available for retention of memory.

Overweight people had 4% less brain tissue than people of normal weight, and obese people had 8% less brain tissue than people of normal weight. These results are serious for children who are obese, just a 4% loss of brain tissue represents, "severe" brain degeneration.

Four areas of the brain are reported to be effected by obesity:

Frontal and temporal lobes: Critical for planning and memory

Anterior cingulated gyrus: Responsible for attention and executive functions

Hippocampus: Important for long-term memory

Basal ganglia: Essential for proper movement and coordination.<sup>[29]</sup>

Excessive caloric intake may lead to oxidative damage leading to structural changes in the



brain... cutting calories and eating foods that make up a healthy diet may be a simpler way to prevent memory loss as we age.<sup>[30]</sup> There are several alternative explanations that might better account for how obesity affects memory. These findings include vascular pathology (e.g. endothelial dysfunction), reduced cardiovascular fitness, inflammatory processes, neuro endocrine dys regulation and micro nutrients deficiency. Each of these conditions is prevalent in obese individuals and associated with poor neuro cognitive function.<sup>[31]</sup> Children who were more physically fit had 12 percent bigger hippocampal volume. They performed better on tests that measured their ability remembering information. For this reason, exercise has an important effect on the brain and improvement of memory and learning.<sup>[41]</sup> Results are showing positive correlation with hypothesis that obesity affects short term memory in children.

### Conclusion

Obesity affects short term memory in children.

**Conflict of Interest:** No conflict of interest among the authors

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