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Impairment of Cognitive Function in Obese School Going Children Representing South Indian Population-A Correlative Population Based Study

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ABSTRACT

Introduction: Research about the child nutrition will play key role in all aspects of child health. On one end India is facing problem in feeding the children and there is malnutrition leading to many diseases, but on the other end overweight and obesity is posing great concern. This study aims at correlating impairment of cognitive function in overweight and obese school going children in south Indian population. Overweight and obesity poses various health issues immediately as well as on a long-term basis.

Aims: To study the correlation between obesity and cognitive function in obese school going children representing south Indian population.

Methodology: After recruiting the children between the age group of 13 years and 17 years, their BMI was calculated. The BMI was then plotted on a standard growth chart prescribed by the Indian academy of paediatrics to calculate the BMI percentile. MMSE test by folstein were performed on all the groups by asking some questions based on folstein scale and scores are given. The total score is for 30. The test is done using set of questions like orientation to time, place, recall, telling the numbers backwards and giving some complex activities. Scores are given to each activity and the added. The score below 21 between 8th grade and 10th grade is considered as impaired cognition and below 23 between 11th grade and 12th grade is considered as impaired cognition.

Result: There is no association between BMI and cognition in our study although the MMSE score decreases as the BMI increases in overweight and obese, the value shows a weak association. There is a need for further research.

Key words: Cognition, MMSE Score, Obesity

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INTRODUCTION

Nutrition in children is of great concern to the society and family. The holistic development of the child socially, psychologically, intellectually and so on depends mainly on the nutrition of the child. Children are the torch bearers of our country. Research about the child nutrition will play key role in all aspects of child health. On one end India is facing problem in feeding the children and there is malnutrition leading to many diseases, but on the other end overweight and obesity is posing great concern. Overweight and obesity is a great risk factor for many metabolic syndromes like hypertension and Diabetes mellitus. They are more prone for coronary artery disease as well. These disorders arise as there are chances of oxidative stress due to lipid peroxidation due to excess lipid available imbalancing the antioxidants available in the body.

This study aims at correlating impairment of cognitive function in overweight and obese school going children in south Indian population. Overweight and obesity poses various health issues immediately as well as on a long-term basis. Cognitive dysfunction is the effect of both short term and long-term health issue due to obesity. There are many studies and hypothesis for establishing the pathophysiology lying behind obesity and cognitive

dysfunction. There are various studies stating that deficiency disorders mainly iron deficiency as one of the reason for cognitive dysfunction. At the same time obesity as a nutritional disorder on the other end is also found to be a reason for cognitive dysfunction according to various studies. Studies are established in other parts of the world, but there are only few studies in Indian population especially south India. There are also evidences that obesity may affect brain structure, leptin and insulin dysregulation, oxidative stress, and inflammation which may be the pathophysiology leading to cognitive dysfunction in obesity and overweight children.

LITERATURE OF REVIEW

Overweight and obesity

The World Health Organization (WHO) defines overweight and obesity as Body Mass Index (BMI) ≥ 25 and BMI ≥ 30, respectively [1]. Obese children are prone for coronary artery disease, hypertension and other metabolic disorders [2,3].

Body Mass Index (BMI) percentile is used as an indicator for classifying the childhood obesity. The exact BMI is not used in classifying the childhood obesity. They BMI is compared with the other children BMI and CDC recommended growth chart is used to calculate percentile in the United states, According to the Indian standards, we use the growth chart updates by the Indian Academy of Paediatrics (IAP) to calculate the percentile [4,5] (Table 1).

Table 1: Categorising BMI percentile.

BMI percentile	Category
Less than 4.9%	Underweight
5%to 84.9%	Normal
85% to 94.9%	Overweight
Above 95%	Obesity

Obesity and cognition

Li, et al. observed that the obese Chinese children have low intelligent quotient than the normal. Overweight and obesity is associated [6].

Mo-suwan, et al. also established that the obese children from Thai are low performers in the school [7]. According to Raine, et al. Physical activity improves cognition in obese children [8]. There are some literatures to prove that dysregulated iron metabolism due to altered hepcidin levels which is considered as the master regulator of iron in human circulation may be one of the reason decrease in cognition in obesity. Studies are there to hypothesise that hepcidin is released by adipose tissue [9-11].

There are also studies to show that iron deficiency is evident in obese children [12-15] and iron plays a vital role in cognition.

Span of attention, sensory perception intelligent quotient are all the part of cognitive which is affected in iron deficiency It is also associated with alteration in metabolic processes in the brain like mitochondrial electron transfer, protein synthesis and also hippocampal function is affected [16,17]. There are also evidences which say that iron deficiency is seen in obesity which is attributed to the altered hepcidin levels in obesity [9-11].

Studies show that cognitive ability is reduced in obese children than the normal BMI studies also proves that there is negative correlation between cognition and BMI z score, waist circumference, visceral fat [18-20].

Atrophy of the frontal lobes and anterior cingulate gyrus, hippocampus is seen in the obese individuals [21] Increase in BMI is associated with lower metabolic activity in the cingulate gyrus, smaller gray matter volume [22-24].

Studies also declare that insulin resistance in obesity may be one of the reasons of cognitive impairment [25]. Studies about adipokines released by the adipose tissue, cytokines and interleukins produced by the adipose tissue can cross the blood brain barrier and affect cognition through inflammation [26]. There are many more studies to help us understand that physical exercise improves cognition [27].

Aim: To study the correlation between obesity and cognitive function in obese school going children representing south Indian population.

Objective:

- To find the Body Mass Index (BMI) percentile in school children between 13 years and 17 years.
- To find the cognitive function using Mini Mental State Examination (MMSE) for all the children
- To group the children based on the BMI percentile into controls (I), overweight (II) and obesity (III).
- To correlate the cognitive function by analysing MMSE scale and BMI percentile statistically between groups I and II, group I and III.
- To establish a link between overweight and obesity with cognitive function.

MATERIALS AND METHODS

After getting written informed consent from the parent/ guardian of the children included in the study and the institutional ethical committee, around 510 children from neighbouring schools of urban setup with age group between 13 years and 17 years of both sexes were recruited for the study. Proper permission was obtained from the school authorities. Questionnaires were distributed to eliminate confounding factors like socioeconomic status, any major illness, any history of drug intake.

Inclusion criteria

All the children of both the sexes with a minimum qualification of 8th grade were included in the study.

Exclusion criteria

- Children with BMI percentile below 5% were excluded from the study because they were considered as under nutrition.
- Children suffering from major illness or chronic drug intake were also excluded

The age is chosen as between 13 years and 17 years of school going children as the MMSE has to be done to individuals with a minimum educational qualification of 8th grade and above according to the recommendations from Tombaugh and McIntyre (1992) in order to maximize the benefits of the MMSE [28].

After recruiting the children between the age group of 13 years and 17 years, their BMI was calculated. The BMI was then plotted on a standard growth chart prescribed by the Indian academy of paediatrics to calculate the BMI percentile [4,5].

Out of 510 children, 18 children had BMI percentile under 5% and therefore they were excluded from the study. The children were grouped based on the BMI percentile as follows (Table 2).

Table 2: Grouping the children based on BMI percentile.

BMI percentile	Category	Group
Less than 4.9%	Underweight	Excluded
5%to 84.9%	Normal	I
85% to 94.9%	Overweight	II
Above 95%	Obesity	III

MMSE test by folstein [29] were performed on all the groups by asking some questions based on folstein scale and scores are given. The total score is for 30. The test is done using set of questions like orientation to time, place, recall, telling the numbers backwards and giving some complex activities. Scores are given to each activity and the added.

The score below 21 between 8th grade and 10th grade is considered as impaired cognition and below 23 between 11th grade and 12th grade is considered as impaired cognition.

The results will be statistically analysed using Pearson's correlation, spearman and kendell correlation between groups I and II, and between group I and III.

RESULTS

The observation in Table 3 shows that there is not much of difference between the MMSE score between control, overweight and obesity.

Table 3: BMI percentile and MMSE score in different groups.

	GROUP I (n=378) MEAN+SD NORMAL	Group II (N= 80) Mean+SD Overweight	GROUP III (n=34) MEAN+SD OBESITY
Age in years	14.9+1.34	14.87+1.37	14.94+1.3
BMI percentile	47.4+22.5	90.5+2.57	96.97+1.76
MMSE score	27.16+2.5	27.2+2.41	26.85+2.67

Table 4: Correlation value of groups and between groups.

	All groups	Group I	Group II	Group III	Group I and II	Group I and III
Pearson correlation	0.054	0.1214	-0.178	-0.25	0.0871	0.078
Spearman Correlation	0.031	0.097	-0.1799	-0.1394	0.0586	0.634
Kendall Correlation	0.022	0.0694	-0.132	-0.1125	0.0419	0.0455

Pearson coefficient (t test)						
Alpha	0.05	0.05	0.05	0.05	0.05	0.05
Corr	0.054	0.1214	-0.178	-0.2509	0.087	0.078
Std err	0.044	0.05118	0.114	0.1711	0.04665	0.049
t value	1.211					
P value*	1.227					
Pearson coefficient (fisher test)						
Rho	0	0	0	0	0	0
Alpha	0.05	0.05	0.05	0.05	0.05	0.05
Corr	0.054	0.1214	-0.178	-0.2509	0.087	0.078
Std err	0.044	0.0515	0.1112	0.174	0.046	0.0493
Z value	1.209					
P value*	0.227					

*P value 0.05 is significant

As in Table 4, the correlation studies of the groups show that when all the children MMSE score is correlated with the BMI without dividing them into groups they are positively correlating, *i.e.* When the BMI percentile increases the MMSE scores also increases. The correlation value shows a weak strength and positive direction.

As in Table 4 correlation studies of group I alone shows similar results as whole sample, *i.e*. the correlation value is positive but far from 1 which means that there is a mild positive correlation, so as the BMI increases the MMSE score is also increasing. The correlation value shows a weak strength and positive direction.

Whereas the correlation studies show a negative value in group II and III which implies that that as the BMI percentile increases the MMSE score is decreasing Table 4. The correlation value shows a weak strength and negative direction.

The correlation studies in Table 4 between the groups namely control and overweight (I and II) and control and obesity (group I and III) shows that the value are in the positive direction but of weak strength.

The alpha value of all the analysis is 0.05 as shown in the Table 4 which means they are correlating either positive or negative but the chances that the correlation does not exist is 5% *i.e*. 1 in 20 will not be correlating.

The rho value in all the analysis within the groups and between the groups as in Table 4 shows 0 which means there is no relationship between the variables.

DISCUSSION

There are few studies to establish the fact that overweight and obesity has role on the cognitive dysfunction indirectly. There are many pathophysiological bases for cognitive dysfunction in basis. Studies show that iron deficiency which may be secondary to rise in hepcidin levels due to its release from the adipose tissue from obese children which plays a key role in iron metabolism may be one of the factor for cognitive dysfunction [9-11]. Studies show that cognitive ability is reduced in obese children than the normal BMI studies also proves that there is negative correlation between cognition and BMI Z score, waist circumference, visceral fat [18-20]. Atrophy of the frontal lobes and anterior cingulate gyrus, hippocampus is seen in the obese individuals [21] Increase in BMI is associated with lower metabolic activity in the cingulate gyrus, smaller gray matter volume [22-24]. Studies also declare that insulin resistance in obesity may be one of the reasons of cognitive impairment [25]. Studies about adipokines released by the adipose tissue, cytokines and interleukins produced by the adipose tissue can cross the blood brain barrier and affect cognition through inflammation [26].

All the above studies make us feel that obesity decreases cognition drastically. In our study as we see from Table 4 we could find that when we take all the 492 children without dividing them into groups the MMSE score [27-29]. Which we have used as a tool to assess cognition increase as the BMI Percentile increases. There is weak but positive correlation between cognition and MMSE score. Similarly group I (control) also shows a weak but positive correlation. But in overweight and obese individuals it is weak but negative correlation between the variables which means that as the BMI percentile increases the MMSE score also decreases. Which is in accordance with the studies referred and mentioned above that cognition is affected as the BMI increases.

But when we compare the results between the groups there is weak positive correlation which means that as the BMI increases the MMSE score increases. When we

analyse the group separately, overweight and obese children show a decline in cognition as BMI increases.

The observation in Table 3 shows that there is not much of difference between the MMSE score between control, overweight and obesity. When we observed individual score, we found that the MMSE score of the normal BMI children varied with a wide range and therefore, it would have made the average of the MMSE score look similar to the score of the overweight and obese children this could have been avoided if the sample size is even more.

Our study shows a weak negative correlation between the variables (cognition and BMI) in obesity and overweight and weak positive correlation in normal BMI children which is not significant. There are also studies which tell us that BMI may not be indicator for cognition. It is the increase in abdominal obesity which is the main reason for all the pathophysiology related to obesity with normal BMI [30].

SUMMARY

The cognition levels of all the children either normal, overweight or obesity is same which may be due to wide range of MMSE score obtained in normal BMI children of our study which has made the average to fall close to the average of the other groups. This may be avoided if more sample size was used. Although the MMSE score are same in all the groups, it is positively correlating in normal group and negatively correlating in overweight and obese but the correlation seems to be weak which is not statistically significant. Once again it may be due to small sample size in group II and III.

CONCLUSION

There is no association between BMI and cognition in our study although the MMSE score decreases as the BMI increases in overweight and obese, the value shows a weak association. There is a need for further research.

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