RESEARCH ARTICLE

ANALYSIS OF BODY MASS INDEX (BMI) AND COGNITION IN ADOLESCENT FEMALES- A CORRELATIONAL STUDY

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Manuscript Info	*Abstract*

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Background: Adolescent is characterised by rapid physical growth and sexual development, accompanied by changes in the percentage of body fat. Obesity and underweight are one of the most prominent problems of the modern society which consists of a wide range of short-term and long-term complications. The rising prevalence of childhood obesity is directly related to the vascular, metabolic condition and risk factor to cognitive decline or dementia. Under-weight is also often associated with acute and chronic medical complications like Anorexia nervosa, low bone density and mass with impaired immune system and increased mortality rate. Therefore purpose of this study is to identify early signs of impaired BMI as a cause of cognitive impairment and prevent the child obesity and underweight to overcome the future health risk factors. The aim of this study is to find a correlation between BMI and MMSE score in Indian adolescent females.

Methodology: 31 female subjects with mean age 16 ± 3 years were selected according to random sampling in this study. The Quetlet's formula was used to measure body mass index. Group division for Underweight, Normal and Over-weight was done for the BMI score then Score of MMSE, a measure of cognition was taken. Data was analyzed using SPSS version 16. The Karl Pearson's Coefficient correlation was calculated to see correlation between BMI and MMSE cognitive function. $P < 0.05$ was considered of statistical significance.

Result: The study found correlative change in variables as observed in group A MMSE mean 25.84 ± 3.83 and BMI mean 16.10 ± 1.08 with $P<0.05$ i.e which was found statically significant. In group B MMSE mean 26.22 ± 1.30 and BMI mean 20.60 ± 1.80 with $P>0.05$ i.e which was found statically non significnat. In group C MMSE mean 23.00 ± 3.46 and BMI mean 26.06 ± 1.15 with $P<0.05$ i.e which was found statically significant. And in total number of subject MMSE mean 25.68 ± 3.3 and BMI mean 18.37 ± 3.51 with $P>0.05$. it was found that there was a significant correlation between the body mass index and cognition in group A and group C but there was no significant

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correlation between body mass index and cognition in group B and total number of subjects(31).

Conclusion: The study conclude to state that there exist a significance correlation and of body mass index on cognition.

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Introduction:-

Adolescence is characterized by rapid physical growth and sexual development, accompanied by changes in the percentage of body fat. Childhood and adolescent obesity has been identified as a risk factor for obesity in adulthood, and it increases adult morbidity and mortality by leading to a variety of adverse health outcomes. On the other hand, under nutrition is still prevalent in developing countries and continues to be a primary cause of poor health. Underweight, overweight, and obesity are increasing worldwide and are emerging as major risk factors for several chronic diseases.[1] Hypertensive individuals are at increased risk of dementia, depression, physical disability.[2]

WHO (1995) proposed the use of BMI to monitor both under nutrition and overweight.[15] The prevalence and severity of overweight is increasing dramatically in children and Adolescents.[16] Body mass index (BMI) is a useful index for the evaluation of obesity. Although in adults a BMI value greater than 28 kg/m^2 is associated with a three to four-fold increased risk of ischemic heart disease, stroke and diabetes mellitus. Increased weight is associated with higher levels of triglycerides and low-density lipoprotein cholesterol (LDL-C) and lower levels of high-density lipoprotein cholesterol (HDL-C).[3] underweight and overweight result from energy deficit and excess, respectively, and are generally thought to be associated with very different environmental, behavioural and individual risk factors. the two conditions are underlying contributors to two distinct types of public health concerns; first, overweight is an important determinant of adult onset diabetes (Lebovitz 1999) heart disease and adverse birth outcomes for pregnant women (Cnattingius et al. 1998, Howard 1999) whereas second, underweight has been associated with low bone mass (Ravn et al. 1999) and all cause mortality (Sharp et al. 1998).[19] Clinicians are increasingly observing adolescents who have lost large amounts of weight, experience typical cognitions and acute medical complications of anorexia nervosa.[14]

Low BMI is associated with an increased risk of developing dementia, whereas high BMI is associated with a lower risk of dementia. In addition, weight loss is associated with an increased risk of dementia suggesting it may be a risk factor or an early sign of Alzheimer disease (AD).[9]

Prospective studies have shown that those with a higher BMI in midlife were at higher risk of cognitive impairment.[4] The immediate risks of obesity for physical health are well established. However, studies based predominantly on western research have shown that obesity in childhood may have adverse effects on cognitive performance and self concept development.[5] High body mass index (BMI) in adolescence has been demonstrate to be strongly related to future coronary heart disease (CHD)[10] but with persistent exposure to the neuropath-logical effects of being overweight or obese, cerebral damage is exacerbated, and progression to dementia occurs.[11]

Nutrition is vital to brain.[7] A large national study of school children 6-18 years was conducted to asses nutritional and socio-cognitive factors associated with body mass index (BMI).[6] For example, as an indicator of parental malnutrition low birth weight (birth weight < 2500g) is associated with cognition, poor school performance and behavioural disorders.[7] Two main changes were revealed in the brain before and after puberty. The brain regions that have consistently been shown to undergo continued development during adolescence are the prefrontal cortex and the parietal cortex. As neurons develop, a layer of myelin is formed around their extension, or axon, from supporting glial cells. Myelin acts as an insulator and massively increases the speed of transmission (up to 100 fold) of electrical impulses from neuron to neuron. Whereas sensory and motor brain regions become fully myelinated in the first few years of life, although the volume of brain tissue remains stable, axons in the frontal cortex continue to be myelinated well into adolescence (Yakovlev & Lecours,1967). The implication of this research is that the transmission speed of neural information in the frontal cortex should increase throughout childhood and adolescence.[8] Brain atrophy involves the loss of tissue volume and is commonly seen with increasing age and neurodegenerative disease.[17] It was well documented that short stature in adolescents indicating prolonged under nutrition is associated with lower lean body mass, deficiencies in muscular strength and productivity.[18]

BMI:- The body mass index (BMI), or Quetelet index, is a value derived from the mass (weight) and height of an individual. The BMI is defined as the body mass divided by the square of the body height, and is universally expressed in units of kg/m2, resulting from weight in kilograms and height in metres.

$$BMI = \frac{MASS(Kg)}{HEIGHT^2(m)} = \frac{MASS(Lb)}{HEIGHT^2(In)} \times 703$$

Cognition:-
Cognition is the activity of knowing the acquisition, organization and use of knowledge including awareness , reasoning , judgment , intuition and memory.[13]

MMSE Scale:-
The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is therefore practical to use repeatedly and routinely.[12]

Methodology:-
It is a co-relational study ,   finding out the correlation between cognitive impairments measured in various subdivisions of Body Mass Index (BMI). This study has been performed in the exercise Lab of Physiotherapy Department, Sardar Bhagwan Singh Post Graduate Institute of Biomedical Sciences and Research, Balawala (Dehradun) and nearby localities. Subjects between the age group of 13-19 years Female only. Body mass index (BMI) Divided into 3 groups, i.e. under-weight(<18), normal(18-24), over-weight (>24). MMSE score above 19 to 30 are included and Subjects having any history of head injury, suffering from any acute condition like fever, malaise associated with neurological conditions and with severe visual and auditory disturbance are excluded. In which ,out of 750 accessible females of Mata Gujri Hostel and nearby localities of Balawala Dehradun, with the age group of 13-19 years females were targeted. Screening was done in the target population and a total of 69 students were selected according to criteria's of the study. A minimum of 31 Female with mean age 16±3 years were selected according to random sampling. All subjects were given verbal instructions for the procedure and informed consent along with the following variables were taken. Height and weight of the subject were taken and the group division i.e. Underweight A (19) , Normal B (9) and Overweight (3) was done. The questionnaire for mini mental state examination was taken then the correlation for each group division i.e. Underweight, Normal and Overweight with cognition was recognized. Data recorded and analyzed,. Karl Pearson's correlation coefficient test is performed for seeing the negative or positive correlation of BMI and cognition. Give 31 females with mean age 16 ± 3 years were selected on the basis of the random sampling Approval was n by Institute Research Committee. Each subject was examined and consent form was taken from all subjects prior to study Value of body mass index was taken . Group division for Underweight, Normal and Over-weight was done for the BMI score. Score of MMSE, a measure of cognition was taken. Hence, the correlation for BMI group divisions i.e. Underweight, Normal and Over-weight with Mini mental state examination (MMSE) was analyzed.

Result:-
Correlation between body mass index and cognition in adolescent female observed in this study. The significant level has been selected as 0.05 and Karl Pearson's correlation coefficient test is performed for seeing the negative or positive correlation of BMI and cognition. If the value of correlation coefficient (r) lies between 0 and 1 then there is a positive correlation and if it lies between 0 and -1 then it is a negative correlation.
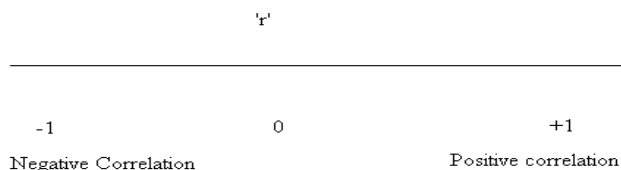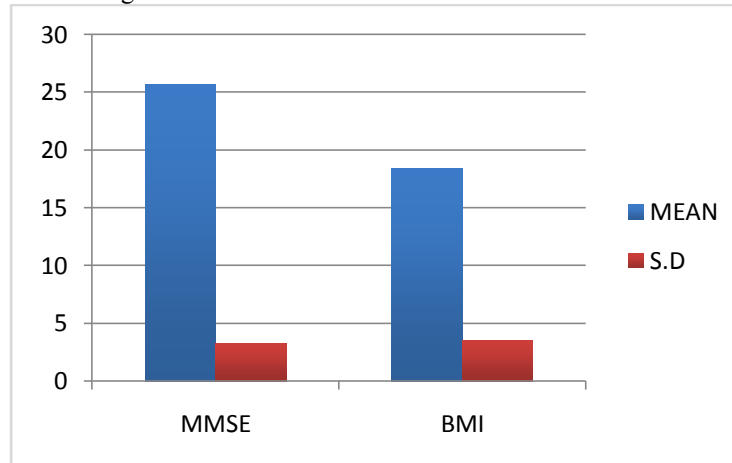
'r'
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-1   0   +1

Negative Correlation   Positive correlation

Table 4.1:- Showing mean and std. Deviation of MMSE and BMI in the total no. of sample.

	MEAN	STD. DEVIATION	N
MMSE	25.68	3.3	31
BMI	18.37	3.51	31

Graph 4.1:- Showing mean and std. Deviation of MMSE and BMI in total no. of sample.

Table 4.2:- Showing mean and std. Deviation of MMSE and BMI in various groups (A,B and C).

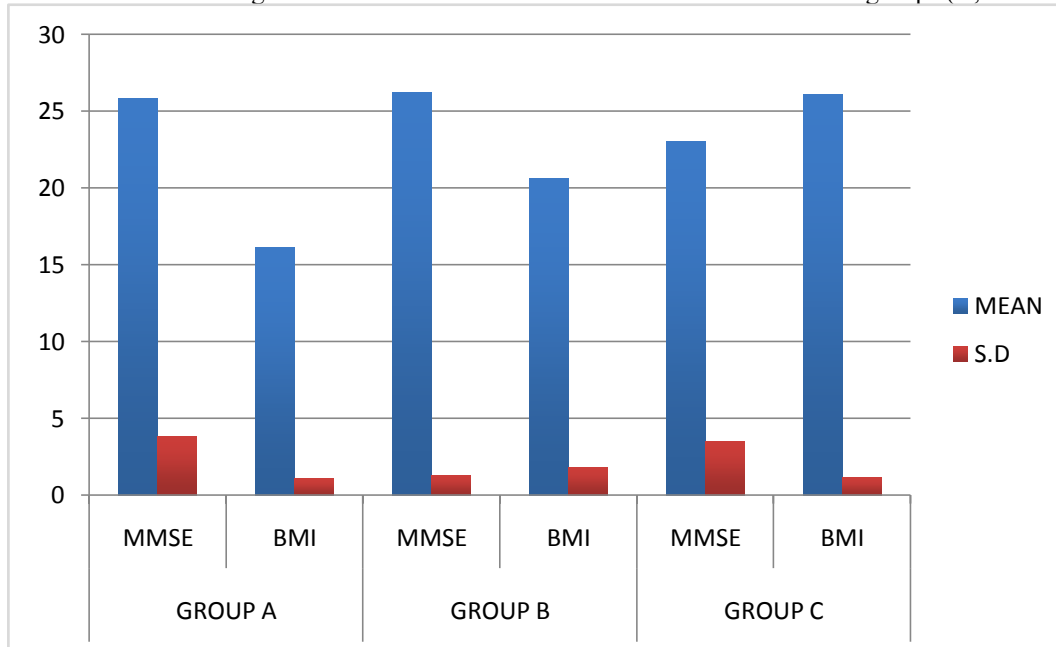| GROUP	VARIABLES	MEAN ± S.D	N
A	MMSE	25.84 ± 3.83	19
	BMI	16.10 ± 1.08	19
B	MMSE	26.22 ± 1.30	9
	BMI	20.60 ± 1.80	9
C	MMSE	23.00 ± 3.46	3
	BMI	26.06 ± 1.15	3

GRAPH 4.2:- Showing mean and std. Deviation of MMSE and BMI in various groups (A,B and C

Table 4.3:- Showing correlation between MMSE and BMI in GROUP A i.e. 19 samples.

GROUP	r - value	Significance value	P- value
Correlation between MMSE and BMI	.518	.023	P < 0.05

The above table is showing the correlation between the body mass index (BMI) and mini mental examination (MMSE) in group A. The result value found to be significant as the P value less than 0.05.

Graph 4.3:- Showing correlation between MMSE and BMI in group A.
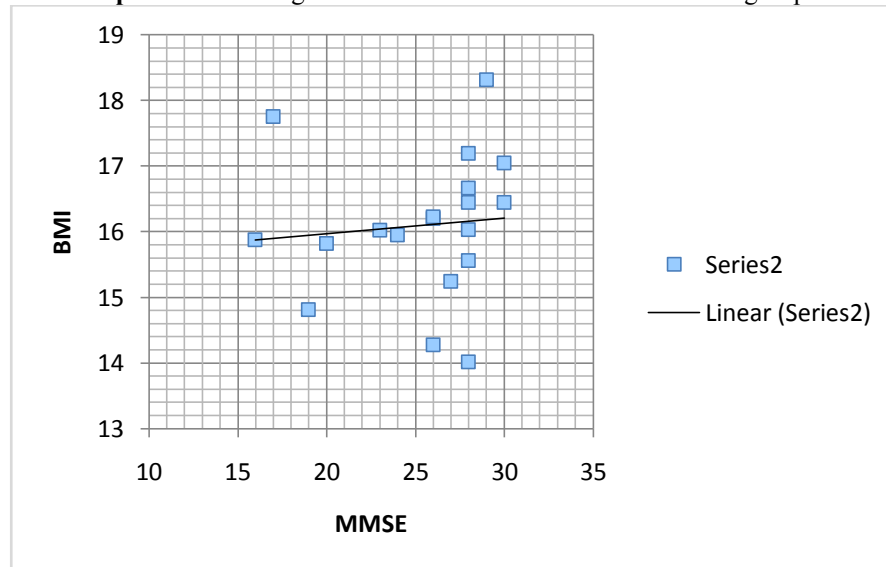
Table 4.4:- showing correlation between MMSE and BMI in GROUP B i.e. 9 samples.

GROUP	r – value	Significance value	P- value
Correlation between MMSE and BMI	.-325	.394	P >0.05

The above table is showing the correlation between the body mass index (BMI) and mini mental examination (MMSE) in group B. The result value found to be non significant as the P value more than 0.05.
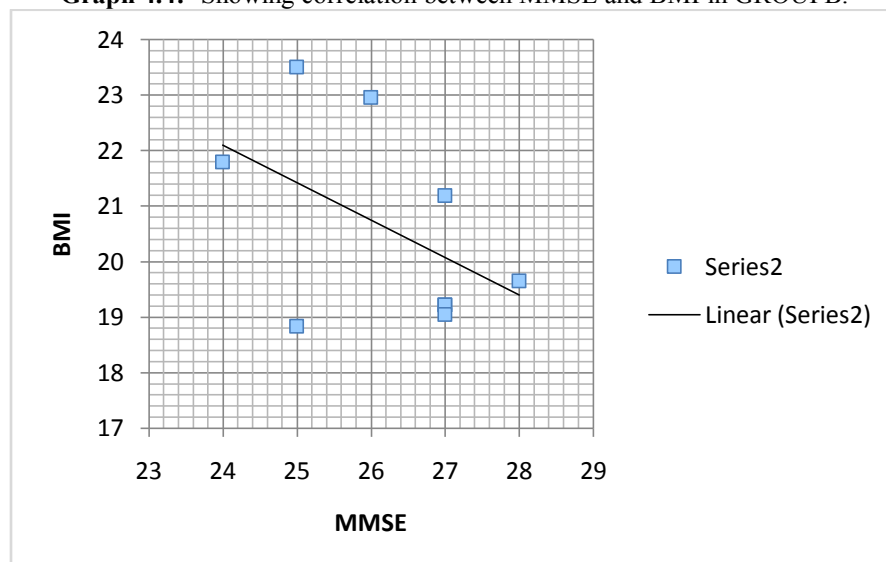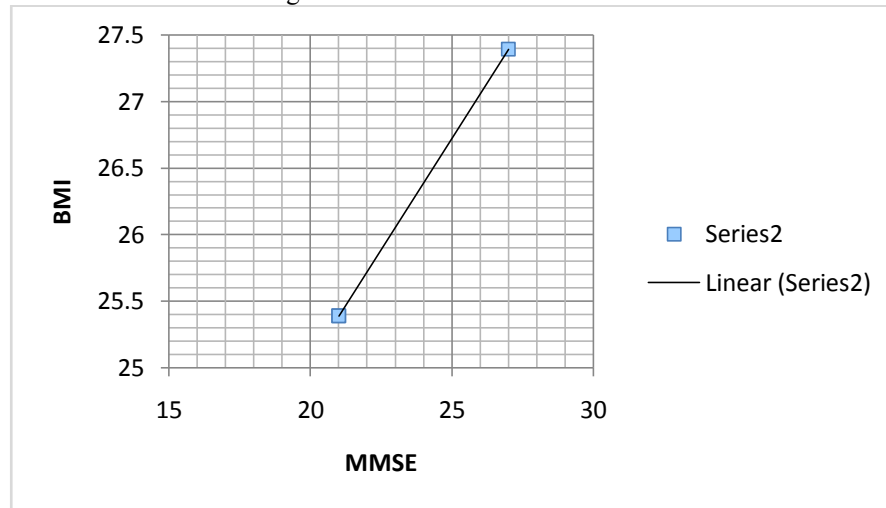
Graph 4.4:- Showing correlation between MMSE and BMI in GROUPB.

Table 4.5:- Showing correlation between MMSE and BMI in GROUP C i.e. 3 samples.

GROUP	r - value	Significance value	P- value
Correlation between MMSE and BMI	1	.	.

The above table is showing the correlation between the body mass index (BMI) and mini mental examination (MMSE) in group C.

The result value found to be significant as the P value less than 0.05.

GRAPH 4.5:- showing correlation between MMSE and BMI in GROUP C.

Table 4.6:- Showing correlation between MMSE and BMI in the total 31 samples.

GROUP	r - value	Significance value	P- value
Correlation between MMSE and BMI	-.018	.923	P > 0.05

The above table is showing the correlation between the body mass index (BMI) and mini mental examination (MMSE) in total no. of samples.

The result value found to be non significant as the P value more than 0.05.

Graph 4.6:- Showing correlation between MMSE and BMI in the total 31 samples.
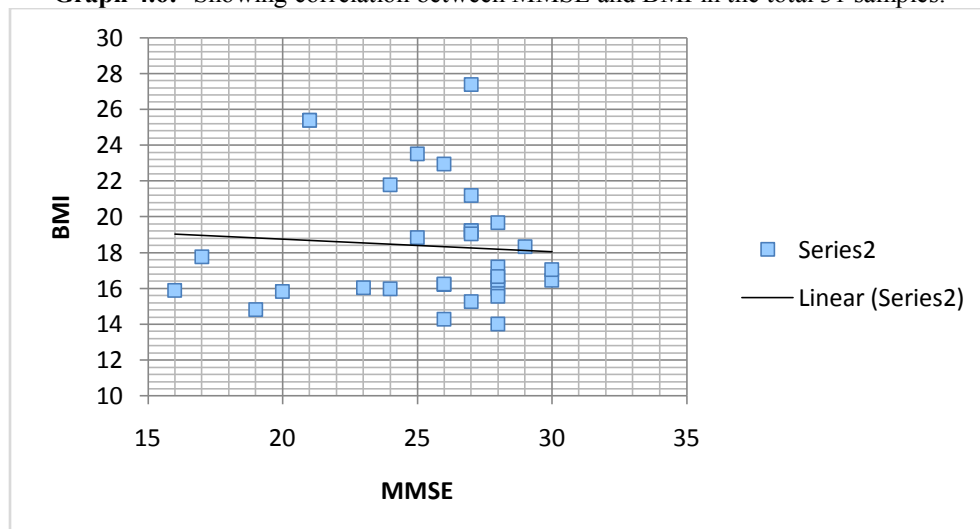
Discussion:-

The aim of this correlative study was to find the correlation between the body mass index (BMI) and cognition in adolescent females. The study design comprises of 31 female subjects and further divided into three categories i.e. underweight(19 subjects), normal(9 subjects) and overweight(3 subjects).After the data analysis, it was found that there was a significant correlation between the body mass index and cognition in group A and group C but there was no significant correlation between body mass index and cognition in group B and total number of subjects(31).

In the few previous studies conducted in middle-aged populations, a higher BMI in midlife was found to be associated with lower cognitive scores in multiple domains both in cross sectional and longitudinal analyses. Vascular disease is likely to underlie the association between obesity and cognition because obesity is a risk factor for vascular disease.[4] Underweight could be a result of poor health a further possibility is that underweight persons experience a dysregulation in hormone secretion corresponding to that in anorexia, which results in cognitive disorders. Further investigation of the mechanisms underlying the cumulative effects of underweight on later cognition would be an important topic for future research. There is clear evidence of poor cognition for persons in the underweight and the overweight and obese categories[4]

In older people, BMI is a strong predictor of skeletal muscle mass, which seems positively related to cognitive abilities.[21] Second, greater BMI is associated with better cardiac output and stroke volume and may thus improve cerebral blood flow and cognition. Finally, BMI has an inverted-U relationship with serum levels of insulin-like growth factor (IGF-1), with highest IGF-1 levels observed in those BMI between 25 kg/m2 and 27 kg/m Higher IGF-1 levels exert beneficial cognitive effects in terms of better frontal-executive functions (set shifting and psychomotor speed) and less cognitive decline in elderly people. Such evidence supports the findings of this study regarding the nonlinear inverted-U relationship between body weight status and cognition.[20]

The authors have suggested that perhaps obesity leads to thickening and hardening of cerebral blood vessels and the development of insulin resistance. In another study, Raji *et al*27 have reported that BMI>30kg/m2 was associated with atrophy in frontal lobes, the anterior cingulated gyrus, hippocampus and thalamus as compared to normal weight individuals.[5]

Cognitive dysfunction and vascular disease are common conditions that often coexist in elderly people, and causal connections can be difficult to establish. It is generally assumed that the main risk factors for dementia syndromes of vascular origin are the same as for ischemic stroke, i.e. hypertension, cardiovascular disease, diabetes and smoking. A low educational level is another factor that, according to recent studies, is related to an increased risk of developing a dementia disorder.[25]

Relationships between BMI and cognitive test scores have already been evidenced in a few previous studies, such as the Framingham Study.[24]Underweight, overweight, and obesity are increasing worldwide and are emerging as major risk factors for several chronic diseases.[1]Hypertensive individuals are at increased risk of disability, independent of other cardiovascular complications and stroke. The mechanisms by which hypertension may lead to these impairments are not known. This was specific to hypertension, but not other vascular factors such as CHD, CHF, or diabetes. White matter hyper intensities (WMH) identified on brain imaging are closely related to hypertension and have been linked with mobility impairments, dementia, and depression.[2]

Under nutrition continues to be a cause of ill health and premature mortality among children and adolescents in developing countries like India. The two most commonly used indicators of under nutrition among adolescents are underweight (low weight for age) and stunting (low height for age).[18] puberty represents a period of synaptic reorganisation and as a consequence the brain might be more sensitive to experiential input at this period of time in the realm of executive function and social cognition.[8]

The identification of causal relations between potential risk factors and cognitive impairment of vascular origin is an urgent field of research. At present, it seems reasonable to consider individuals with signs of cognitive impairment as being at higher risk of further cognitive decline. This decline is potentially preventable by more intensive treatment of risk factors.[25]

Conclusion:-
The study conclude to state that there exist a significance correlation and of body mass index on cognition.

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