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Cognitive benefits of good nutrition: Investigating memory performance in young adults

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ABSTRACT

Background: During early adulthood Nutrition plays a pivotal role in supporting cognitive functions. Evidence suggests that nutritional deficiencies and imbalanced dietary habits are associated with impaired cognitive performance. However, the precise relationship between specific nutritional indicators and memory in young adults remains insufficiently elucidated.

Aim: The study aimed to investigate the association between nutritional status and memory performance among young adults, focusing on how anthropometric, biochemical, and dietary factors may influence cognitive functioning.

Materials and Methods: This cross-sectional study included 106 healthy participants aged 20–22 years. A well-structured questionnaire and blood analysis was performed for data collection regarding sociodemographic data, Nutritional status and dietary profile. Memory performance was evaluated using the PGI Memory Scale.

Results: Underweight individuals showed the highest proportion of below-average memory scores, with a statistically significant association between BMI and memory performance in this group. In contrast, participants with normal, overweight, and obese BMI categories exhibited higher proportions of average to excellent memory, though without statistically significant associations. Dietary analysis indicated a balanced intake of cereals, pulses, vegetables, and fruits, but also revealed a high frequency of fast food and sugary item consumption, suggesting a mixed dietary pattern among participants.

Conclusion: The study highlights a significant link between undernutrition and reduced memory performance in young adults, emphasizing the importance of balanced dietary habits during early adulthood. consistent nutritional monitoring and public health strategies are essential to promote cognitive health and prevent the adverse effects of poor dietary patterns.

KEYWORDS: Cognition, Nutritional status, Malnutrition, Obesity.

INTRODUCTION

In recent decades, there has been a growing emphasis on the impact of young people dietary status on cognitive performance. Cognitive functioning refers to our ability to gather and utilize knowledge in order to adapt to changes in our surroundings. Attention, memory, thought, and perception are all examples of cognitive processes [1]. The memory process includes encoding, consolidation, and retrieval. Nutritional status has been demonstrated to be an important factor in cognitive performance at school, in higher education, and in the workplace [2]. Researchers have identified intelligence as a trait impacted by both hereditary and environmental influences. Although genetic factors are primarily responsible for cognitive abilities, environmental effects play an important role in their stability and development [3].

Nutritional aspects:

Every single cell in the living body, even neurons, derive fuel from calories found in foods containing carbohydrates, amino acids, and lipids. Furthermore, micronutrients aid in the effective transmission along these pathways, as does the creation of neurotransmitters, known as chemical substances in the brain that aid in the transport of sensory data across synapses. Certain vitamin or mineral deficits or excesses can affect brain nerves, altering memory, diminishing abilities to solve problems, and decreasing cognitive abilities [5].

Poor diet can have an impact on the brain's quickly developing cognitive processes. Young people are particularly prone to unhealthy eating habits due to rapid changes in physical growth and mental development; thus, their dietary needs are not met [6]. Some harmful food habits among young adults include skipping meals, eating away from home, snacking, and consuming fast food [7,8]. Body mass index (BMI) is a vital factor of cognition, academic success, attendance, conduct, and physical wellness in children, and critical indications for defining adolescents' nutritional health [9]. Anthropometric measures are Dietary status is the total of an individual's anthropometric parameters as impacted by the consumption of nutrients and utilization, as evaluated by data from physical, biochemical, and dietary investigations [10]. Some research on brain activity in low- and high-BMI participants revealed that persons with greater BMI had lower activity in memory networks than those with normal weights. [11]

New research has found that obese adolescents perform worse on cognitive tests, implying that nutrition may possibly have an impact on their cognitive abilities. Malnutrition is generally caused by inadequate consumption of macronutrients and micronutrients. Micronutrient levels are critical for healthy childhood development. Severe Anemia, which can be caused by a shortage of iron, folate, or vitamin B12, among other factors, has a negative impact on work capacity, intellectual performance, and child cognitive development [12].

In addition, epidemiological and experimental research indicate that certain food groups found in these dietary patterns, including as fruits and vegetables, legumes, whole grains, nuts, and olive oil, may benefit cognitive functioning [13,14]. Specific nutrients, such as unsaturated fatty acids and antioxidants, have also been linked to a lower incidence of cognitive decline [15]. Young people from low-income socioeconomic status groups have been shown to have poor nutrition, lower calcium intakes, restricted access to medical care, and a lack of immunization. Another study found that there is a strong and favourable association between socioeconomic level and cognition among adolescents [16].

AIM OF THE STUDY

The study seeks to explore how variations in nutritional intake may influence different domains of memory functioning. Through this research, the goal is to understand whether nutritional patterns and physical health markers are significantly linked to cognitive performance during early adulthood.

THE OBJECTIVES OF THE STUDY:

1. To assess the nutritional status of young adults using Body Mass Index (BMI), Mid-Upper Arm Circumference (MUAC), skinfold thickness, dietary assessment like Food Frequency Questionnaire, haemoglobin levels, RBC count and Haematocrit.
2. To examine the correlation between nutritional status and memory test performance among study participants.

METHODOLOGY

The study was conducted on 106 healthy volunteers taken based on the inclusion and exclusion criteria.

Inclusion criteria: According to inclusion criteria the subjects are taken in the age group of 20–22 years out of which 67 were females and 39 were males.

Exclusion criteria: Participants with neurological and psychiatric disorders, history of head injury, Family history of Psychiatric illness, antidepressants and other disorders which could affect memory. The objectives and procedure of the study were explained to the subjects. The ethics committee for human subjects approved the study. The experiment was performed at Psychiatric department, Srinivas hospital, Mukka, Mangalore. conducted in morning in a sound proof room in sitting position.

TOOLS OF THE STUDY:

The study design and methods were carried out from February 2024 to January 2025. A cross-sectional study approach, based on previously validated questionnaire was adopted in this study. A self-administered questionnaire on eating patterns was employed, taken from earlier published studies [17]. The questionnaire consisted of three parts. The first part included questions concerning demographic data such as age, gender, education level. The second part on socioeconomic data. based on the three main criteria: Education level of the head of the family, Occupation of the head of the family, Family income. Revised Kuppuswamy's socioeconomic scale [18]. the third part on the questionnaire consisted of questions on general dietary habits, food consumption pattern, food frequency per day and type of meals consumed (10 items) and questions on frequency of consumption of Fast-food/fried items/snacks/Drinks(9items) in this section, food items were categorized into main dishes, side dishes, snacks, and beverages to understand consumption patterns. For this study:

- Main dishes referred to staple meals typically forming the core of lunch or dinner, such as rice with curry, chapati with vegetables, or pulao.
- Side dishes included accompaniments like fried items, pickles, salads, or small servings of additional preparations that complement the main dish.
- Snacks encompassed baked foods, savouries, junk food, and sweets consumed between meals.
- Drinks included both desserts like milkshakes and sugary beverages.

The anthropometric assessment includes measurements of height, weight, and body composition to determine the nutritional status of participants.

Height and Weight Measurement:

A calibrated stadiometer was used to measure height to the nearest 0.1 cm, and a Digital Weighing Scale was used to measure weight to the nearest 0.1 kg.

Body Mass Index (BMI):

A person's body mass index can be used to assess their nutritional state and identify whether they are underweight, overweight, or obese. It was calculated using the height and weight of the individual by using the formula: BMI = Weight in Kg/ height in m2. the obtained results were compared to the WHO standards and the individuals were classified as Underweight: BMI < 18.5 kg/m^2, Normal weight: BMI 18.5–22.9 kg/m^2, Overweight: BMI 23.0–24.9 kg/m^2, Obesity: BMI < 25 Kg/m2 according to their BMI. [19].

Mid Upper Arm Circumference (MUAC): Measured at the midpoint between the shoulder tip and elbow tip (on the left arm) using a measuring tape.

Skinfold Thickness Measurement: A skinfold calliper was used to assess subcutaneous fat, estimating body fat percentage or fat mass.

Blood Test Analysis: Blood samples were taken from all participants using a sterile technique.

Hemoglobin, Red blood cell and hematocrit were estimated through laboratory test. The blood sample collection, testing and analysis were conducted by a standard clinical laboratory.

Memory Test:

A standardized memory test battery was administered to assess different memory domains, such as short-term memory, long-term memory, and working memory.

Battery of memory test - The PGI memory scale is a validated memory scale has been employed it has 10 subtests assessing verbal and nonverbal memory, remote memory, recent memory, short-term memory, and long-term memory [20].

STATISTICAL ANALYSIS:

Data were analysed using SPSS version 25. Descriptive statistics were calculated and results were expressed as mean ± standard deviation (SD) for continuous variables and frequencies and percentages for categorical variables. An Independent Samples t-test was used to compare the means of two independent groups to determine whether there was a statistically significant difference between them. The Chi-square test was applied to assess the association between categorical variables. One way ANOVA was used to compare the means among three or more independent groups. For all statistical tests, a P-value less than 0.05 was considered statistically significant.

RESULT

The sociodemographic data are presented in Table 1. Out of a total of 106 participants, 39 (37%) were male and 67 (63%) were female. Both groups had a similar mean age of approximately 20 years (males: 20 ± 0.12 years; females: 20 ± 0.13 years), indicating a homogenous age distribution. In terms of

socioeconomic class, no individuals were from the lower class. The vast majority belonged to the middle class, with 38 males and 66 females, and only a very small proportion—1 male and 1 female—coming from the upper class. This distribution suggests that the participants were predominantly young adults from a middle-class background.

Table.1 *(Sociodemographic Profile of the Participants)*

Variables	Male(N=39)			Female (N=67)				
	Number	%	Mean ±SD	Number	%	Number	%	Mean ±SD
Age	39	37	20±0.12	67	63	106	100	20±0.13
Socioeconomic Class								
Lower Class	0	0				0	0	
Middle Class	38	37		66	63	104	98	
Upper Class	1	50		1	50	2	2	

when we compare anthropometric measurements between males and females, including height, weight, Body Mass Index (BMI), Mid-Upper Arm Circumference (MUAC), and skinfold thickness (Table 2). The statistical significance of differences between genders is evaluated using p-values. The results indicate that height does not significantly differ between males and females ($p = 0.26$). However, weight ($p < 0.001$) and BMI ($p < 0.001$) show significant differences, with males having higher mean values compared to females. Conversely, MUAC is significantly higher in females than in males ($p < 0.001$), suggesting a greater upper-arm fat and muscle mass in females. But skinfold thickness is nearly identical between males and females (mean = 23 mm for both), with no statistically significant difference ($p = 0.714$), indicating similar subcutaneous fat deposition across genders.

Table.2 *(Assessment of Anthropometry and blood variables of the participants)*

sl.no.	Variables	Male(N=39)		Female (N=67)		
		Mean	SD	Mean	SD	P-value
1	Height	159	9	157	8	0.26
2	Weight	59	10	50	9	<0.001
3	Body Mass Index	23	3	20	3	<0.001
4	MUAC	26	3	29	5	<0.001
5	Skinfold Thickness	23	9	23	9	0.714
6	Haemoglobin	15	2	13	2	<0.001
7	Red blood cell count	5.4	0.6	4.7	0.48	<0.001
8	Haematocrit	46	5.6	41.1	4.8	<0.001

Also, our study indicate that males have significantly higher hemoglobin levels (mean ±SD 15±2) compared to females (mean ±SD 13±2), with a highly significant p-value ($p < 0.001$). Similarly, the RBC

count is higher in males (MEAN ±SD 5.4±0.6) than in females (mean ±SD 4.7±0.48), also showing a statistically significant difference ($p < 0.001$). Hematocrit, which represents the proportion of blood volume occupied by red blood cells, is notably higher in males (mean = 46%) compared to females (mean = 41.1%), with a significant p-value ($p < 0.001$) (Table 2). Physiologically male have more RBC, Hemoglobin and hematocrit value than female It is mainly due to an effect of sex hormones on erythropoiesis [21].

When the correlation between the memory score of the participants with different groups of BMI was examined the underweight Group (N= 24) shows Highest proportion of Below Average Memory (11 out of 24). And a significant association with memory performance ($F = 3.764$, $P = 0.027$), suggesting BMI may influence memory in this group. Normal Weight Group (N = 42) shows Majority of the participants fall under Above Average and Excellent Memory (26 out of 42). The ANOVA test shows no significant association ($F = 1.874$, $P = 0.167$). Overweight Group (N = 17) participants Memory scores are more evenly distributed, with a slight gradient towards Excellent Memory (7 out of 17). Statistical test suggests no significant impact ($F = 1.46$, $P = 0.271$). Obese Group (N=23) participants show High proportion in Above Average (12 out of 23) and Excellent Memory (7 out of 23). The lowest F-value ($F = 0.493$, $P = 0.618$) suggests no statistical association (Table 3).

Table.3 *(Correlation of memory test performance with BMI)*

Sl.no	Body Mass Index	Below Average memory	Average Memory	Above Average Memory	Excellent	Total	F-value	P-value
1	Underweight	11	2	5	6	24	3.764	<0.05
2	Normal weight	16	0	13	13	42	1.874	0.167
3	overweight	7	1	2	7	17	1.46	0.271
4	Obesity	4	0	12	7	23	0.493	0.618

The result of frequency at which different food items are consumed by respondents, shows distinct patterns in daily and weekly intake. (figure 1) Cereals are mainly consumed on a daily basis, with the largest group (37%) having them once a day and a notable number also having them twice a day (20%). Pulses show a similar trend, with 25% of respondents consuming them twice daily and 23% once daily, while a significant proportion (35%) report a twice-weekly intake. Animal-based proteins (egg, milk, fish, meat) are also incorporated regularly, as 23% consume them three times a day and 26% once daily, with additional consumption occurring on a weekly basis. Green leafy vegetables and other vegetables are consumed both daily and weekly, indicating that these items are a regular part of the diet, though with a varied pattern (for example, 26% consume green leafy vegetables once daily and 23% twice a week). Roots and tubers display a more moderate consumption, with the highest percentages being those who consume them twice daily (27%) or twice weekly (20%). Fruit consumption is relatively frequent, with 22% having them three times daily and another 22% twice a week, suggesting that fruits are an integral component of the diet. Nuts have a diverse consumption pattern, with 27% consuming them twice weekly and 20% once daily, reflecting variability in how often they are included in meals. Sugar is consumed quite regularly, as evidenced by 30% of respondents reporting a three-times-daily

intake, while fats and oils are also common, with 25% consuming them three times daily. Overall, these results illustrate a diverse dietary pattern where staple items like cereals, pulses, and sugar are consumed multiple times daily, complemented by regular but slightly less frequent intakes of vegetables, fruits, proteins, and other items.

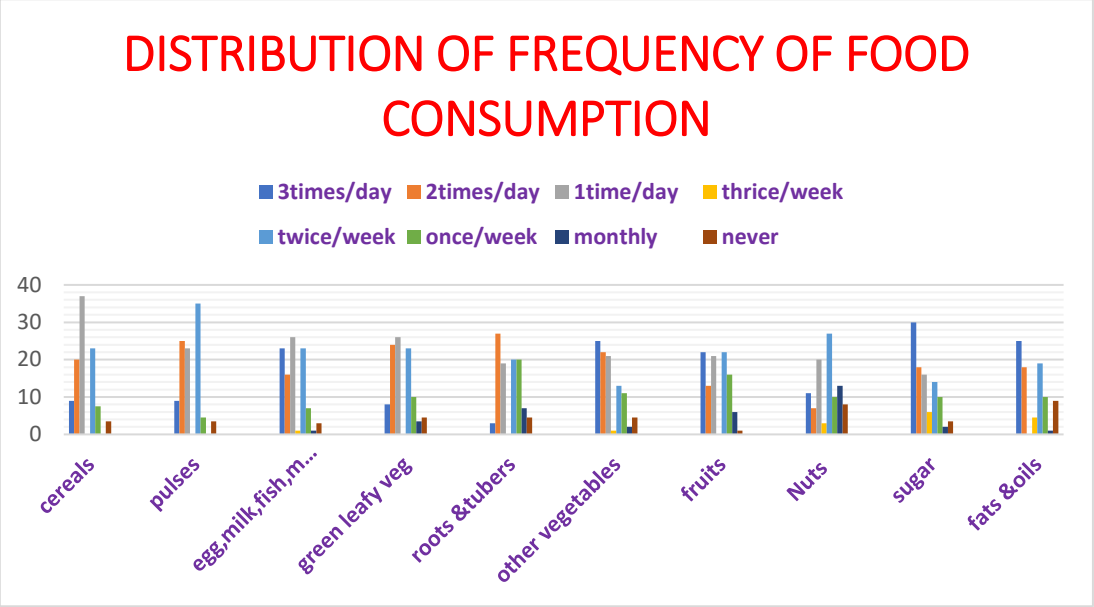

Figure 1 *(Distribution of frequency of food consumption pattern among study participants in percentage)*

The Main dishes and side dishes are consumed most frequently, (Figure.2) with the majority of respondents eating them either twice (41% and 25%, respectively) or once daily (27% and 25%, respectively), indicating their importance in daily meals. Baked foods, savories, and junk food show varied consumption patterns, with a significant proportion consuming them once daily (30%, 26%, and 15%, respectively), while others consume them weekly or less frequently. Notably, junk food consumption is spread across different frequencies, with 25% eating it twice daily and 17% consuming it twice a week, suggesting its regular inclusion in diets despite health concerns.

Desserts and drinks are commonly consumed, with 21% having them once daily, 22% twice weekly, and 15% once weekly, reflecting a mix of daily and occasional intake. Sweets also exhibit diverse consumption patterns, with a notable percentage consuming them daily (19%) or weekly (21% twice weekly and 18% once weekly). Spreads and processed foods are consumed less frequently, with many respondents having them once a week or less, and a notable portion (14% for spreads and 11% for processed foods) never consuming them.

Overall, the data suggests that the high intake of junk food and desserts indicates a preference for convenience and taste, while the moderate consumption of processed foods and spreads suggests a more controlled intake of highly processed items.

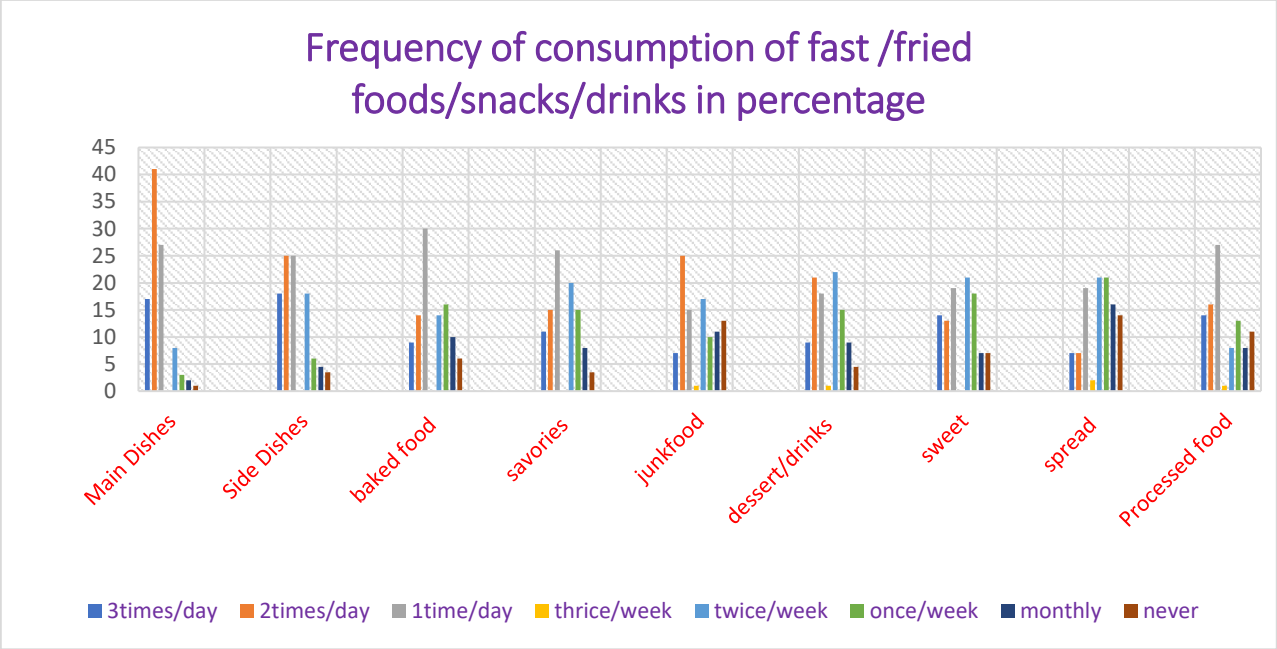

Figure 2: *(Frequency of consumption of fast /fried foods/snacks/drinks in percentage.)*

DISCUSSION

The purpose of this study was to evaluate the nutritional status and analyse the relationship between BMI and memory status in the younger population.

In our findings, underweight (N=24) peoples were higher than the obese (N=23) and overweight (N=17) people. The other study involving university students reported that the proportion of underweight students was higher than the obese and overweight students [22]. A similar outcome indicating that getting underweight could be an impending issue of concern among medical students [23]. Being underweight has also been related to a variety of ailments, including lowered immunity, osteoporosis, anaemia, and psychological disorders. [24]

The results of the present study suggest that underweight group shows highest population of below average memory. This finding is strengthened by the fact that underweight people have a 34% greater risk of dementia than normal-weight people, whereas 29% of very obese individuals have a lower risk [25]

In our study majority of the obese participants shows excellent and above average memory score which was supported by previous study Higher BMI in early adulthood and midlife was associated with better cognitive performance, particularly in memory-related tasks [26] As per our finding's cereals, egg, milk, fish. meat and green leafy vegetables are consumed once in a day. fruits, sugar, fats, oils are consumed three times a day. and pulses, nuts are consumed twice a week indicating healthy consumption pattern except sugar. This balanced approach to nutrition suggests a focus on whole foods while limiting added sugars, which can contribute to various health issues when consumed excessively. By prioritizing nutrient-dense foods, individuals can support their overall well-being and maintain a healthier lifestyle. Previous study revealed multiple nutrients that primarily regulate overall cognition [27]. Other studies describe the effect of appropriate diet consumption on executive function [28].

Also, in our study frequency of fast food, bakery items, savouries and processed food are consumed daily once it becomes evident that many individuals are not only indulging more frequently but are also failing to prioritize healthier food choices. Then dessert/ drinks, sweat, spread are consumed twice a week indicating higher intake of junk food and moderate consumption of processed foods and spread. they contribute significantly to an overall pattern of unhealthy eating [29] This combination of behaviours suggests an urgent need for public health initiatives that promote awareness of the impacts of these dietary trends and encourage more balanced eating practices for improved well-being.

Limitation: The sample size could have been larger in this study, and the predominance of female participants may have influenced the BMI subclassification. Additionally, data on the student's current residence were not collected, as most were hostel residents likely consuming similar food, potentially limiting dietary variability.

CONCLUSION

Our goal was to investigate whether Poor dietary habits have been associated with various health issues particularly memory impact and its onset could begin as early as adulthood. It's essential to raise awareness about how our dietary choices impact our overall health and nutrition. This research underscores the importance of consistently monitoring BMI over a person's life to better understand how body weight may influence cognitive function.

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Ethical Approval and Consent to Participate: This study was approved by the Ethics Committee of Srinivas University (Ethics Code: 33/Ahs/2023) on 13 December 2023. All participants provided written informed consent prior to enrolment in the study. This manuscript has not been published, submitted, or accepted for publication elsewhere.

Conflict of Interests: The authors declare there is no conflict of interests.

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