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Research Article

Anthropometric measurements and its relation with Attention Span and Memory Retention

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Abstract

To study the relation between anthropometry and attention span and memory retention among school children, a total of 240 subjects aged 13-15 years with frequent consumption of fast food were selected from three private and three government schools of Ludhiana city. Anthropometric profile of the subjects was collected and BMI was calculated. Attention span by D2 Attention Span test by Brickenkamp (1962) and memory retention test (Bhatia 1955) were conducted among the selected subjects. Further, the correlations between different variables were assessed which revealed that majority of the children were underweight. The memory retention scores were found to be slightly higher among private school children than in government school children. The girls from private schools were having better attention span than their counterparts in government schools. BMI showed a positive correlation with the fast food consumption and a negative correlation with the attention span.

Keywords: Anthropometry, Memory retention, attention span, BMI

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Introduction

Anthropometry is broadly accepted as one of the successful techniques to estimate the growth and nutritional status of an individual or population [1, 2]. Today, anthropometry is being used in many studies practically; for example, for assessing the nutritional status and for monitoring the growth pattern of children. The study of human body measurement is known as anthropometry which is basically used in anthropometrical classification and comparison. The fitness and well-being of kids and teenagers depends upon the food consumption providing desired energy and nutrients to encourage ideal physical growth, social and cognitive development [3]. Lack of energy, poor concentration and obesity leads to inferiority complex, heart disease, depression, high cholesterol, premature ageing, stunted growth and tooth decay [4] are the main ill effects of regular consumption of fast foods. Apart from the physical growth, mental health is also very important for proper growth in children. The process or mental action of acquiring knowledge through thought, experience and senses is known as cognition. There are various components of cognition such as attention, memory, executive functions, visuo-spatial functions, comprehension, learning, motor speed and expressive speech. Out of these, the encoding, storage, and retrieval of information is indicated by memory, which is very important from a developmental viewpoint because the capability to hold information and process it, supports various higher level accomplishments such as language, categorization and social cognition [5]. The recollection of held information in the mind in response to an external stimulus is called 'Retrieval', and the capability to hold information is called 'Retention'. Memory 'Retention' and 'Retrieval' are considered as the prime memory processes [6]. Cognitive research literature has emphasized that these processes are linked to one another and also to factors such as learning, testing and capacity limit of memory, attention demand, and complexity of material. The conventional concept of learning and retrieval is that learning takes place during events of studying, while retrieval helps to assess the learned contents [7-9].

The array of brain dysfunction can be defined by a neuropsychological assessment. Neuropsychological measures can exhibit the delay in normally developing cognitive processes as well as permanent cognitive deficits. A primary target would seem to be short-term working memory as an index of how nutrition affects cognitive development in young children [10]. Latest proofs and findings propose that consuming excessive amount of dietary fat, mainly saturated fat and trans-hydrogenated oils (trans-fatty acids: TFA) can hamper learning and memory. Also, central obesity, which might get induced by neonatal injections of MSG i.e. Monosodium Glutamate, can again reduce the grasping and memorizing capabilities [11].

Materials and Methods

The study was conducted in three private and three government schools of Ludhiana City. At least 40 students of eighth standard were taken from each school. Thus, making a total of 240 students. Stratified random sampling was used for selecting students in 13-15 years age group from co-educational schools of Ludhiana city. Demographic profile of the respondents pertaining to gender (male/female), annual family income, background (rural/urban), educational background of parents, occupation of mother, food habits, meal patterns and frequency of fast food consumption was collected. Further, anthropometric profile was also recorded and BMI was calculated.

Attention span was assessed with the help of D2 Attention Span test [12]. The purpose of this test was to assess constant attention and visual scanning capability of the subjects. The test page consisted of 14 lines and 47 signs with letters in each. Each line consisted of 16 different letters, 'd' or 'p' marked with one, two, three or four small dashes. During the test, the participant had to look for "d"s having two dashes and ignored the dissimilar letters and had to scan the lines to strike them off. The test subject was given 20 seconds for every line. The test can be applied individually or in group. Scores of d2 test and their meanings are given [13] below:

- **Total Number of Items Processed (TN):** It is the quantitative measure of performance of all items processed both appropriate and inappropriate ones.
- **Total Number of Errors (E):** It contains the errors of omission (E) and errors of commission (E2).
- **Percentage of Errors (%E):** It is a variable that measures the quality of performance. It denotes the fraction of errors made across all items processed. Lesser the percentage of errors, better is the subject's accuracy, quality of the task and attention level.
- **Total Number-Errors (TN-E):** It represents the total number of items processed minus the errors. TN-E represents the Total Performance score. TN-E, shows a normal distribution, it is extremely dependable and it provides a gauge of correlation between accuracy and speed of the performance. However, TN-E gives less importance to the qualitative side of the performance and gives more weight to its quantitative side. Under rare circumstances, when qualitative and quantitative scores i.e. total score and percentage of errors are abnormally high; TN-E has a propensity to overestimate the total performance. But these overestimations can be circumvented by taking into account the error scores or alternatively by investigating concentration performance score as it is done lately.
- **Concentration Performance (CP):** It is an outstanding index with respect to the accuracy of performance and the coordination of speed. It is derivated by subtracting E2 from the number of correctly processed items. In disparity with TN-E, certain tendencies like crossing out all the letters indiscriminately or skipping over of sections randomly cannot distort the CP.

Memory retention was assessed with the help of Immediate Memory Test from Bhatia's Battery of Performance Tests of Intelligence [14]. Immediate memory has a close relation with mental development or general intelligence; hence it was selected for testing the memory retention in the children.

Hindi consonants and digits were taken as the units of sounds, because they put the literate and illiterate at par. The test was started with two letters or digit sounds. A practice was given to the subject 1-2 times and then the consonants and digits were read out distinctly and with even intonation and then it was proceeded with more letters till failure is recorded. Under each head, three alternative sets of letters were given. If there was failure in the first set, second was tried and then the third. When the failure was recorded in all the three alternatives, a final failure was noted and the test was stopped and there was no further proceeding up the series. Under this, 2 tests were conducted:

Immediate Memory for Sounds (Direct)

In this test, the subjects were instructed to listen attentively and repeat the letters directly as pronounced by the investigator.

Immediate Memory for Sounds (Reversed)

In this, the subjects were instructed to listen and repeat the letters as pronounced by the investigator, but in a reversed order. The highest scores in these tests were recorded to be as 63, if the subject clears the test without any failure. The scores were categorized in three categories: low (0-21), medium (22-42) and high (43- 63). Scores obtained from these two tests i.e. D2 Attention Span test and Immediate Memory Test, were associated with the measures of fast food consumption such as fast food consumption frequency and percentage contribution of fast food to total calorie intake. Correlation was used to find out the relationship between anthropometry, memory and attention span

variables.

Results and Discussion

Anthropometric Profile

Basic Anthropometric Measurements of the subjects

Table 1-4 displayed the anthropometric profile of the subjects.

Weight

The average weight of the boys in private schools was 44.5±11.23, 47.69±10.17 and 56.5±3.54 kg and for government school boys was 42.05±8.76, 42.90±16.16 and 48.42±10.07 kg in the age group of 13-15 years, respectively. However, the average weight for girls in private schools was 42.63±10.33, 43.17±4.71 and 42±0.0 kg and 38.06±7.79, 40.23±8.20 and 42.36±8.97 kg in government schools according to the age group i.e. 13, 14 and 15 respectively. This showed that private school children (both boys and girls) had more weight than government school children. A significant difference ($p \leq 0.05$) of weight between boys and girls was observed in the age group of 15 years while others depicted a non-significant difference. From Table 3, it was further revealed that boys in the age group of 13+ years were having a 100 percent adequacy of their weight completely meeting the ICMR standards. Also, boys of 14+ years were having 94.4 percent of adequacy while boys of 15+ years were found to be having 101.9 percent adequacy which showed that their weight were more than the ICMR standards. Comparitively, weight of girls from only 13+ age group were adequately meeting the ICMR standards with percent adequacy of 92.9, while girls (14 and 15 years) were found to be mildly underweight meeting 88.5 and 85.4 percent of the ICMR standards.

Table 1 Basic Anthropometric Measurements (weight) of the subjects

Age group (years)	Weight						
	Boys (n=121)		Total (n=120)	Girls (n=119)		Total (n=120)	t-value
	Private (n=62)	Govt. (n=59)		Private (n=58)	Govt. (n=61)		
13+	44.5±11.23	42.05±8.76	43.3±10.0	42.63±10.33	38.06±7.79	40.35±9.06	1.60
14+	47.69±10.17	42.90±16.16	45.3±13.17	43.17±4.71	40.23±8.20	41.7±6.45	1.52
15+	56.5±3.54	48.42±10.07	52.5±6.81	42±0.01	42.36±8.97	42.18±4.49	2.09*

Values are Mean±SD; *Significant at 0.05 level

Height

The average height of the boys in private schools was 156.61±11.35, 163.74±10.93 and 155.97±1.46 cm and for government school boys was 152.23±15.44, 159.58±12.78 and 163.24±9.36 cm in the age group of 13-15 years, respectively. Thus, boys of private schools in age category of 13+ and 14+ were taller than their counterparts in government schools. A similar pattern was observed in girls, when girls in private schools were found to be taller with the mean height 153.10±9.69, 154.86±6.14 and 160.02±0.01 cm from government school girls having mean height 151.61±7.32, 153.91±11.82 and 156.46±9.36 cm according to the age group i.e. 13, 14 and 15 respectively. Thus, the average heights of private school children were more than the government school children. A non-significant difference ($p \leq 0.05$) of height of boys and girls of both private and government schools was observed in all the age groups i.e. 13, 14 and 15 years. It was perceived that boys (13-15 years) were meeting 98.4, 99.2 and 95.9 percent of the ICMR standards showing almost adequate height. Similarly, girls (13-15 years) were meeting 99.1, 98.3 and 99.6 percent of the ICMR standards showing adequate height (**Table 3**).

Table 2 Basic Anthropometric Measurements (height) of the subjects

Age group (years)	Height						
	Boys (n=121)		Total (n=120)	Girls (n=119)		Total (n=120)	t-value
	Private (n=62)	Govt. (n=59)		Private (n=58)	Govt. (n=61)		
13+	156.61±11.35	152.23±15.44	154.42±13.4	153.10±9.69	151.61±7.32	152.4±8.5	1.43
14+	163.74±10.93	159.58±12.78	161.67±11.8	154.86±6.14	153.91±11.82	154.4±8.98	1.67
15+	155.97±1.46	163.24±9.36	159.6±5.41	160.02±0.01	156.46±9.36	158.24±4.7	1.77

Values are Mean ± SD

Table 3 Percent of height and weight of boys and girls in comparison to ICMR standards

Parameters	Boys	ICMR	Girls	ICMR
Weight (kg)				
13+	100	43.3	92.9	43.4
14+	94.4	48.0	88.5	47.1
15+	101.9	51.5	85.4	49.4
Height (cm)				
13+	98.4	157.0	99.1	153.8
14+	99.2	163.0	98.3	157.0
15+	95.9	166.3	99.6	158.8
#ICMR 2010				

Table 4 Derived Anthropometric Measurements of the subjects

Age group (years)	BMI						
	Boys (n=121)		Total (n=120)	Girls (n=119)		Total (n=120)	t-value
	Private (n=62)	Govt. (n=59)		Private (n=58)	Govt. (n=61)		
13+	18.12±3.83	18.27±3.59	18.20±3.71	18.10±3.71	16.57±3.10	17.33±3.40	0.99
14+	17.61±2.15	16.77±5.51	17.19±3.83	18.03±2.03	16.98±3.15	17.50±2.59	0.08
15+	23.22±1.02	18.19±3.53	20.70±2.27	16.40±0.01	17.46±4.17	16.93±2.09	0.93

Body Mass Index

Body mass index provide the most useful basic population level measure of under nutrition and obesity. It can be used to estimate the prevalence of malnutrition within a population. Based on this classification, as seen in **Table 4**, the results revealed that average BMI of boys in private schools was ranging from 18.12±3.83, 17.61±2.15 and 23.22±1.02 kg/m^2 and in government schools was 18.27±3.59, 16.77±5.51 and 18.19±3.53 kg/m^2 in the age group of 13-15 years, respectively (**Figure 1**). While among girls, the average BMI was 18.10±3.71, 18.03±2.03 and 16.40±0.01 kg/m^2 in private schools and 16.57±3.10, 16.98±3.15 and 17.46±4.17 kg/m^2 in government schools in the age group of 13-15 years, respectively (**Figure 2**). From the data, it was observed that the mean BMI values of all the children i.e. boys and girls in both private and government schools fell in the category of below 18.5 which reflected that they were underweight. A non-significant difference ($p \leq 0.05$) was observed in the all the age groups.

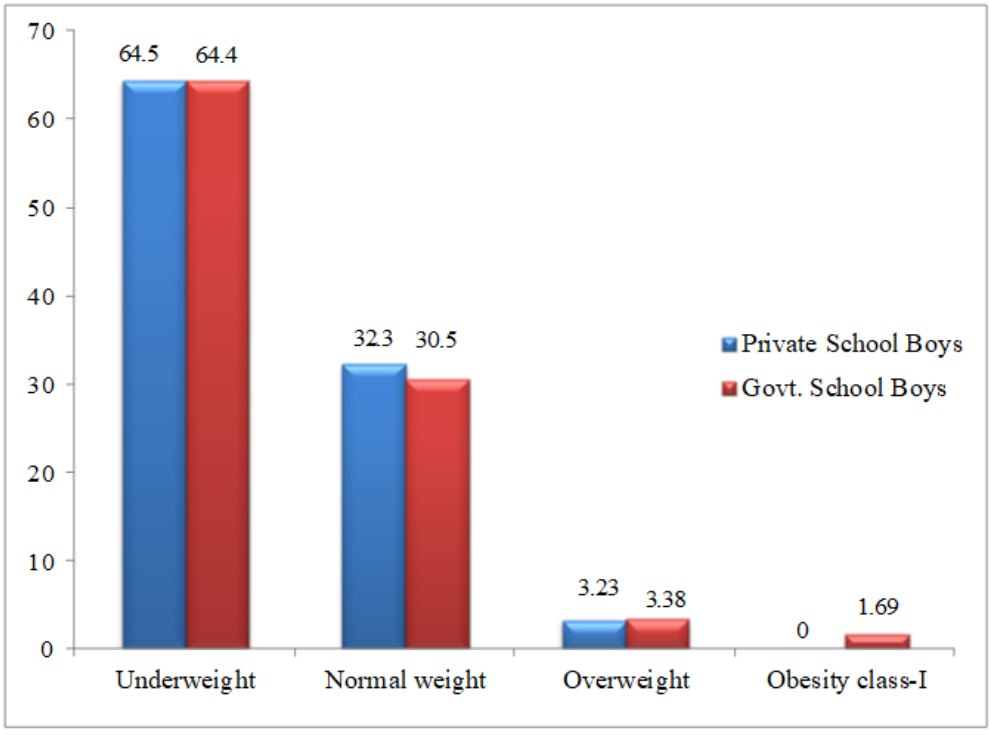

Figure 1 BMI of private and govt. school boys' percent of WHO classification

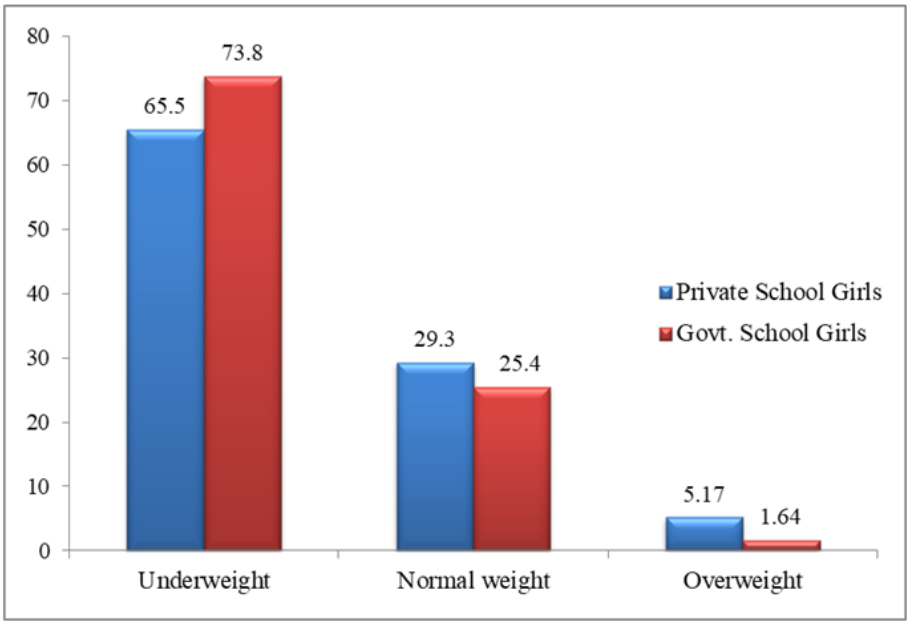

Figure 2 BMI of private and govt. school girls' percent of WHO classification

A similar study on anthropometric profile of school children belonging to different regions of Himachal Pradesh showed that the boys and girls were having a significant difference in their height, waist circumference, hip circumference and BMI, whereas there were no significant differences in their body weight. The boys and girls within the age group of 13 to 17 years were differing in their height, waist circumference, hip circumference and BMI, whereas they showed similarity in their body weight [15]. Another study stated that compared to the WHO reference, percentiles of height and BMI were normally lower. This difference was more in boys than in girls and has increased as they came close to adolescence. The prevalence of short stature (< -2 SD) and thinness (< -2 SD) was higher in boys (9.8% and 12%) than in girls (3.4% and 6.1%), but the prevalence of overweight (> 1 SD) was higher in girls (8.6%) than in boys (4.5%) [16]. Similarly, another study confirmed that height, weight and BMI percentiles increased with age among both boys and girls (5-12 years), and both had approximately the same height and a lower weight and BMI as compared to the WHO and USCDC references [17].

The distribution of subjects according to BMI showed that majority of the boys and girls of private and government schools were having BMI lower than normal values. The data showed (**Table 5**) that the most of the boys of private and government schools (64.5 and 64.4 percent) and girls in private and government schools (65.5 and 73.8 percent) in the age group of 13-15 years were underweight. Among those, majority of boys (27.4 and 32.2 percent) and girls (27.6 and 37.7 percent) from both private and government schools were suffering from severe thinness. While 14.5 and 15.3 percent boys and 20.7 and 21.3 percent girls from private and government schools respectively, were moderately thin and mild thinness was also seen among boys (22.6 and 16.9 percent) and girls (17.2 and 19.7 percent) of priavte and government schools. Further, it was seen that in the normal category of BMI, 32.3 and 30.5 percent of private and government school boys and 29.3 and 25.4 percent girls of private and government schools were present. It was also seen that 3.23 and 3.38 percent boys and 5.17 and 1.64 percent girls in both the groups were slightly overweight whereas only 1.69 percent of government school boys were lying in the obesity class-I category. Thus, it was seen that majority of the children from both the schools were underweight and that too most of them were severely thin. It was revealed in a study that as per WHO growth standards for children between 5 and 19 years, taking BMI for age criteria into account, 9092 (70.4%) subjects came out to be normal, 3660 (28.3%) thin and 164 (1.3%) overweight/obesity. 8224 (63.7%) subjects were suffering from some sort of morbidities. Mean morbidities rank for subjects with thinness was found to be significantly higher compared with normal and overweight/obese subjects. Thinness was found to be the major predictor of morbidity, age, sex and residing in rural areas [18].

Memory Retention and Attention Span scores

Memory Retention Scores of the subjects

As depicted in the **Table 6**, the data of the present study revealed that 6.67 and 20.8 percent of the children in private and government schools obtained low scores (0-21) in the Immediate Memory Test, while majority of the children from private and government schools, obtained medium scores (22-42) i.e. 82.5 and 71.7 percent. However, a few percent of the children obtained high scores (43-63) i.e. 10.8 and 7.5 percent from private and government schools

respectively. Highest mean scores were observed for high scores i.e. 47.00±3.83 and 46.00±3.43 in private and government schools respectively. It was reported that a significant difference in a no. of parameters like memory ($p<0.001$), concentration ($p<0.001$), grades obtained ($p<0.001$), attendance ($p<0.001$) etc. between breakfast skippers and breakfast nonskippers [19]. Another study showed that a more evenly distributed energy intake throughout the morning by consuming a mid-morning snack improves memory performance in school-age low socio economic (LSES) children even when the total amount of energy consumed during the morning is not altered [20].

Table 5 Distribution of the school children according to BMI

BMI Categories		**Boys (n=121)**		**Girls (n=119)**		**Total (n=240)**	
		Private (n=62)	**Govt. (n=59)**	**Private (n=58)**	**Govt. (n=61)**	**Private (n=120)**	**Govt. (n=120)**
		Frequency (%)		**Frequency (%)**		**Frequency (%)**	
Underweight	Below 18.5	40 (64.5)	38 (64.4)	38 (65.5)	45 (73.8)	77 (64.2)	83 (69.2)
Severe Thinness	<16.00	17 (27.4)	19 (32.2)	16 (27.6)	23 (37.7)	33 (27.5)	42 (35)
Moderate Thinness	16.00-16.99	9 (14.5)	9 (15.3)	12 (20.7)	13 (21.3)	21 (17.5)	22 (18.3)
Mild Thinness	17.00-18.49	14 (22.6)	10 (16.9)	10 (17.2)	12 (19.7)	24 (20)	22 (18.3)
Normal weight	18.50-24.99	20 (32.3)	18 (30.5)	17 (29.3)	15 (25.4)	37 (30.8)	33 (27.5)
Overweight	25.0-29.9	2 (3.23)	2 (3.38)	3 (5.17)	1 (1.64)	5 (4.16)	3 (2.5)
Obesity Class-I	30.0-34.9	0	1 (1.69)	0	0	0	1 (1.69)
Obesity Class-II	35.0-39.9	0	0.00	0	0.00	0	0.00
Obesity Class-III	≥40.00	0	0.00	0	0.00	0	0.00

Figures in parenthesis indicate percentage

Table 6 Memory Retention Scores of the subjects

S. No.	**Scores**	**Private (n=120)**		**Govt. (n=120)**		**Total (n=240)**	
		Frequency	**Mean± SD**	**Frequency**	**Mean± SD**	**Frequency**	**Mean± SD**
1	Low	8 (6.67)	19.38± 1.69	25 (20.83)	17.84± 3.13	33 (8.68)	18.61± 2.41
2	Medium	99 (82.50)	31.87± 5.08	86 (71.67)	28.95± 5.05	185 (29.86)	30.41± 5.06
3	High	13 (10.83)	47.00± 3.83	9 (7.50)	46.00± 3.43	22 (3.13)	46.50± 3.63

Attention span Scores of the subjects

It can be observed from the data in Table 7 that mean TN (Total Number of Items Processed) scores out of total 658 items, were 186.11±81.64 and 184.53±85.66 in private and government schools, followed by mean E (Total Number of Errors) scores which were 177.40±59.07 and 191.63±48.09 and lastly mean of CP (Concentration Performance) scores, out of total 290, were found out to be 115.33±58.29 and 99.61±49.43. It is clearly visible from the data that number of errors was less in private school children as compared to government school children, which led to high CP scores in private school children and low CP scores in government school children. Other than that, a significant ($p\leq0.05$) difference was witnessed in the number of errors (E) and in the concentration performance (CP) of the children of private and government schools. This concluded that less the number of errors, more will be the CP scores and the more the CP scores; the better will be the attention span. Thus, the children from private schools were having better attention span than their counterparts in government schools. In another study, it was also found that having a mid-morning snack resulted in a smaller decline in immediate and delayed memory in LSES but not in high socio economic status (HSES) children. Having a snack did not influence sustained attention and psychomotor speed in either LSES or HSES children [20]. Cognitive abnormalities exhibited by children with epilepsy in arithmetic computation, response inhibition, attention, fine motor dexterity, and psychomotor speed (all *p* values <0.001), are detectable at or near the time of diagnosis and largely remain stable over the ensuing 5 to 6 years without evidence of progressive worsening or recovery [21]. As a result of a study it was seen that there was a significant difference in favor of the experiment group between the attention spans of children who received the brain teasers curriculum and children who received the National Education Ministry Pre-School curriculum. This result shows that brain teasers are effective in improving the attention span [22].

Gender wise comparison on basis of selected variables

Gender based comparison was done between different factors. As depicted in **Table 8**, the average fast food consumption among boys was 2.71±0.81 and 2.61±0.78 was the average among girls. Average attention and memory

scores were (102.79±58.75 and 112.23±49.60) and (29.73±8.03 and 30.87±8.48) among boys and girls respectively. However, a non-significant difference was observed in the fast food consumption, attention scores and memory scores of the boys and girls. The results revealed that girls were having less frequent consumption of fast foods and comparitively higher attention and memory scores than boys. Similar results were found in a study where an experiment was conducted where men and women were compared on their ability to remember phonologically-familiar novel words and phonologically-unfamiliar novel words. Learning of phonologically-familiar novel words (but not of phonologically-unfamiliar novel words) can be supported by long-term phonological knowledge. Results revealed that women outperformed men on phonologically-familiar novel words, but not on phonologically-unfamiliar novel words [23]. In another study it was observed that 100(%) of boys and girls consume fast food. 84(%) boys eaten fast food daily that compare to 80(%) girls eaten fast food daily [24].

Table 7 Attention Span Scores of the subjects

S. No.	Scores	Private (n=120)		Govt. (n=120)		Total (n=240)		t value
		Mean	SD	Mean	SD	Mean	SD	
1	Total Number of Items Processed	186.11	81.64	184.53	85.66	185.32	83.65	0.15
2	Total Number of Errors	177.40	59.07	191.63	48.09	184.52	53.58	2.05*
3	Concentration Performance	115.33	58.29	99.61	49.43	107.47	53.86	2.11*
* significant at 0.05 percent level								

Table 8 Gender wise comparison on basis of selected variables

Factors	Boys (n=121)	Girls (n=119)	t-value
Fast Food Consumption	2.71±0.81	2.61±0.78	0.958
Attention Span Scores	102.79±58.75	112.23±49.60	1.346
Memory Retention Scores	29.73±8.03	30.87±8.48	1.076

Correlation Analysis

Table 9 showed that BMI had a negative correlation ("r"= -0.069) with attention span but a positive correlation with memory retention ("r"= 0.017) and fast food consumption ("r"=0.050). Thus, indicating that with increase in BMI there was a decreae in attention span while an increase was seen in memory retention and fast food consumption. It was reported by an author that there is no significant relationship between fast food consumption, BMI and the pattern of consumption of fast food [25]. Also, a study stated that the subjects who were consuming fast food everyday had higher BMI than others [26].

Table 9 Coefficient correlation (r) between various factors

S. No.	Variable 1	Variable 2	Correlation Coefficient (r)
1	BMI	Attention Span	-0.069
2	BMI	Memory Retention	0.017
3	BMI	Fast Food Consumption	0.050
**Correlation is significant at 0.01 level (2-tailed)			
*Correlation is significant at 0.05 level (2-tailed)			

Conclusion

Hence, BMI of the children revealed that majority (64.2% for private and 69.2 % for government) of the children were underweight. Also, BMI showed a positive correlation with the fast food consumption and a negative correlation with the attention span. It was also seen that private school children were having better attention span ($p \leq 0.05$) and memory retention scores than government school children. Also, girls were having better attention span and memory retention scores than boys.

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