

**Research Article****Does the body mass index have an impact on the level of alertness?**<sup>1</sup>Dinesh Vedanathan Syce, <sup>2</sup>Senthilvel Vasudevan<sup>1</sup>Department of Physiology, Sri Lakshminarayana Institute of Medical Sciences, Puducherry, India<sup>2</sup>Department of Community Medicine, Sri Venkateshwaraa Medical College Hospital & Research Centre, Puducherry, India**(Received: 13-10-2025****Revised: 14-02-2026****Accepted: 02-03-2026)**Corresponding Author: <sup>1</sup>Dinesh Vedanathan Syce Email: [sycedinesh@gmail.com](mailto:sycedinesh@gmail.com)**ABSTRACT**

**Introduction:** Since the correlation between measures of adiposity and tests for alertness such as the reaction time has not been conclusively established, the present study was undertaken. **Aims:** This study sought to determine if the BMI had any correlation with the visual and auditory reaction time in south Indian males.

**Methods:** Fifty young adult males volunteered for this study. The visual and auditory reaction time was recorded in all subjects. At the time of statistical analysis, the reaction time data was sorted into five BMI groups: underweight, normal weight, overweight, grade:1 obesity and grade: 2 obesity. The relationship between BMI and reaction time was analyzed by Pearson Correlation Coefficient test or Spearman Correlation Coefficient test wherever applicable. Comparisons of visual and auditory reaction time between and within the various BMI groups were performed by Bonferroni Post hoc Test.

**Results:** The authors observed certain trends, a negative correlation between the BMI and visual reaction time ( $r$  value = 0.087) and a positive correlation between BMI and auditory reaction time ( $r$  value = 0.051). These findings, however, did not reach statistical significance ( $p$  value = 0.725). It was further observed that the longest visual and auditory reaction time was observed in individuals with grade: 1 obesity.

**Conclusions:** These findings, although not entirely conclusive, seemed to suggest that body adiposity might affect the level of alertness.

**Keywords:** BMI, adiposity, visual reaction time, auditory reaction time, alertness

**1. INTRODUCTION**

It is a well-known fact that increased body obesity adversely affects cardiovascular, respiratory and endocrine function. The potential adverse effects of obesity on cognitive function and alertness, however, is not as well documented. Recent studies seemed to suggest that obesity may negatively influence brain structure thereby resulting in a potential impairment of cognitive functions and alertness. The reaction time, the time taken to respond to a stimulus, is a simple and yet surprisingly reliable clinical tool employed routinely to assess the level of alertness. It has been conclusively demonstrated that both the auditory and visual reaction time are quicker in males [1], in younger subjects [2] and in left-handed individuals [3]. It

is not, however, clear if there is any significant correlation between the reaction time and indices of adiposity such as the Body mass index (BMI). Work done so far is inconclusive at best. Some researchers were of the opinion that an increase in BMI was associated with faster auditory and visual reaction time [4], while others were of the view that a higher than normal BMI is actually associated with slower reaction time [5]. There are studies that concluded that a lower than normal BMI was associated with slower reaction time [6] while others demonstrated that there was no correlation whatsoever between the reaction time and the BMI or other indices of obesity [7]. Since the relationship between the levels of adiposity and levels of alertness has not been definitively established, the present study was undertaken to investigate if there was a

correlation, negative or positive, between the BMI and the auditory and visual reaction times. The authors chose as their subject population, a group of young adult males, a demographic group increasingly affected by sedentary lifestyles and rising obesity rates. The authors sought to determine, in this study, if minor variations in BMI might affect the level of alertness and in so doing contribute to existing information.

## **2. MATERIALS AND METHODS**

### **2.1 Participants**

This cross-sectional study was conducted in the Physiology Department at PIMS, Pondicherry between 2009 and 2010. The fifty subjects who were chosen for this study were all males, all right-handed and all between the ages of 18 and 25.

### **2.2 Exclusion criteria**

Those with systemic illnesses, neuromuscular and sleep disorders were excluded.

### **2.3 Ethical clearance**

Clearance was obtained from the research and ethical committees of the institute and a written consent was obtained from each participant.

### **2.4 Assessment of the reaction time**

Only a single subject was tested every day. The subject was instructed to be present at the research laboratory at exactly 9 o'clock in the morning for the tests to commence. The height and weight of the subject was accurately measured and the BMI was calculated. The BMI was calculated by dividing the weight in kilograms by the square of the height in meters and was expressed as ( $\text{Kg}/\text{m}^2$ ). The subject was then taken to a temperature-controlled room for the assessment of the reaction time. An electronic device was employed to estimate the auditory and visual reaction times. While estimating the auditory reaction time, the subject was instructed to press a switch with the index finger of his dominant hand as soon as he heard an electronically generated sound. The visual reaction time was similarly estimated by evaluating the speed at which the subject reacted to a flickering light. The subject was familiarized with the procedure before the actual recordings commenced.

### **2.5 Data management**

The collected data was entered and compiled using Microsoft Excel 2010 and analyzed by SPSS 23.0 version.

### **2.6 Statistical Analysis**

Categorical variables were expressed as frequency and proportion. Continuous variables were expressed as mean and standard deviation. The relationship between BMI and Reaction Time was analyzed by Pearson Correlation Coefficient test or Spearman Correlation Coefficient test wherever applicable. Association between BMI groups and visual and auditory reaction time was analyzed using one-way ANOVA test and  $p$ -value  $< 0.05$  was considered statistically significant. The multiple comparisons of visual and auditory reaction time between and within the various BMI groups were performed by Bonferroni Post hoc Test. Since the Kolmogorov-Smirnov test, a test of normality, showed that the data was non-normal, we employed a non-parametric correlation test Spearman Rank Correlation Coefficient test to determine a relationship between BMI and visual and auditory reaction time.

## **3. RESULTS**

The mean and standard deviation of the age, weight, BMI, visual and auditory reaction time of the fifty subjects are all presented in Table: 1. While calculating the results, the subjects' reaction time data was sorted into five categories based on the BMI of the subject. Data obtained from individuals with a BMI under  $18.5 \text{ kg}/\text{m}^2$  was placed in the first group, the second group included data from those with a BMI between  $18.5$  to  $22.9 \text{ kg}/\text{m}^2$ , Group-3 had a BMI between  $23$  and  $24.9 \text{ kg}/\text{m}^2$ , Group-4 had a BMI between  $25$  to  $29.9 \text{ kg}/\text{m}^2$  and Group-5 had a BMI equal to and above  $30 \text{ kg}/\text{m}^2$ . According to this sorting, most of the participants 23 (46.0%) were under Group-2 (normal weight), followed by 11 (22.0%) in Group-3 (overweight), 6 (12.0%) were in Group-1 (Underweight), 6 (12.0%) in Group-4 (Grade I Obesity) and 4 (8.0%) were in Group-5 (Grade II Obesity). As evidenced by this, most of the subjects in this study were of normal weight and only ten were considered obese.

While exploring the relationship between the BMI and visual reaction time, we found that the mean BMI was  $22.79 \pm 4.14 \text{ kg/m}^2$  and the mean visual reaction time was  $196.43 \pm 24.46 \text{ ms}$ . This relationship showed a negative correlation with r value of  $-0.087$ , but the p value was  $0.548$  ( $p > 0.05$ ) which was not statistically significant. The mean auditory reaction time was  $166.01 \pm 15.24 \text{ ms}$ . The relationship between the mean BMI and the mean auditory reaction time showed a positive correlation (r value =  $0.051$ ), but the p value was  $0.725$  which was not statistically significant ( $p > 0.05$ ). These data are presented in Table: 2. The overall association between BMI and visual reaction time showed no association in the ANOVA test with F value of  $0.215$  and p value of  $0.929$  ( $p > 0.05$ ). However it was observed that the mean visual reaction time was the highest ( $201.87 \pm 37.13 \text{ ms}$ ) in Group-4 (Grade I Obesity), followed by Group-1, Group-2 and Group-5 as evidenced by Table: 3. The multiple comparisons of visual reaction time between and within the various BMI groups were performed by Bonferroni Post Hoc Test. This test also failed to show any statistical significance between the groups with p value  $> 0.05$  as shown in Table: 4.

**Table 1 Anthropometric data and mean reaction time measurements (n= 50)**

Basic Characteristics	No. of Subjects	Percentage
Group-1 Underweight (BMI $\leq 18.5$ )	6	12.0
Group-2 Normal Weight (BMI : 18.5 – 22.9)	23	46.0
Group-3 Overweight (BMI : 23 – 24.9)	11	22.0
Group-4 Grade I Obesity (BMI :25.0 – 29.9)	6	12.0
Group-5 Grade II Obesity (BMI : $\geq 30$ )	4	8.0
Average age (in years)	$20.98 \pm 2.84$ (Range: 18 – 25)	
Average Weight (in Kgs.)	$63.46 \pm 11.64$ (Range: 43 – 101)	
Average BMI ( $\text{Kg/m}^2$ )	$22.79 \pm 4.14$ (Range: 15.79 – 36.65)	
Visual Reaction Time (ms)	$196.43 \pm 24.46$ (Range: 153.0 – 264.2)	
Auditory Reaction Time (ms)	$166.01 \pm 15.24$ (Range: 135.0 – 206.4)	

**Table 2. Distribution of mean, standard deviation and correlation coefficient value and its significance (n = 50)**

Variables	Mean	Standard Deviation	r value	p-value
Body Mass Index	22.79	4.14	$-0.087$	$0.548$ NS
Visual Reaction Time	196.43	24.46		
Body Mass Index	22.79	4.14	$0.051$	$0.725$ NS
Auditory Reaction Time	166.01	15.24		

BMI: Body mass index expressed in  $\text{kg/m}^2$ , Visual Reaction Time in ms, Auditory Reaction Time in ms. r –value : Correlation Coefficient Value. NS: Not Significant ( $p > 0.05$ );

**Table 3. Association between Body Mass Index classifications and Visual Reaction Time**

Body Mass Index Classification (Kg/m <sup>2</sup> )	N	Mean	SD	95% Confidence Interval for Mean		Min	Max	F-value & p-value
				Lower Bound	Upper Bound			
Group-1 Underweight (BMI <18.5)	6	199.5	17.8	180.7	218.2	179.0	220.0	$0.215$ $0.929$ *
Group-2 Normal Weight (BMI 18.5 – 22.9)	23	196.7	23.5	186.5	206.8	153.0	238.0	
Group-3 Overweight (BMI 23 – 24.9)	11	191.0	26.5	173.2	208.9	153.0	239.0	
Group-4 Grade I Obesity (BMI 25.0 – 29.9)	6	201.8	37.1	162.9	240.8	161.0	264.2	
Group-5 Grade II Obesity (BMI >30)	4	196.7	18.8	166.7	226.7	175.0	214.0	

BMI: Body mass index expressed in  $\text{kg/m}^2$ , Visual Reaction Time in ms, Min: Minimum, Max: maximum. SD: standard deviation, \*p-value  $> 0.05$  Statistically Not Significant

**Table 4. Multiple Comparisons of Visual Reaction Time by Bonferroni Post Hoc test**

(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group 1 (BMI<18.5)	Group 2 Normal Weight	2.79	11.59	1.000	-31.43	37.01
	Group 3 Overweight	8.41	12.83	1.000	-29.48	46.29
	Group 4 Grade I Obesity	-2.37	14.60	1.000	-45.46	40.73
	Group 5 Grade II Obesity	2.75	16.32	1.000	-45.43	50.93
Group 2 (BMI :18.5 -22.9)	Group 1 Underweight	-2.79	11.59	1.000	-37.01	31.43
	Group 3 Overweight	5.62	9.27	1.000	-21.74	32.99
	Group 4 Grade I Obesity	-5.15	11.59	1.000	-39.37	29.07
	Group 5 Grade II Obesity	-0.04	13.70	1.000	-40.48	40.40
Group 3 (BMI 23 -24.9)	Group 1 Underweight	-8.41	12.83	1.000	-46.29	29.48
	Group 2 Normal Weight	-5.62	9.27	1.000	-32.99	21.74
	Group 4 Grade I Obesity	-10.78	12.83	1.000	-48.66	27.11
	Group 5 Grade II Obesity	-5.66	14.76	1.000	-49.24	37.93
Group 4 (BMI 25.0 -29.9)	Group 1 Underweight	2.37	14.60	1.000	-40.73	45.46
	Group 2 Normal Weight	5.15	11.59	1.000	-29.07	39.37
	Group 3 Overweight	10.78	12.83	1.000	-27.11	48.66
	Group 5 Grade II Obesity	5.12	16.32	1.000	-43.07	53.30
Group 5 (BMI >30)	Group 1 Underweight	-2.75	16.32	1.000	-50.93	45.43
	Group 2 Normal Weight	0.04	13.70	1.000	-40.40	40.48
	Group 3 Overweight	5.66	14.76	1.000	-37.93	49.24
	Group 4 Grade I Obesity	-5.12	16.32	1.000	-53.30	43.07

*p-value > 0.05 Statistically Not Significant. BMI: Body mass index expressed in kg/m<sup>2</sup>, Sig. – Significant*

The overall association between BMI and auditory reaction time showed no association in the ANOVA test with F value of 0.174 and p value of 0.950 (p>0.05). It was however noticed that the mean auditory reaction time was the highest 170.90 ± 18.80 ms in Group-4, (Grade I Obesity), followed by Group-1, Group-2 and Group-3. The least mean auditory reaction time was seen in Group-1 as shown in Table: 5. The multiple comparisons of auditory reaction time

between and within the various BMI groups were performed by Bonferroni Post Hoc Test and was found to be statistically insignificant (p value > 0.05) as shown in Table: 6. It was however observed that the highest visual and auditory reaction time values were observed in Group-4.

**Table 5. Association between Body Mass Index classifications and Auditory Reaction Time**

Body Mass Index Classifications (Kg/m <sup>2</sup> )	N	Mean	SD	95% Confidence Interval for Mean		Min	Max	F-value & p-value
				Lower Bound	Upper Bound			
Group-1 Underweight (BMI <18.5)	6	165.00	8.27	156.32	173.68	157.0	178.0	0.174 0.950*
Group-2 Normal Weight (BMI 18.5 -22.9)	23	165.08	16.69	157.86	172.30	135.0	205.4	
Group-3 Overweight (BMI 23 - 24.9)	11	165.58	16.68	154.38	176.78	135.0	186.0	
Group-4 Grade I Obesity (BMI 25.0 -29.9)	6	170.90	18.80	151.17	190.63	151.0	206.4	
Group-5 Grade II Obesity (BMI >30)	4	166.75	7.89	154.20	179.31	158.0	176.0	

*BMI: Body mass index expressed in kg/m<sup>2</sup>, Auditory Reaction Time in ms, Min: Minimum, Max: maximum. SD: standard deviation, \*p-value > 0.05 Statistically Not Significant*

#### 4. Discussion

In this study we noticed that in all subjects, regardless of body mass, the visual reaction time was longer than the auditory reaction time. Most researchers have reported similar results [8]. The reason for a slightly longer visual reaction time is probably due to the fact that more elaborate chemical reactions in the photoreceptors are involved in the recognition of a visual stimulus as opposed to the relatively quicker process in the perception of an auditory stimulus. Others, however, are of the opinion that the auditory reaction time was in fact longer than the visual reaction time [9]. The probable explanation for

this being that the auditory pathway is more polysynaptic as compared to the visual pathway.

**Table 6. Multiple Comparisons of Auditory Reaction Time by Bonferroni Post Hoc test**

(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group 1 (BMI<18.5)	Group Normal Weight 2	-0.078	7.23	1.000	-21.43	21.278
	Group Overweight 3	-0.582	8.00	1.000	-24.23	23.062
	Group 4 Grade I Obesity	-5.90	9.11	1.000	-32.80	20.997
	Group 5 Grade II Obesity	-1.750	10.19	1.000	-31.82	28.322
Group 2 (BMI :18.5-22.9)	Group Underweight 1	0.08	7.23	1.000	-21.28	21.434
	Group Overweight 3	-0.50	5.7851	1.000	-17.58	16.575
	Group 4 Grade I Obesity	-5.82	7.23	1.000	-27.18	15.534
	Group 5 Grade II Obesity	-1.67	8.55	1.000	-26.91	23.566
Group 3 (BMI 23-24.9)	Group Underweight 1	0.58	8.01	1.000	-23.06	24.225
	Group Normal Weight 2	0.50	5.79	1.000	-16.58	17.582
	Group 4 Grade I Obesity	-5.32	8.01	1.000	-28.96	18.325
	Group 5 Grade II Obesity	-1.17	9.21	1.000	-28.37	26.033
Group 4 (BMI 25.0-29.9)	Group Underweight 1	5.90	9.11	1.000	-20.00	32.797
	Group Normal Weight 2	5.82	7.23	1.000	-15.53	27.178
	Group Overweight 3	5.32	8.00	1.000	-18.33	28.962
	Group 5 Grade II Obesity	4.15	10.19	1.000	-25.92	34.222
Group 5 (BMI >30)	Group Underweight 1	1.75	10.19	1.000	-28.32	31.822
	Group Normal Weight 2	1.67	8.55	1.000	-23.57	26.909
	Group Overweight 3	1.17	9.21	1.000	-26.03	28.369
	Group 4 Grade I Obesity	-4.15	10.19	1.000	-34.22	25.92

*p-value > 0.05 Statistically Not Significant. BMI: Body mass index expressed in kg/m<sup>2</sup>, Sig. – Significant*

In this study we sought to determine the relationship between BMI and the reaction time. According to the World Health Organization (WHO), individuals with a BMI under 18.5 kg/m<sup>2</sup> are considered to be underweight, those

with a BMI between 18.5 - 22.9 kg/m<sup>2</sup> are of normal weight, those with BMI of 23 - 24.9 kg/m<sup>2</sup> are overweight, individuals with a BMI between 25 to 29.9 kg/m<sup>2</sup>, are mildly obese and those with a BMI of 30 kg/m<sup>2</sup> and above are considered severely obese [10,11]. During the analysis of the data in the present study, our subjects were divided into the above five BMI groups. The statistical analysis demonstrated that the relationship between the BMI and the visual reaction time showed a negative correlation (r value – 0.087), but the p value was not statistically significant. This seemed to indicate that with an increase in the BMI, the visual reaction time decreased meaning it became quicker. The relationship between the mean BMI and the auditory reaction time showed a positive correlation (r value = 0.051) but was again found to be statistically insignificant. This seemed to indicate that with an increase in the BMI, the auditory reaction time increased (slowed down). It was further observed that the highest visual and auditory reaction time values were observed in Group- 4. To summarize, although most tests were found to be statistically insignificant, it was observed that the highest (slowest) visual and auditory reaction time values were observed in Group- 4 (Grade - I obesity), which seemed to imply that obesity might adversely affect the level of alertness.

Literature does not conclusively document if the BMI and other indices of adiposity had any bearing on the reaction time. Some researchers were of the opinion that an increase in body adiposity was associated with quicker reaction times [4]. The explanation was that since the myelin sheath enveloping neurons is composed predominantly of lipids, those with greater quantities of body lipids had better myelination, faster impulse conduction and consequently a quicker reaction time. Researchers have demonstrated that higher adiposity predominantly improved central processing of information rather than peripheral [12]. Conversely, in underweight individuals, a decrease in the lipid levels might interfere with myelination consequently resulting in a prolongation of the visual and auditory reaction time [6,13].

Other studies have demonstrated quite the opposite. These studies conclusively proved that an increase in the BMI was actually associated with a prolongation of the reaction time in both genders [5, 14-17]. Longer reaction times in obese females might be due to fluid and salt retention associated with the levels of female sex hormones [18]. Some researchers were of the opinion that the prolongation in the reaction time in obese subjects was largely due to the greater time taken for central processing of information rather than neuromuscular transmission [19, 20]. Studies showed that increased level of adiposity in students was associated with decreased cognitive function and poor working memory, further underscoring the effect of obesity on central processing [21]. The longer central processing in obesity was probably due to the higher incidence of vascular disease and secretion of hormones and cytokines from the adipose tissue that could cross the blood-brain barrier and potentially impact central processing [22]. Others have demonstrated that an increase and decrease in the BMI were both associated with a prolongation of the auditory and visual reaction time [23]. Other researchers were of the firm view that there was no correlation whatsoever between the reaction time and indices of obesity such as BMI, Waist-Hip Ratio, waist to height ratio, Waist circumference or body fat percentage in either adults [7, 24] or children [25].

## 5. CONCLUSION

The present study, although limited in scope, suggests that there may be a negative correlation between the BMI and the visual reaction time. It was further observed that the highest visual and auditory reaction time values were observed in individuals with grade - I obesity. The implications of this study, although not conclusive, are that obesity may slow down both the visual and auditory reaction time. Although not conclusive, these results seem to suggest that body adiposity may in fact affect the level of alertness.

## Conflict of Interest

The authors wish to declare that there are no known conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

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## Ethical clearance

Clearance was obtained from the research and ethical committees of the institute before the commencement of the project..

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*Dinesh Vedanathan Syce & Senthilvel Vasudevan : Body adiposity may affect the reaction time.*

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