Original Article

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A Cross Sectional Study on the Relationship Between the Body Mass Index (BMI) and the Audiovisual Reaction Time (ART)

Physiology Section

DEEPMALA NAGORAO DEORE, SUREKHA P. SURWASE, SHAZIA MASROOR, SAMINA T. KHAN, VINOD KATHORE

ABSTRACT

Introduction: The reaction time is the time interval between the stimulus application and the proper response. The neuro-physiological studies suggest a relationship of the BMI with the cognition, attention and the memory.

Aim: To study the relationship between the Body Mass Index (BMI) and the audiovisual reaction time in young healthy females.

Materials and Methods: This study was carried out in the Department of Physiology on 90 young, healthy females who were in the Ist year MBBS and BDS at GMC and GDC Aurangabad.

The height and weight were recorded and the BMI was calculated. The subjects were divided into 3 groups: those with normal weight, underweight and overweight according to the WHO criteria.

The simple reaction time was measured with the help of Audio Visual Reaction Time Apparatus in all the three groups.

The data was analyzed by the one way ANOVA test by using the Graphpad Prism Software.

Result: There was a prolongation of both ART and VRT in the underweight and the overweight individuals. When the VRT was compared, it was found to be statistically significant.

Conclusion: Our study showed that the BMI of an individual affected the audio visual reaction time, which was an indirect measure of the sensory motor association.

Key Words: Audiovisual reaction time, Body mass index, Young females

INTRODUCTION

An animal's ability to cope with the environmental changes for the maintenance of homeostasis depends on the integrity of the cell communication and the responses which are given by the various systems in terms of the sensory perception and the motor response [1]. The time response is supposed to be the best factor for the management of the homeostasis, which we call as the reaction time [2].

The reaction time is the time interval between the onset of the stimulus and the initiation of the response, under the condition that the subject has been instructed to respond as rapidly as possible [3]. The reaction time provides an indirect index of the processing capability of the CNS and a simple means of determining the sensorimotor performance [4]. Studies have shown the association of overweight and obesity with cardiovascular, respiratory, neurophysiological and endocrine diseases [5].

The Body Mass Index (BMI) has been widely accepted as a simple marker of the adiposity in population-based studies, and it has been recognized as an instrument which can be used for diagnosing the obesity in all the age-groups [6].

The present study was an attempt to look for any association between the BMI and the audiovisual reaction time in young, healthy, female students.

MATERIALS AND METHODS

This study was carried out in Department of Physiology, Government Medical College, Aurangabad Maharashtra, India. It involved 90 young healthy females who were in the first year MBBS and BDS courses at GMC and GDC, Aurangabad, who were in the age group of 18-20 years and who belonged to similar socioeconomic statuses. The subjects who suffered from medical conditions which were known to impact the cognitive functioning, which included neurological disorders, head injuries, cardiovascular diseases, and Diabetes were excluded from the study. The subjects were briefed about the study protocol and an informed consent was taken from them.

The approval of the Institutional Ethics Committee, Govt. Medical College, Aurangabad, Maharashtra, India was taken.

THE BMI CALCULATION

For the calculation of the BMI or the Quetelet index, the height and weight were recorded at the clinical examination.

The weight was recorded with the subjects being without their shoes and with light clothes on a standard scale. It was recorded to the nearest 0.5 kg.

The height was measured with a stadiometer while the subjects stood completely erect with their heads in the Frankfort plane. It was measured to the nearest 1cm.

These data were used to calculate the BMI. The BMI of each subject was calculated by dividing her body weight in kilograms by the square of her height in metres. The categorization of the BMI was done according to the BMI criteria for the Indian population [7]. The subjects were divided into 3 groups:

BMI ≤18.49 kg/m^2, underweight;
BMI 18.5–22.99 kg/m^2, normal weight
BMI ≥23 kg/m^2 overweight or obese

The recording of the audiovisual reaction time:

Each subject was made familiar with the apparatus and the procedure, to alleviate any fear or apprehension. The Auditory Reaction Time (ART) and the Visual Reaction Time (VRT) were measured in a quiet room of the Department of Physiology at GMCH, Aurangabad. The ambient temperature which was maintained was 26±1°C.

These tests were done with the subject sitting comfortably in a chair. The ART and VRT were measured by using a reaction time instrument which was supplied by Medicaid Systems RTM-604 (Chandigarh, India). This instrument was equipped with a sensitive quartz clock which measured up to 1/10th of a msec. The accuracy of this instrument was ± one digit.

All the subjects were right handers and they used their right hands to press the switch to stop the quartz clock of the apparatus. Before measuring the VRT, each subject was asked to identify the flashing of the yellow light. She was instructed to press the switch as soon as she saw the light.

For measuring the ART, she was asked to concentrate on the sound signal which was produced and to press the switch immediately. The sound signal was a continuous beep of 1 KHz on the speaker. The intensity of the stimulus was the same for all the groups.

To avoid the effect of a lateralized stimulus, the visual and the auditory signals were given from the front of the subjects. From the auto-display, the reaction time was noted. Three readings of each stimulus were noted after giving three practical trials and their mean was taken as the reaction time [8].

Statistical Analysis

The results were expressed as mean ± S.D. The data was analyzed by the one way ANOVA test with the post-hoc Tukey's test for the intercomparison between the groups by using the Graphpad Prism Software. A p value of < 0.05 was taken as the cut off for the measure of the significance.

RESULT

In the present study, the Body Mass Index was significantly different among the three study groups [Table/Fig-1].

Parameter	Normal (n=32)	Underweight (n=34)	Overwt & Obese (n=24)	P-value
Height (m)	154.81 ± 6.21	156.65 ± 3.19	154.2 ± 5.11	0.2094
Weight (kg)	49.93 ± 5.26	41.46 ± 3.09***	60.46 ± 5.64***	< 0.0001
BMI (kg/m^2)	20.79 ± 1.37	16.90 ± 1.24***	25.42 ± 1.95***	< 0.0001
ART (sec)	0.1695 ± 0.091	0.1816 ± 0.079	0.1727 ± 0.069	0.0731
VRT (sec)	0.2090 ± 0.0121	0.2254 ± 0.0129*	0.2324 ± 0.0120**	0.0039

[Table/Fig-1]: Body Mass Index

The VRT was more as compared to the ART in all the study groups. There was a prolongation of the ART in the underweight and the overweight or the obese girls as compared to that in the normal girls. When they were compared statistically, the difference was not significant.

The VRT was also prolonged in the underweight and the overweight or the obese individuals as compared to that in the normal girls. This result was statistically significant for both the groups as compared to that in the normal weight individuals.

DISCUSSION

In our study, the reaction times were longer for the responses to the auditory stimuli than for the responses to the visual stimuli. The cause of the visual reaction time being greater than the auditory reaction time was not very clear, although almost all of the research which was done on the reaction time had reached the same conclusion [9, 10].

Most likely, it was due to the fact that the visual reaction time involved chemical changes in its occurrence. Also, the visual pathway involved many collateral pathways to various association areas and hence, a greater delay in the comprehension of the visual stimulus, as it was interpreted in a more complex and an elaborate fashion. There was some degree of difference in the type of receptor and the manner in which the receptor got stimulated i.e. the retina versus the organ of corti.

In contrast, Shenvi et al., found that the auditory reaction time was greater than the visual reaction time and they rationalized that the auditory pathway must be more polysynaptic as compared to the visual pathway [11].

The reaction time is an important component of the motor movements. The reaction time includes the latency in the sensory neural code which traverses the peripheral and the central pathways, the perceptive and the cognitive processing, a motor signal which traversed both the central and the peripheral neuronal structures and finally, the latency in the end effecter activation i.e. the muscle activation. It is one of the important methods to study a person's central information processing speed and the fast coordinated peripheral movement response [12].

In the present study, both ART and VRT were increased in the overweight individuals when they were compared to the values in the normal weight girls and this was statistically significant for the VRT.

Gunstad J et al., showed that the younger and the middle-aged adults (age 21-50 yrs) and the obese individuals had a poorer memory performance when they compared persons across the adult lifespan (age 21-82 yrs). They also showed the relationship between the elevated BMI values and the reduced cognitive performance and suggested that this relationship does not vary with age [13-14].

The vascular disease is likely to underlie the association between obesity and cognition, because obesity is a risk factor for the vascular disease, which, in turn, is related to a higher risk of the cognitive impairment. Other hypotheses which have been made on the underlying mechanisms concern the secretions of the adipose tissue such as hormones, cytokines, and growth factors, that can cross the blood-brain barrier and affect the brain health.

Our findings also showed the association between underweight and cognition in the early midlife. These findings showed significant differences in the VRT values.

Gustafson D. observed that in the elderly, the association between underweight and the cognitive functions was likely to be the result of a preclinical dementia [15]. Our results on the cross-sectional associations between underweight and cognition in the early midlife were consistent with this hypothesis. Underweight could be a result of poor health [16]; a further possibility is that the underweight persons experience a dysregulation in the hormone secretion which corresponds to that in anorexia, which results in cognitive disorders [15].

Further investigations of the mechanisms which underlie the cumulative effects of underweight on the later cognition, would be an important topic for future research.

CONCLUSION

This study suggested that both obesity and underweight were associated with a lower cognitive performance in the early midlife.

The VRT values showed significant differences in both overweight and underweight individuals, suggesting the use of the reaction time as a useful tool for neurological studies.

As the association of ART was not found to be statistically significant, further studies on a large population are invited to prove this association.

REFERENCES

[1] Parekh N, Gajbhiye IPR, Wahane M, Titus J. The study of the auditory and the visual reaction times in healthy controls, in patients of Diabetes mellitus who were on the modern allopathic treatment, and in those who performed aerobic exercises. *J Indian Acad Clin Med* 2004; 5(3):239-43.

[2] Hultsch DF, Macdonald SW, Dixon RA. The variability in a reaction time performance and in younger and older adults. *J Gerontol*, 2002; series B57 (2):101.

[3] Teichner WH. The recent studies on the simple reaction time. *Psychol Bull* 1954; 51: 128–49.

[4] Lofthus GK. The sensory motor performance and the limb preference. *Percepts Motor Skills* 1981; 52: 688–93.

[5] Elias MF, Elias PK, Sullivan LM, Pawolf , D'Agostino RB. A lower cognitive function in the presence of obesity and hypertension: the Framingham heart Study. *International Journal of Obesity* 2003; 27: 260–68.

[6] Cereda E, Sansone V, Meola G, Malavazos A E. The increased visceral adipose tissue rather than the BMI, as a risk factor for dementia. *Age and Ageing* 2007; 36: 488–91.

[7] Stommel M, Schoenborn CA. Variations in the BMI and the prevalence of the health risks in diverse racial and ethnic populations. *Obesity* (Silver Spring). 2010;18(9):1821–1816. doi: 10.1038/oby.2009.472.

[8] Das S, Gandhi A, Mondal S. The effect of premenstrual stress on the audiovisual reaction time and the audiogram. *Ind J Physiol Pharmacol* 1997; 41: 67–70.

[9] Namita, Ranjan DP, Shenvi DN. The effect of shift working on the reaction time in hospital employees. *Indian J Physiol Pharmacol* 2010; 54 (3) : 289–93.

[10] Ta M, Sevim Olga, Akyüz M, Akyüz Ö, Ta R. Determination of the physical fitness profiles of the female basketball players in the universities' super league and associating the profiles with the body compositions. *International Journal Of Human Sciences*, 2011; 8 (2).

[11] Shenvi D, Balasubramanian P. A comparative study on the visual and the auditory reaction times in males and females. *Ind J Physiol Pharmacol* 1994; 38: 229–31.

[12] Botwinick, Jack; Thompson, Larry W. The premotor and the motor components of the reaction time. *Journal of Experimental Psychology*, Jan 1966; 71(1): 9-15.

[13] Gunstad J, Paul R, Cohen R, Tate D, Gordon E. Obesity is associated with memory deficits in young and middle-aged adults. *Eating and Weight Disorders: Ewd*, 11 1 :e15-19.

[14] Gunstad J, Paul R, Cohen R, Tate D, Spitznagel M, Gordon E. An elevated Body Mass Index is associated with an executive dysfunction in otherwise healthy adults. *Comprehensive Psychiatry*, 48 1 :57-61.

[15] Gustafson D. The adiposity indices and dementia. *Lancet Neurol* 2006;5: 713–20.

[16] Sabia S, Kivimaki M, Shipley MJ, Marmot MG, Singh-Manoux A. The Body Mass Index over the adult life course and the cognition in late midlife: the Whitehall II Cohort Study. *Am J Clin Nutr* 2009; 89:601-07.

AUTHOR(S):

1. Dr. Deepmala Nagorao Deore
2. Dr. Surekha P. Surwase
3. Dr. Shazia Masroor
4. Dr. Samina T. Khan
5. Dr. Vinod Kathore

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Government Dental College, Aurangabad, Maharashtra, India.
2. Associate Professor, Government Medical college, Aurangabad, Maharashtra, India.
3. Assistant Professor, Government Medical college, Aurangabad, Maharashtra, India.
4. Professor and Head, Government Medical college, Aurangabad, Maharashtra, India.
5. Assistant Professor, Government Medical college, Aurangabad, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Deepmala Nagorao Deore
Department of Physiology,
Government Medical College, Panchakki Road,
Aurangabad, Maharashtra.
Phone: 9766215740
E-mail: Deepmala.deore@yahoo.com
E-mail: drranjan68@gmail.com

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