A Cross Sectional Study - Effect of Postural Changes on Choice Reaction Time with Reference to Body Mass Index in Medical Students

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ABSTRACT

BACKGROUND

Reaction time (RT) is a simple, non-invasive means of estimating sensorimotor co-ordination and monitoring performance of an individual. The effect of body mass index (BMI) on RT, suggests that underweight, overweight and obese have increased RT as compared to normal BMI individuals. We wanted to compare the effects of supine, sitting and standing postures on RT and determine the influence of BMI on the same.

METHODS

An observational cross-sectional study was carried out over 2 months in the Department of Physiology on 60 medical students (30 males and 30 females). Visual and auditory choice reaction times of subjects were measured in supine, sitting and standing postures for green, red and yellow colours and high, medium and low frequency sounds.

RESULTS

In sitting posture, significant and moderate negative correlation was observed between BMI and visual reaction time (VRT) while the correlation between auditory reaction time (ART) and BMI was weak negative but non-significant. In standing posture, non-significant and weak negative correlation was observed between BMI and VRT, also the correlation between ART and BMI was weak negative but not significant. In supine posture, significant and moderate negative correlation was observed between BMI and ART while the correlation between VRT and BMI was weak negative but not significant.

CONCLUSIONS

When compared with normal BMI group, higher BMI subjects had longer visual as well as auditory reaction times. The difference was not found to be statistically significant though. A weak or moderate negative correlation between BMI and reaction time (r value < 0.4 in magnitude) was observed in three different postures.

KEYWORDS

Choice Reaction Time, Visual Reaction Time, Auditory Reaction Time, Posture, Body Mass Index

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DOI: 10.18410/jebmh/2021/145

How to Cite This Article:
Gaule A, Bhattad G, Sood A. A cross sectional study - effect of postural changes on choice reaction time with reference to body mass index in medical students. J Evid Based Med Healthc 2021;8(13):740-744. DOI: 10.18410/jebmh/2021/145

Submission 11-09-2020,
Peer Review 21-09-2020,
Acceptance 04-02-2021,
Published 29-03-2021.

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BACKGROUND

Reaction time provides an estimate of integrity and processing ability of the central nervous system, providing an indirect index of the same.[1] It is a non-invasive and basic means of determining sensorimotor co-ordination and estimating performance of an individual.[2] The reaction time is the process by which visual or auditory information is processed and analysed followed by generation of the response in the form of execution of the motor act.[3-5]

The relation of the effect of BMI on RT, suggests that underweight, overweight and obese have increased RT as compared to normal weight population.[6,7] But, does similar influence of BMI on RT continues to be seen with change in posture, needs to be evaluated. There is paucity of literature on the effect of BMI on cognition, measured in terms of RT, in different postures.

Considering RT, primarily as an index of sensorimotor co-ordination, integrity of central nervous system (CNS) and estimating the performance of an individual and its relation to changes in cognitive performance associated with various postural changes in literature, this study was designed to re-investigate the inconsistent findings and compare the effects of supine, sitting and standing on choice reaction time and to investigate the upshot on body mass index of the same.

METHODS

This observational cross-sectional study was carried out in the Department of Physiology at a medical college of a tertiary care hospital. This study was carried out over a period of two months from August 2018 to September 2018 as part of research project that was submitted to and accepted by Indian Council of Medical Research (ICMR). Ethical clearance was duly obtained from the institutional ethics committee on 19 / 04 / 2018.

Inclusion Criteria

- Apparently healthy medical students of age between 18 - 24 years.
- BMI of all ranges.
- Females in the follicular phase of their menstrual cycle.

Exclusion Criteria

- Students with hearing defects, high refractory errors, colour blindness and hypothyroidism.
- Any diseases related to CNS, peripheral nervous system (PNS), muscles, joints, and bones.
- Any addiction to substances like, alcohol, tobacco.
- Any medications that may have adverse effect on CNS etc.
- Subjects having any skeletal deformity.

Sample Size

Of all the medical students who volunteered and met the inclusion criteria, during the defined study period, a total of 60 students (30 males and 30 females) were enrolled by complete enumeration technique.

Data Collection and Data Analysis

Subjects were explained in detail about the purpose of the study and the procedure to be performed to their satisfaction. Written informed consent was obtained from each subject. Complete history was obtained, and clinical examination was done. The tests were carried out in an soundproof room covered with blind curtains in the Department of Physiology so as to avoid any effect of external stimuli. Subjects were asked to avoid consumption of tea or coffee prior, for at least three hours.

The subjects were called for testing at the same time daily in the morning, to avoid effect of any bias.

Rinne's test and Weber test screening was done for all subjects. For visual screening Snellen's chart and Jaeger's chart was also used. The height was measured by a measuring tape making them stand erect with their heels, buttocks, back & occiput touching the wall. The subjects were made to stand on a digital weighing scale and their weight was measured. Height was calibrated up to 0.1 cm & weight up to 0.01 kg. BMI was finally calculated using the formula: BMI = weight in kg / (height in meter).[2] Before the readings were taken, every subject was made to rest for 5 mins, lying down. Basal heart rate and blood pressure were than taken. Blood pressure was recorded using a mercury sphygmomanometer by auscultatory method in supine position and basal pulse rate by three finger method.

Choice reaction time **(**CRT) assesses psychomotor abilities, processing speed, attention, response inhibition and stimulus categorisation. The reaction time apparatus RTM-608 manufactured by Biotech, India was used in this study.

Examiner sat on side of primary control while participant sat on opposite side with secondary control. To prevent the view of the examiner by the subject a white board was placed in the slot provided on the apparatus. The examiners side was provided with timer. Below the timer, there was a key provided for resetting the machine to zero timing to make start again with a new reading. Each subject was made to use headphones for auditory choice reaction time

At the start of test student was asked to click the appropriate corresponding key as quickly as possible. Subject used his index finger of the dominant hand to press appropriate key. The CRT was recorded in supine, sitting and standing postures. For each posture three readings were taken and the mean of the three was considered. All the 3 positions of the subject was studied in same single sitting, at the same time of the day in all the subjects (between 9 am to 10 am) to overcome the effect of diurnal variation and fatigue.

The choice reaction time in supine position was carried out on a head tilt table. The table was tilted to 30 degree for convenient view of the subject.

For the VRT, any of the three red, green or yellow lights were shown at random to the subject. The timer was switched on immediately and the same colour light got switched on both sides. As the subject viewed any of the

colour light on his side and he / she was to switch the corresponding key as soon as possible. As soon as the key was clicked the timer stopped displaying the reaction time for the subject in seconds. Maximum resolution of time was 0.0001 seconds (milliseconds). If the key pressed was not correct, the timer continued to run, till the correct key was attempted again.

For recording ART, same process was carried out. High, medium, low frequency sounds were used for the test with headphone.

At the commencement, six to seven practice sessions were presented to subjects. A verbal cue "ready" was told to subjects as a beginning signal. Fore period was fixed at 2 seconds. Fore period is time interval between the warning signal and the actual presentation of the stimulus. Average of the three readings recorded for both VRT and ART, was taken as the final reading.

Statistical Analysis

The data was uploaded on Microsoft Excel program and analysis was done using SPSS version 25.0 software. Quantitative data was presented with the help of mean and standard deviation (SD). Pearson's coefficient of correlation (r) was used to correlate between posture and BMI. P-value less than 0.05 was taken as significant level. One-way analysis of variance (ANOVA) was used to describe the difference in mean CRT across various categories of BMI.

RESULTS

CRT		BMI: Underweight (< 18.5) (n = 14)	Normal (18.5 - 24.9) (n = 38)	Overweight (≥ 25.0) (n = 8)	P-Value *
VRT Green	Sitting	0.3126 ± 0.04206	0.2994 ± 0.06062	0.2729 ± 0.03710	0.264
	Standing	0.3042 ± 0.06769	0.2889 ± 0.07026	0.2819 ± 0.05020	0.701
	Supine	0.3812 ± 0.06553	0.3579 ± 0.07795	0.3542 ± 0.03985	0.546
VRT Red	Sitting	0.2904 ± 0.05991	0.2756 ± 0.05293	0.2445 ± 0.02201	0.145
	Standing	0.2699 ± 0.06667	0.2781 ± 0.05639	0.2268 ± 0.03786	0.078
	Supine	0.3555 ± 0.05374	0.3413 ± 0.07616	0.3593 ± 0.06800	0.710
VRT Yellow	Sitting	0.2715 ± 0.06644	0.2320 ± 0.05944	0.2137 ± 0.03168	0.049
	Standing	0.2566 ± 0.06447	0.2354 ± 0.06041	0.2232 ± 0.01184	0.365
	Supine	0.3306 ± 0.08622	0.2997 ± 0.07468	0.2786 ± 0.05898	0.261
ART High	Sitting	0.4597 ± 0.10870	0.3651 ± 0.09293	0.3234 ± 0.08319	0.002
	Standing	0.4189 ± 0.11946	0.3567 ± 0.08367	0.3816 ± 0.15565	0.165
	Supine	0.4595 ± 0.12607	0.4359 ± 0.10035	0.4135 ± 0.10745	0.614
ART Medium	Sitting	0.3950 ± 0.12311	0.3871 ± 0.09214	0.3515 ± 0.07487	0.582
	Standing	0.3884 ± 0.09653	0.3823 ± 0.08621	0.3520 ± 0.10985	0.646
	Supine	0.4486 ± 0.08751	0.4428 ± 0.09170	0.3960 ± 0.11023	0.391
ART Low	Sitting	0.4622 ± 0.10962	0.4357 ± 0.10388	0.4197 ± 0.06663	0.592
	Standing	0.4475 ± 0.10022	0.4130 ± 0.11131	0.3738 ± 0.06715	0.278
	Supine	0.3651 ± 0.10972	0.4892 ± 0.10160	0.5039 ± 0.09098	0.006

Table 1. Difference in CRT across Categories of BMI

(N = 60) Post-hoc (Bonferroni)

Table 1 shows the mean choice reaction time across different categories of BMI. It can be observed that, significant difference was seen in different groups of BMI with respect to certain CRT namely VRT yellow and ART high in sitting position and ART low in supine position. The students in underweight category have significantly prolonged VRT yellow and ART high in sitting position as compared to normal and obese students (P = 0.04 and P = 0.002 respectively). They also have shorter ART low in supine position than normal and obese students. (P = 0.006)

Post-hoc (Bonferroni) was applied to see if significant changes occur between two groups. We found that, there was significant difference between ART high in underweight v / s normal BMI category (P = 0.008) and underweight v / s obese category (P = 0.006). Significant difference was also seen between ART supine in underweight v / s obese category (P = 0.01) and normal v / s obese category (P = 0.009).

In sitting posture, significant and moderate negative correlation was observed between BMI and VRT while the correlation between ART and BMI was weak negative but non-significant (Table 2). In standing posture, non-significant and weak negative correlation was observed between BMI and VRT also the correlation between ART and BMI was weak negative but non-significant (Table 2).

In supine posture, significant and moderate negative correlation was observed between BMI and ART while the correlation between VRT and BMI was weak negative but non-significant (Table 2). Irrespective of posture, significant and weak negative correlation was observed between BMI and VRT also the correlation between ART and BMI was weak negative and significant.

Correlation		VRT	ART
Sitting	Pearson correlation	- .304*	- .246
	Sig. (2-tailed)	.023	.068
	N	56	56
Standing	Pearson correlation	- .233	- .136
	Sig. (2-tailed)	.083	.317
	N	56	56
Supine	Pearson correlation	- .174	- .363**
	Sig. (2-tailed)	.200	.006
	N	56	56
Overall	Pearson correlation	- .191*	- .228**
	Sig. (2-tailed)	.013	.003
	N	168	168

Table 2. Correlation Coefficient between BMI vs. Reaction Time, and BMI vs. VRT and ART

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

There was negative significant correlation between BMI vs. reaction time for yellow in sitting position. In sitting posture, significant and moderate negative correlation was observed between BMI and VRT while the correlation between ART and BMI was weak negative but non-significant. In standing posture, non-significant and weak negative correlation was observed between BMI and VRT also the correlation between ART and BMI was weak negative but not significant. In supine posture, significant and moderate negative correlation was observed between BMI and ART while the correlation between VRT and BMI was weak negative but not significant.

	Correlation Value	P-Value	Interpretation
VRT	**BMI**		
Green	- .270*	0.037	Negative and S
Red	- .278*	0.031	Negative and S
Yellow	- .295*	0.022	Negative and S
ART	**BMI**		
High	- .310*	0.016	Negative and S
Medium	- 0.117	0.375	Negative and NS
Low	- 0.178	0.174	Negative and NS

Table 3. Sitting

	Correlation Value	P-Value	Interpretation
VRT	**BMI**		
Green	- 0.229	0.079	Negative and NS
Red	- 0.214	0.1	Negative and NS
Yellow	- 0.186	0.155	Negative and NS
ART	**BMI**		
High	- 0.084	0.521	Negative and NS
Medium	- 0.14	0.286	Negative and NS
Low	- 0.17	0.195	Negative and NS

Table 4. Standing

	Correlation Value	P-Value	Interpretation
VRT	**BMI**		
Green	- 0.108	0.412	Negative and NS
Red	- 0.229	0.079	Negative and NS
Yellow	- 0.196	0.134	Negative and NS
ART	**BMI**		
High	- .290*	0.025	Negative and S
Medium	- .296*	0.022	Negative and S
Low	- .295*	0.022	Negative and S

Table 5. Supine

DISCUSSION

In terms of global burden of obesity as a disease, more than one third of all adults are currently overweight or obese and the population of individuals with excessive body weight is rapidly increasing in many countries and we are counting. A study by Skurvydas et al. showed prolonged RT in obese subjects, where there subjects for RT were young males.[6] Numerous neurophysiological studies have shown that overweight and increased body mass index may adversely affect intellectual pursuits, memory and cognition in young and middle age people.[6,8-10] The mechanisms that may be involved are, secretions of hormones, cytokines, growth factors by the adipose tissue, that may affect brain health.[11]

Mignardot et al.[12] hypothesised that in obese individuals the distance between the location of cutaneous mechanoreceptors may be more (because of stretching of skin) and probably may be the reason for altered or decreased discrimination threshold of somato-sensory perception. Whole body representation (homunculus) is identified as per the inputs received by the various sensory receptors. These receptors may provide dysfunctional information to the somato-sensory cortical area in the brain in overweigh individuals.

In addition, it has been observed in obese patients that the lifestyle is usually sedentary, and this may also contribute to the dysfunctional body representation. In addition, if one needs to develop suitable muscular responses, appropriate to the postural challenges, the internal systems must be based on an accurate body representation. Therefore, it was assumed that obesity altered the subjects' body representation and internal commands necessary for postural control, especially in complex postural tasks.[12]

Similarly, it was found that cognition was affected in underweight subjects. Previous studies have attributed preclinical dementia for the decreased cognitive mechanisms in overweight individuals. Another hypothesis used to explain this is based on hormonal imbalance resulting due to anorexia.[11]

Studying the mechanisms underlying the cumulative effects of underweight on cognition and processing abilities of CNS would be an important topic for future research. The present study explores the effects on various groups of BMIs, in different postures that has not been examined previously. In present study, both the VRT and ART in overweight subjects were found to be longer when compared with normal weight individuals. The difference was not found to be statistically significant.

Future studies are required to further investigate the association of gender and cognition with respect to changing posture. Bigger sample size, specifying different ranges of BMI will have to be studied to establish the association with reaction time in different postures.

CONCLUSIONS

Significant difference was seen in different groups of BMI with respect to certain CRT namely VRT yellow and ART high in sitting position and ART low in supine position. The students in underweight category have significantly prolonged VRT yellow and ART high in sitting position as compared to normal and obese students (P = 0.04 and P = 0.002 respectively). They also have shorter ART low in supine position than normal and obese students. (P = 0.006).

In sitting posture, significant and moderate negative correlation was observed between BMI and VRT while the correlation between ART and BMI was weak negative but non-significant. In standing posture, non-significant and weak negative correlation was observed between BMI and VRT; also the correlation between ART and BMI was weak negative but not significant.

In supine posture, significant and moderate negative correlation was observed between BMI and ART while the correlation between VRT and BMI was weak negative but not significant. The VRT and ART in overweight subjects were found to be longer when compared with normal weight individuals. The difference was not found to be statistically significant. In standing, sitting and supine, there was weak or moderate negative correlation between BMI and reaction time (r value < 0.4 in magnitude).

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

REFERENCES

[1] Lofthus GK. Sensory motor performance and limb preference. Percepts Motor Skills 1981;52(3):683-693.
[2] Das S, Gandhi A, Mondal S. Effect of premenstrual stress on audiovisual reaction time and audiogram. Ind J Physio Pharmacol 1997;41(1):67-70.
[3] Madan M, Thombre DP, Das AK, et al. Reaction time in clinical diabetes mellitus. Ind J Physiol Pharmacol 1984;28(4):311-314.

[4] Malathi A, Parulkar VG, Dhavale HS, et al. A preliminary study of reaction time in schizophrenics. Ind J Physiol Pharmacol 1990;34(1):54-56.
[5] Baayen HR, Milin P. Analyzing reaction times. Int J Psychol Res 2010;3(2):12-28.
[6] Skurvydas A, Gutnik B, Zuoza AK, et al. Relationship between simple reaction time and BMI. Homo 2009;60(1):77-85.
[7] Nene AS, Pazare PA, Sharma KD. A study of relation between body mass index and simple reaction time in healthy young females. Ind J Physio Pharmacol 2011;55(3):288-291.
[8] Cournot M, Marquie JC, Ansiau D, et al. Relation between body mass index and cognitive function in healthy middle aged men and women. Neurology 2006;67(7):1208-1214.
[9] Gunstad J, Paul RH, Cohaen RA, et al. Obesity is associated with memory deficits in young and middle aged adults. Eat Weight Disord 2006;11(1):e15-e19.
[10] Gunstad J, Paul RH, Cohaen RA, et al. Elevated body mass index is associated with executive dysfunction in otherwise healthy adults. Compar Psychiatry 2007;48(1):57-61.
[11] Sabia S, Kivimaki M, Shipley MJ, et al. Body mass index over the adult life course and cognition in midlife: the Whitehall II cohort study. Am J Clin Nutr 2009;89(2):601-607.
[12] Mignardot J, Olivier I, Promayon E, et al. Obesity impact on the attentional cost for controlling posture. PLoS One 2010;5(12):e14387.