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EFFECT OF AGE, GENDER AND BODY MASS INDEX ON VISUAL AND AUDITORY REACTION TIMES IN INDIAN POPULATION

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Abstract : The effect of Age. Gender and Body Mass Index (BMI) on the *Visual* (VRT) and Auditory reaction time (ART) was studied in 30 males and 30 females in the age group of 18-20 years along with 30 males and 30 females in the age group of 65-75 years. Statistical analysis of the data by one-way ANOVA and post-hoc by Tukey-HSD test showed that BMI, VRT and ART were significantly higher in old than young individuals. Females had higher BMI and longer reaction times than males. There was significant positive correlation between BMI and reaction times (VRT and ART) in both males and females by Pearson correlation analysis. Older individuals should be more careful and vigilant about the injuries and falls due to increased reaction time. Longer reaction times and higher BMI in females could be attributed to fluid and salt retention due to female sex hormones affecting sensorimotor co-ordination.

Key words : gender body mass index visual reaction time auditory reaction time sensorimotor co-ordination

INTRODUCTION

Reaction time is defined as an interval of time between the application of stimulus and the initiation of appropriate voluntary response under the condition that the subject has been instructed to respond as rapidly as possible (1). Thus it indicates the time taken by an individual to react to external stimulus (2). In everyday life one has to respond almost instantaneously to many diverse situations. Many simple situations of reaction time are usually at our home itself e.g. response to a door bell, telephone ring or whistle of pressure cooker.

One measure of information processing is reaction time and is used to judge the ability of the person to concentrate and coordinate. It provides an indirect index of the integrity and processing ability of the central nervous system (3) and a simple, non invasive means of determining sensorimotor co-ordination and performance of an individual (4).

With improving health care and services, the entire world has seen a spurt of growth

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in geriatric population. Some factors like nutrition, exercise, personal habits, environmental influences, substances like antioxidants in heroic doses can slow down the process of aging to some degree, still it has proved to be almost an inevitable process.

The process of aging is characterised by progressive and generalised impairment of homeostasis resulting in declining ability to respond to external or internal stresses and increased risk of diseases (5). It is associated with many changes including a general decline in sensorimotor function, which may impair the ability to perform activities of daily living safely and independently (6). A critical element in safe performance of activities of daily living is the ability to react to incoming stimuli and its slowing has obvious consequences for life, such as applying the brakes of a car to avoid collision.

One persistent finding in literature is a slowing of responses with advancing age (6, 7, 8). As the proportion of older individuals continue to rise, it is increasingly important that they are able to remain mobile and independent. One of the largest implications that an increased reaction time may have is in the area of slips and falls. Falls are commonly incurred by one third of the elderly population and are a common source of morbidity and mortality in them (9).

Further, studies indicate that the females have a faster processing ability and hence have a shorter reaction time as compared to their male counterparts (10). Shandan et al (11) have reported that girls above eight years age have mental alertness superior to the boys of comparable age and have intellectual abilities which are at least one to two years ahead of the boys. These observations have been contradicted by other workers (2, 12).

The effect of Body Mass Index (BMI) on reaction time has not been studied extensively to establish any correlation between the two, but the factor of BMI is likely to influence reaction time. BMI is an index of weight adjusted for stature which is body weight (in kilograms) divided by the square of the height (in meters). It is a convenient, easy to measure and useful tool for diagnosing obesity or malnutrition and related health risks. The acceptable range of BMI is from 18.5 to 25. BMI values above 25 are considered abnormal. Individuals with BMI values 25-30 are overweight, and those with values more than 30 are obese (13). Though, there is a strong correlation between BMI and total fat mass there can be misclassification. For example, athletes having larger skeletal muscles and shorter individuals usually have high BMI, but they are not obese. Hence diagnosis should take into account certain factors like person's age, gender, fitness, and ethnicity.

Considering reaction time as a good indicator of sensorimotor co-ordination and performance of an individual and keeping in view the conflicting reports about the reaction time in male and female subjects, with a lacunae present in literature in respect of determination of reaction time with reference to BMI of an individual, present study is undertaken to study the effect of Age, Gender and Body Mass Index on Visual and Auditory reaction time.

MATERIALS AND METHODS

The study was carried out in the premises of Seth G. S. Medical College and K.E.M. Hospital, Mumbai with prior approval from the Dean, H.O.D of Physiology and Medicine department and Ethics committee for research on human subjects of the Institute.

Subjects were divided into four study groups of young males, young females, old males and old females, as per their age and sex respectively. For study group comprising of young individuals, healthy 30 male and 30 female first year medical undergraduate students in the age group of 18-20 years and for study group comprising of old individuals, healthy 30 male and 30 female in the age group of 65-75 years from the geriatric OPD seen by the Medicine Department of the Hospital, fulfilling the inclusion criteria were selected randomly.

Chronically ill subjects with history of any major illnesses like diabetes, hypertension, neuromuscular disorders, psychiatric disorders, addictions to alcohol and tobacco or any medications for long duration in present or past were excluded. The purpose, procedure and non invasive nature of the study were explained and written informed consent for the study was taken from each subject. Tests for hearing, vision and motor system examination and reflexes in upper limb were carried out to rule out any visual, auditory and neuromuscular disorders respectively. Age (years), sex and anthropometric parameters; height (meters) and weight (kg) were noted for each subject. Height of the subject was measured using a measuring scale whose least count is 0.1 cm. Height of each subject was converted in unit of metres. Weight was measured using weighing machine whose least count was 0.5 kg. BMI of each subject was calculated using Quetelet's index: BMI = Weight (kg)/Height^2 (m).

None of the subjects had seen or worked on the apparatus of reaction time before the test. The apparatus used to measure reaction time was Research Reaction timer with two response choices by Anand Agencies, Pune-2. It is a portable device with inbuilt four-digit chronoscope with least count of 1/1000 sec. i.e. 1 millisecond. Green light stimuli and click sound stimuli were selected for recording VRT and ART respectively. Before measuring VRT and ART, each subject was made familiar with the apparatus. All the readings were taken between 9-10 am in the morning in a quite room. While performing the test, all the subjects were made to sit comfortably in a chair and were motivated to better their results as much as possible. As soon as the stimulus was perceived by the subjects, they were asked to respond by pressing the response switch by index finger of dominant hand. Three readings of each stimuli; green light and click sound were noted from auto display in msecs. for each subject after giving three practice trails. Lowest reading was taken as the value for the reaction time task; VRT and ART respectively, which was considered for statistical analysis.

Statistical analysis of data

In the present study, all data collected were analyzed using SPSS Version 17. Mean was calculated for different parameters in each study group. Mean is a measure of central tendency and is the one value around which other values are dispersed. Standard

deviation (S.D) which denotes the measure of variability or dispersion from the mean value was calculated. The recorded values were expressed as Mean±SD. Statistical analysis of the data was done using one-way Analysis of Variance (ANOVA) and Post-hoc by Tukey-Honestly significant difference (HSD) test as each study group had equal sample size (n=30). ANOVA is a group of statistical techniques used to compare the means of two or more samples to see whether they come from same population. This technique expands on the tests for two means, such as the t-test. Statistical significance of difference was determined. The P value gives the probability of any observed difference having happened by chance. P value of 0.05 means that the probability of the difference having happened by chance is 0.05 in 1 i.e. 1 in 20. P value below 0.05 was considered to be statistically significant and P value below 0.01 was considered to be highly significant.

RESULTS

Table I depicts Mean and standard deviation values of different parameters: Age, Body Mass Index (BMI), Visual reaction time (VRT) and Auditory reaction time (ART) for each study group with inter-group comparison of significance. As shown in Table I, BMI were significantly higher in older individuals than young individuals for both sexes (P<0.001). BMI were more in females than males in both age groups, but the difference was not statistically significant. VRT were significantly higher in older individuals than young individuals in either sex (P=0.000). ART were also significantly higher in old individuals than young individuals in either sex (P = 0.000). Reaction times for each stimulus visual and auditory (VRT and ART) were higher in females than males in both age groups, but difference between two were not statistically significant.

Table II shows that on correlation of BMI with reaction times (VRT and ART) in males

TABLE II: Correlation of BMI with reaction times (VRT and ART) in males and females of both age groups.

Parameters	*Males (n=60)*		*Females (n=60)*	
	r-value	*P-value*	*r-value*	*P-value*
VRT	0.514**	0.000	0.506**	0.000
ART	0.472**	0.000	0.543**	0.000

**P<0.01-statistically highly significant.

TABLE I: Comparison of Age, BMI, Visual (VRT) and Auditory reaction time (ART) in different study group subjects.

Parameters	*Young males (n=30)*	*Young females (n=30)*	*Old males (n=30)*	*Old females (n=30)*
Age (years)	18.46±0.57	18.57±0.50	70.03±3.52	71.87±3.48
BMI (kg/m^2)	19.82±3.54$^{□□,ΔΔ}$	21.72±3.32$^{□□,ΔΔ}$	25.39±5.00**$^{,\#\#}$	26.82±4.24**
VRT (msecs)	220.4±28.27$^{□□,ΔΔ}$	235.6±33.51$^{□□,ΔΔ}$	340.5±36.44**$^{,\#\#}$	359.1±38.75**$^{,\#\#}$
ART (msecs)	189.6±20.45$^{□□,ΔΔ}$	197.7±34.46$^{□□,ΔΔ}$	332.3±42.16**$^{,\#\#}$	341.3±41.69**$^{,\#\#}$

Data presented are mean±SD. Analysis of data was done by one-way ANOVA and post-hoc by Tukey-HSD test. The * depicts comparison with young males, # depicts comparison with young females, □ depicts comparison with old males and A depicts comparison with old females. **, ##, □□, ΔΔ depicts P<0.01-statistically highly significant.

and females of both age groups by Pearson correlation analysis, there was a statistically significant positive correlation between BMI and reaction times (P=0.000).

DISCUSSION

In the present study, both VRT and ART were significantly higher in old than the young individuals for both the sexes. Though the analysis of literature shows a common observation but the course, location and the nature of slowdown is not very clear. All the components of reaction time; the mental processing time to perceive a signal and to decide upon a response, movement time and device response time are likely to get delayed in elderly. Senile changes in peripheral processes, like decelerated muscular response and impulse transduction through sensory nerves can account for 20% of reaction time lengthening (14). But since sensory receipt and motor outflow times are believed to remain similar across the lifespan, the cause could be the slowed processing rate of Central Nervous System in old individuals (15).

Older people also have a tendency to be more careful and monitor their responses more thoroughly. When troubled by a distraction they tend to devote their exclusive attention to one stimulus, and ignore another stimulus completely than young people, further slowing their reaction time (16). Though the effect of age increases with task complexity, cognitive slowing is argued to be a common phenomenon in the elderly (17).

Thus, we can conclude that reaction time task is a good indicator of sensorimotor performance of an individual, as the young individuals performed better in the reaction time tasks than old in the present study. Old people who tend to fall in the nursing homes have shown a significant slower reaction time than those who do not tend to fall (18). This indicates that the old individuals should be more careful and vigilant about the injuries and fall that may occur as a result of increased reaction time.

In the present study, VRT and ART in females were longer as compared to males for both age groups, but not statistically significant. This finding is consistent with the observation of other workers (2, 12) but in contrary to the observation by Shenvi et al (10).

BMI were significantly more in old than young individuals. This can be explained on the basis of observations that as we age, a decrease in our physical abilities leads to a decrease in our metabolic rate, which in turn contributes to weight gain and increased BMI. BMI were also found to be more in females than males, but not statistically significant. The difference in BMI between male and female could be due to obesity but can also be due to other causes such as fluid retention (13). Most likely it is due to the fluctuations in the reproductive hormone concentrations throughout the women's lives, that uniquely predispose them to excess weight gain than males (19).

There was a significant positive correlation found between BMI and reaction times (VRT and ART) in males and females of both age groups. This finding is consistent with the observation of Skurvydas that subjects with greater body mass index react

significantly slower than others (20). In the present study on correlation, it is evident that female subjects who have a higher BMI also have higher reaction times (VRT and ART) as compared to males, but not significant. Bruce and Russel (21) have indicated that varying level of sex steroids during different phases of menstrual cycle have sodium and water retaining effect associated with weight gain in females. This retention of salt and water could modify the axonal conduction and alter the rate of impulse transmission. Further, it is also suggested to alter the availability of the neuro-transmitter at the synaptic level. Thus, we can conclude that the increased synaptic delay coupled with the reduced velocity of nerve impulse due to the effect of female sex hormones affects the sensorimotor co-ordination and the processing speed of the Central Nervous System.

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