

# Influence of Body Mass Index, Handedness and Gender on Ruler Drop Method Reaction Time among Adults

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## ABSTRACT

**Background:** The interval between stimulus and response is called reaction time. It measures the sensorimotor function and performance of an individual. It involves stimulus processing, decision making and response programming. Many factors such as age, gender, handedness, physical fitness, sleep, fatigue, distraction, personality type and type of stimulus have been shown to affect reaction time. Thus the aim of this study was to assess the effect of body mass index, handedness and gender on reaction time.

**Methods:** A cross-sectional study was conducted in the Department of Physiology, Kathmandu University School of Medical Sciences, from October 2019 to December 2019, among 113 student volunteers. Height and weight were recorded and body mass index was then calculated. In ruler drop method, the students were made to sit with their forearm resting on a flat horizontal table surface, with their open hand at the edge of the surface. When the examiner suspended and released the ruler vertically the students were instructed to catch it as quickly as possible.

**Results:** Females had a faster reaction time than males when testing either hand ( $178.46 \pm 17.56$  Vs  $195.99 \pm 15.67$ ; right hand) and ( $184.25 \pm 17.02$  Vs  $199.57 \pm 15.91$ ; left hand). In females, right hand responded faster than left hand. In both gender, reaction time was faster in normal weight compared to overweight individuals but it was statistically insignificant.

**Conclusions:** Females responded faster than males. Right hand had shorter reaction time than left hand in females. Reaction time was insignificantly prolonged in overweight individuals.

**Keywords:** Body mass index; reaction time; ruler drop method

## INTRODUCTION

Reaction time is the time interval between the application of the stimulus and response. It evaluates the processing speed of central nervous system and coordination between the sensory and motor systems.<sup>1</sup> Reaction time determines the alertness of a person and is considered better when lesser in drivers, military people, sportsmen and doctors.<sup>2</sup> Several methods can be used to test reaction time such as catching a dropped ruler and computer based specialized software.<sup>3</sup>

Reaction time can be affected by several factors.<sup>4</sup> In almost all age groups, males are reported to have faster reaction time than females.<sup>5-8</sup> In majority of right handed people, the reaction time was faster in right hand compared to left hand.<sup>9-13</sup> Obesity influences cognitive functions, memory deficits and executive dysfunction in

young as well as middle aged individuals.<sup>14,15</sup> The purpose of the study was to evaluate the influence of gender, handedness and body mass index (BMI) on reaction time.

## METHODS

The cross-sectional study was carried out in the Department of Physiology, Kathmandu University School of Medical Sciences with approval from the Institutional Review Committee of Kathmandu University School of Medical Sciences/Dhulikhel Hospital (IRC-KUSMS). Participants were informed about the test, its procedure and the rationale of it and 113 participants willing to participate were enrolled for this study, aged between 17-25 years amongst which 67 were females and 46 were males. Written informed consent was taken before the test and visual reaction time was evaluated.

Each participant was called individually to departmental

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research laboratory and asked to fill up the questionnaire. Hand preference was ascertained by eliciting questions for the hand he/she preferred for performing the activities such as eating meals, combing hair, brushing teeth and writing. Height and weight were measured using inch tape and standardized weighing machine respectively. Body mass index (BMI) was then calculated using the formula weight in kilograms divided by the square of the height in meters, {weight (kg)/height (m<sup>2</sup>)}. Body weights were categorized using the WHO standard; normal weight (18.5 to 24.9 kg/m<sup>2</sup>) and, overweight (25.0-29.9 kg/m<sup>2</sup>).

Participant was made to sit on the chair placing his one hand on the horizontal surface of table near the edge. While applying the test, the thumb and the index finger were made open with distance of about 25 mm using the spacer. One edge of the ruler is placed in between the subject fingers vertically. Then the participant was instructed to catch the ruler as soon as possible once drooped. The distance at which the subject grabs the ruler was recorded, in centimeters, by measuring from the end of the ruler to superior aspect of the adult's hand. This distance was converted to reaction time in milliseconds (ms). Prior to the test, each participant had trial for two times after a demo. Then procedure was repeated three times and the mean of all was taken. The reaction time (RT) is calculated as  $t = (\sqrt{2d/g})$  where  $t$  = reaction time,  $d$  = distance travelled by the ruler,  $g = 9.81 \text{ m/s}^2$  (gravitational constant).<sup>3,19</sup>

Data were expressed as mean ± standard deviation (SD). The difference between RT and the variables of interest (gender, handedness and BMI) were tested by t-test assuming equal variance. A p value of <0.05 was considered to be statistically significant. All data were analyzed using SPSS version 25.0.

## RESULTS

One hundred and thirteen students (Male: 40.71% and Female: 59.29%) aged between 17 to 25 years were

included in this study. The mean age, height, weight and body mass index of the participants were comparable, and presented below (Table 1).

**Table 1. Anthropometric variables.**

Variable	Male	Female	p-value
Age (years)	21.15±1.70	20.13±1.44	0.01
Frequency	46(40.71%)	67 (59.29%)	
Height (m)	1.67± 0.83	1.58± 0.62	0.00
Weight (kg)	63.74±8.45	52.21±9.62	0.00
BMI	22.79±2.73	20.76±3.48	0.01

Table two shows comparison of reaction time between male and female using unpaired t test. In females, reaction time was faster compared to males in either hand.

**Table 2. Gender differences in reaction time (RT).**

Gender	Male	Female	p-value
Right Hand RT (ms)	195.99±15.67	178.46±17.56	0.00
Left Hand RT (ms)	199.57±13.91	184.25±17.02	0.00

In females, reaction time was significantly faster in right hand compared to left hand however in males, reaction time tend to be faster in right hand but insignificant (Table 3). In this study, all the participants were right handers.

**Table 3. Reaction time difference between the left and right hand.**

Gender	Right Hand RT (ms)	Left Hand RT (ms)	p-value
Male	195.99±15.67	199.57±13.91	0.147
Female	178.46±17.56	184.25±17.02	0.011

As in table 4, male versus female, there was no significant difference in reaction time of overweight person compared to normal weight person.

**Table 4. Reaction time difference between normal weight and overweight person.**

Gender	Male			Female		
	Normal weight	Overweight	p-value	Normal weight	Overweight	p-value
Right Hand RT (ms)	196.94±15.47	192.78±16.38	0.464	176.19±16.49	182.88±21.2	0.403
Left Hand RT (ms)	199.17±13.95	203.68±12.49	0.364	184.4±15.67	188.06±22.68	0.634

## DISCUSSION

In the present study we observed that the reaction time is shorter in females compared to males. Our findings are consistent with research done by Shenvi<sup>16</sup> and Skandhan.<sup>17</sup> In contradiction to our result, several researchers found that males have faster reaction times than females.<sup>5-8</sup> The difference in reaction time between male and female is due to the lag between the presentation of the stimulus and the beginning of muscle contraction. Though the muscle contraction time is the same for both males and females,<sup>18</sup> motor responses in males are comparatively stronger than females; this explains why males have faster reaction time. Two factors such as participation in fast action sports and driving are proposed for decreasing magnitude of the sex differences in visual reaction time.<sup>19</sup> Nowadays; reaction time is getting faster in females, possibly because more women are participating in sports and driving. In addition, mental alertness in girls from the age of eight years onwards is superior as compared with that in boys.<sup>17</sup>

In our study, all participants were right handers and we found that the reaction time of right hand is shorter than that of left hand. Similar results are reported by several authors.<sup>9-13</sup> Cerebral hemisphere concerned with categorization or symbolization i.e. sequential analytical process is categorical hemisphere, has often been called, dominant hemisphere while the hemisphere specialized for spatiotemporal and visuospatial relations is representational hemisphere, has often been called non dominant hemisphere. Hemispheric specialization is related to handedness. Handedness appears to be genetically determined. In 96% of right handed persons, forming 91% of the human population, the left cerebral hemisphere is dominant or categorical, and the right being dominant in the remaining 4%. In left handers, 15% have the right hemisphere as dominant, 15% have no clear lateralization and in the remaining 70%, left hemisphere is the dominant one. The hemispheres of the cerebrum are specialized for different tasks. Representational hemisphere is thought to govern creativity, spatial relations, face reorganization, and emotions however the categorical hemisphere is regarded as verbal and logical brain. Also, the right hemisphere controls the left hand, and the left hemisphere controls the right hand.<sup>20</sup> Singh et al. have reported faster motor conduction velocity in dominant upper limb i.e., right hand in right handed persons.<sup>21</sup>

In this study, no significant difference in the reaction time of overweight and normal weight individuals of

either sex were found. These findings contradict to research done by several authors who found a longer reaction time in overweight young males<sup>22</sup> and females<sup>23</sup> as compared to their normal weight counterparts. This may be due to different technique used to measure the RT. One study employed the use of computer and a joystick<sup>22</sup> while this present research utilized the ruler drop method as described by Arachna et al.<sup>3</sup> Several studies have shown influence of obesity or elevated body mass index on cognitive functions, memory deficits and executive dysfunction in young as well as middle aged individuals.<sup>14, 15</sup> Possible mechanism could be secretions of adipose tissue like hormones, cytokines, growth factors may affect brain health.<sup>22</sup> In our study reaction time was insignificantly prolonged in overweight individuals. This factor might become significant with further increase in BMI.

## CONCLUSIONS

The reaction of people appeared to be influenced by gender and handedness. However, in this age group; 17 - 25 years, BMI does not affect simple reaction time measurement.

## ACKNOWLEDGEMENTS

Authors would like to thank all participants for their kind participation in the study.

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