# Effect of Body Mass Index (BMI) On Auditory And Visual Reaction Time In Formula Car Racers Using INQUISIT 4.0: A Pilot Study

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***Abstract-***
**Background: Reaction time is the measure to know how person responds to any given stimulus. A Stimulus can be auditory, visual or both. BMI is index found by dividing weight to square of height. A quick reaction time is important for sports for better results. Motorsport is not only recreational activity but also high-profile international sport. A lot of studies have been conducted in motorsports for technical aspects of car, but very limited studies had been conducted regarding motor, perceptual, and cognitive skills of athlete performance in motorsports. INQUISIT 4.0 is application-based reaction time test which had a good inter and intra rater reliability compared to the ruler drop test.**
**Methodology: A pilot Study was carried out in which Permission from Ethical Committee had been taken. Consent from participants and authorities had been taken. 15 Participants were selected according to inclusion criteria. BMI was calculated. 5 racers from each BMI group were taken. Visual and Auditory reaction time was measured with INQUISIT 4.0 application.**
**Result: Using ANOVA test, the mean difference for all reaction time tests for all the BMI categories was statistically insignificant.**
**Conclusion: Body Mass Index (BMI) is not having effect on auditory and visual reaction time in formula car racers. Normal category has quicker reaction time response than underweight and overweight category**

***Keywords:*** **Body Mass Index, Reaction Time, Motorsports, Formula Cars.**

## INTRODUCTION

Reaction time is the measure to know how person responds to any given stimulus. A Stimulus can be auditory, visual or both. Luce and Welford had described three types of reaction time: Simple, Recognition and choice[(1).] Human Nervous system shall recognize any kind of stimulus presented to it. Neurons have a role in transmitting signals to brain and spinal cord. Spinal cord later relays further information to muscles and the response is noted. [(1)]Reaction Time has a significant effect to our daily living activities. A quick reaction time is important for sports for better results. Factors affecting reaction time include age, sex, left or right hand, central versus peripheral vision, practice, fatigue, fasting, breathing cycle, personality types, exercise, and intelligence of the subject. [(1)]

The effect of Body Mass Index (BMI) on reaction time is not studied yet in much depth to find any co relation with reaction time and its effect on Reaction time. [(2)]BMI is index found by dividing weight (in kilograms) to square of height (in meters).It is a convenient, easy to measure and useful tool for diagnosing obesity or malnutrition and related health risks.[(2)] From 18.5 to 25 is considered normal , below18.5 it is malnourished or underweight category and above 25 are overweight or obese category. Individuals with BMI values 25-30 are overweight, and those with values more than 30 are obese.[(2)]

The neurophysiological studies taken place before have shown that there is relationship of the BMI with the cognition, attention and the memory. [(3)]

Motorsport is not only recreational activity but also high-profile international sport. The goal of any racing driver is achieving the fastest possible lap time.[(4)]A lot of studies have been conducted in motorsports for technical aspects of car but very limited studies had been conducted regarding motor, perceptual, and cognitive skills of athlete performance in motorsports. Knowing these skills and their knowledge may play role for making driver fitness programs. [(4)]

Risk of mishaps has been reduced considerably by technical advances in race car construction. If we look of the formula cars, we shall realize importance of strength and sensorimotor competence in racing drivers and can also help to reduce the risk of overuse injuries. [(5)]

There are also sequential gear boxes which allow an upward shift without use of a pedal. In downward shifts, the left leg has to be used for the clutch, while at the same time the right leg is performs action of braking and heel-and-toe throttle on two pedals (brake and throttle). It requires great sensorimotor control as good amount of coordination is needed. [5]In previous studies Race car drivers have demonstrated better reaction time than controls. [5]
All racing tracks have a stationary start and during a heat or race or practice session, on the starting signal, rider has to move as quickly as possible and accelerate to a speed of over 100 kilometers per hour, reaching 80 kilometers per hour in about 2.4 seconds. [6]In competitive sports, the final success is very often determined by minimal differences. [6]The importance of reaction time has been considered advantageous in many endurance-based motorsports, which includes karting, touring car racing and sports car racing. [6]
Knowing the trajectory or race line is important to determine lap time. Through an optimization algorithm it is possible to determine the best compromise between shortest track and track with the minimum curvature. The aim of racing driver is to take the shortest route on the racetrack and save the time on in order to obtain best or quick lap time .So it becomes necessary to identify drivers input for optimal trajectory. [7]

## NEED OF STUDY

Motorsport is not only recreational activity but also a high-profile international sport. A lot of studies have been conducted in motorsports for technical aspects of car, but very limited studies have been conducted regarding motor, perceptual, and cognitive skills of athlete performance in motorsports. Knowing these skills and their knowledge may play a role for making driver fitness programs. The final success in motorsports is very often determined by minimal differences & it is where exactly a quick reaction time plays role for formula race car drivers. Since BMI is one of the indicators of health its effect on Reaction Time can help to determine further training program for Formula car racers.

## AIM

The aim of the study is to find the effect of Body Mass Index (BMI) on auditory and visual reaction time.

## OBJECTIVE

Effect Of Body Mass Index (BMI) On Auditory and Visual Reaction Time Of Formula Car Racers Using INQUIST 4.0

## MATERIAL AND METHODOLOGY

### MATERIALS REQUIRED

INQUISIT 4.0 version application on laptop
Pen and paper
.Measuring tape
Weighing machine

### METHODOLOGY

Study design: Pilot study
Study setup: Kari Motor Speedway, Coimbatore
Sampling technique: Purposive Sampling
Sample size:15
Study duration: 6 months

### OUTCOME MEASURE

INQUISIT 4.0 application for auditory reaction time and visual reaction time

### HYPOTHESIS

| INCLSION CRITERIA | EXCLUSION CRITERIA |
|---|---|
| Age: 25.9±7.6, min 16.0, max 46.0 years | Any recent musculoskeletal injury. |
| Both genders will be included | Anyone with less than 2 years of experience or has played less than 6 track day races. |
| More than 2 years of racing experience, apart from go-karting. | Consumption of substances with caffeine two hours from the tests |
| Participation in at least 6 Track Day races | Racers who are not willing for participation. |
| Racer holding the FMSCI license and willing to participate. | |

**Null hypothesis**
There will be no effect of body mass index on auditory and visual reaction time
**Alternate Hypothesis**
There will be effect of body mass index on auditory and visual reaction time

## PROCEDURE

Permission from Ethical Committee had been taken .Consent from participants, racing teams, FMSCI – Federation of Motorsports Club of India, JK Tyre motorsports was taken .Participants were selected as per inclusion criteria .Procedure was explained to the participants .After filling consent form the participants' demographic data including age, gender, height, weight, Number of years in motorsports, Any prior racing experience before Formula car and information regarding the exercise session. Height and weight were measured to calculate BMI. Auditory and Visual reaction time was been recorded using the outcome measure. Auditory Reaction Time was been recorded with and without helmet on. For each of it mean, fast and slowest reaction time was been recorded with the outcome measure .The data was collected and analyzed using proper statistical tests.



## DATA ANALYSIS AND RESULT

| Categories | Underweight | Normal | Overweight |
|---|---|---|---|
| No. Of Participants | 5 | 5 | 5 |

TABLE NO. 1

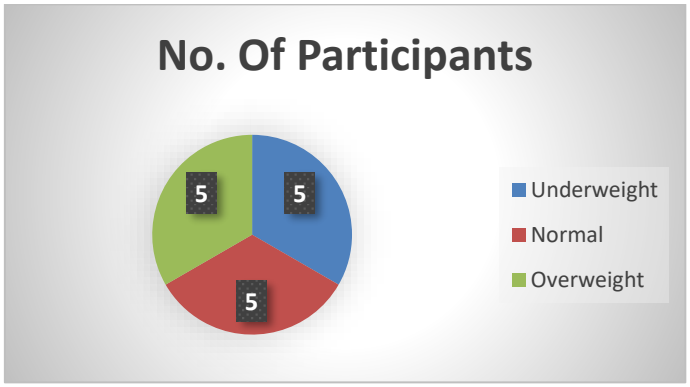


CHART NO.1

INTERPRETITON: TABLE NO. 1 &CHART NO.1 shows that out of 15 participants who participated in the study among them Body Mass Index was as follow 5 were underweight 5 were normal and 5 were overweight

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | F Value | P Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | | |
| MEAN VISUAL | UNDER | 266.5 | 36.4 | 16.3 | 221.3 | 311.7 | 218.2 | 316.1 | 2.423 | 0.6 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| RT (MILLISECONDS ) | WT | | | | | | | | | |
| | NORMAL | 230.7 | 18.4 | 8.2 | 207.9 | 253.5 | 213.2 | 261.2 | | |
| | OVER WT | 237.1 | 24.3 | 10.8 | 206.9 | 267.34 | 210.8 | 269.5 | | |

TABLE NO. 2

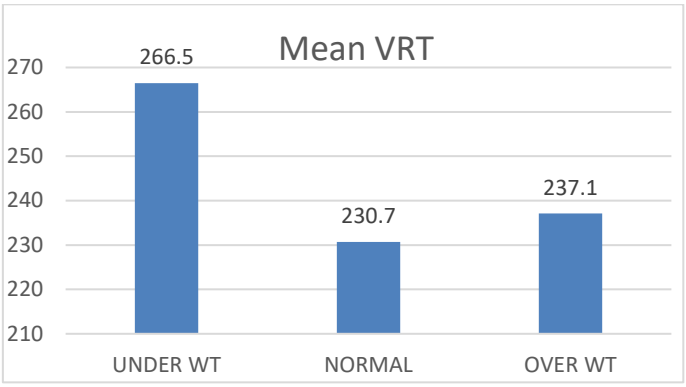


CHART NO. 2

INTERPRETITION: TABLE NO. 2 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 2 indicates the mean value of mean visual reaction time of each BMI category

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | | |
| FASTEST VISUAL RT (MS) | UNDER WT | 200 | 20.2 | 9 | 174.9 | 225.1 | 176 | 231 | 0.5524 | 0.5895 |
| | NORMAL | 189.8 | 16.8 | 7.5 | 169 | 210.6 | 173 | 218 | | |
| | OVER WT | 193.2 | 6.5 | 2.93 | 185.04 | 201.36 | 186 | 202 | | |

TABLE NO. 3

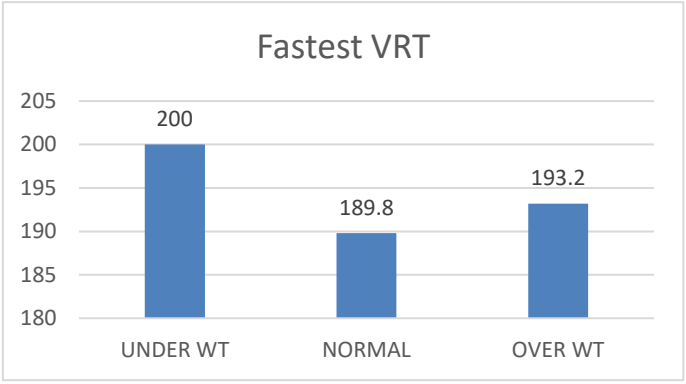


CHART NO 3

INTERPRETITION: TABLE No. 3 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 3 indicates the mean value of fastest visual reaction time of each BMI category

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SLOWEST VISUAL RT (MS) | UNDER WT | 433.2 | 131 | 58.6 | 270.6 | 595.8 | 297 | 644 | 2.15 | 0.122 |
| | NORMAL | 306 | 42.3 | 18.9 | 253.5 | 358.5 | 252 | 350 | | |
| | OVER WT | 354.2 | 75.533 | 33.779 | 260.43 | 447.97 | 260 | 445 | | |

TABLE NO. 4

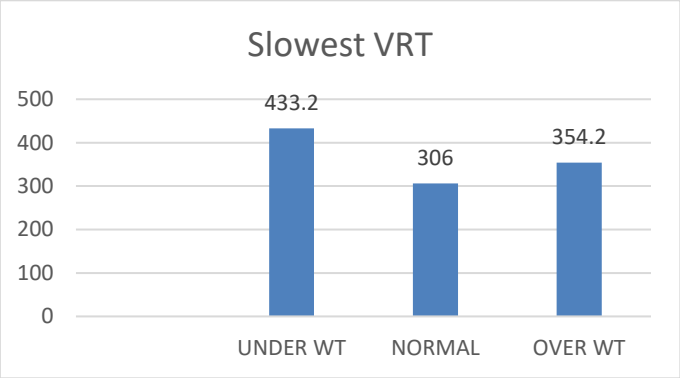


CHART NO 4

INTERPRETITION: TABLE NO.4 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 4 indicates the mean value of slowest visual reaction time of each BMI category

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |
| MEAN ART (MS) | UNDER WT | 265.5 | 20.8 | 9.3 | 239.6 | 291.4 | 237.4 | 287.8 | 0.748 | 0.494 |
| | NORMAL | 262.59 | 36.066 | 16.129 | 217.81 | 307.37 | 203.25 | 292.5 | | |
| | OVER WT | 298.1 | 77.7 | 34.7 | 201.6 | 394.5 | 233 | 429.9 | | |

TABLE NO. 5

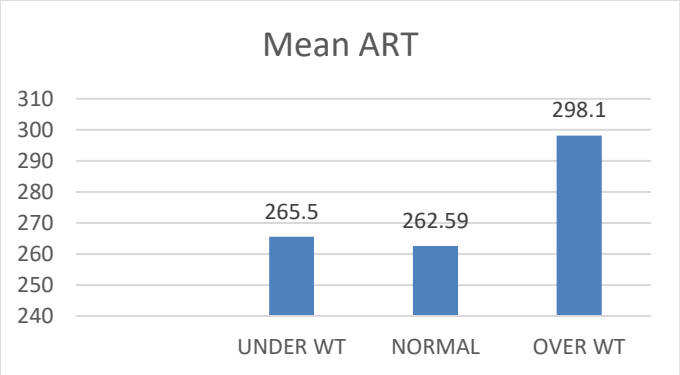


CHART NO.5

INTERPRETITION: TABLE NO. 5 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 5 indicates the mean value of mean auditory reaction time of each BMI category

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |
| FASTEST ART (MS) | UNDER WT | 201.2 | 13.6 | 6.1 | 184.3 | 218.1 | 181 | 215 | 1.588 | 0.244 |
| | NORMAL | 162.6 | 67.89 | 30.365 | 78.306 | 246.89 | 46 | 213 | | |
| | OVER WT | 202.8 | 9.9 | 4.4 | 190.5 | 215.1 | 192 | 219 | | |

TABLE NO. 6

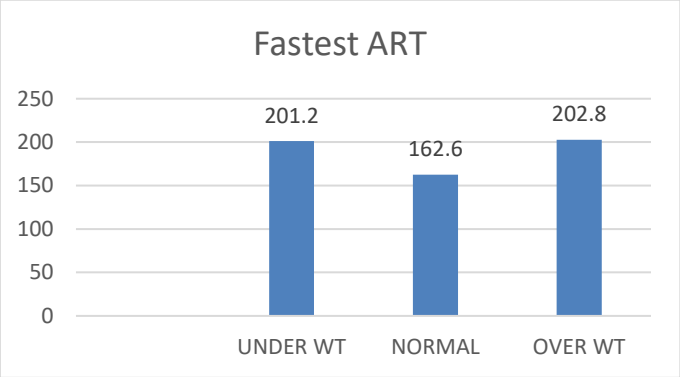


CHART NO. 6

INTERPRETITION: TABLE NO. 6 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 6 indicates the mean value of fastest auditory reaction time of each BMI category

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |
| SLOWEST ART (MS) | UNDER WT | 425.8 | 84.9 | 38 | 320.3 | 531.2 | 328 | 561.8 | 0.884 | 0.438 |
| | NORMAL | 420.2 | 221.07 | 98.867 | 145.75 | 694.65 | 264 | 787 | | |
| | OVER WT | 912.2 | 1139.2 | 509.4 | -502.2 | 2326.6 | 310 | 2943 | | |

TABLE NO.7

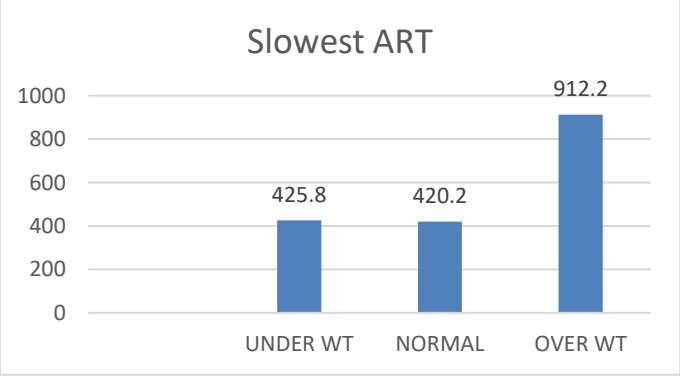


CHART NO. 7

INTERPRETITION: TABLE NO. 7 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 7 indicates the mean value of slowest auditory reaction time of each BMI category.

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |
| MEAN AUDITORY RT WITH HELMET (MS) | UNDER WT | 265.4 | 36.6 | 16.3 | 220 | 310.8 | 212.4 | 311.3 | 0.137 | 0.873 |
| | NORMAL | 251.15 | 42.915 | 19.192 | 197.87 | 304.43 | 212.55 | 323.45 | | |
| | OVER WT | 259.9 | 49.9 | 22.3 | 197.9 | 321.9 | 215.6 | 343.7 | | |

TABLE NO. 8

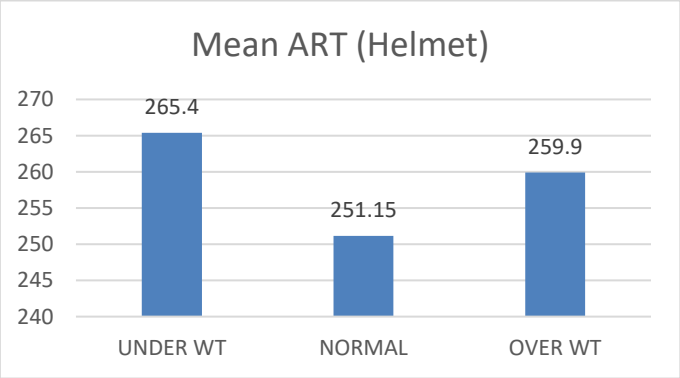


CHART NO.8

INTERPRETITION: TABLE NO. 8 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 8 indicates the mean value of mean auditory reaction time with helmet of each BMI category.

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |
| FASTEST ART WITH HELMET (MS) | UNDER WT | 205.8 | 20.1 | 9 | 180.9 | 230.7 | 184 | 224 | 0.4988 | 0.564 |
| | NORMAL | 184.2 | 39.771 | 17.786 | 134.83 | 233.57 | 125 | 233 | | |
| | OVER WT | 194.6 | 19.7 | 8.8 | 170.1 | 219.1 | 169 | 222 | | |

TABLE NO. 9

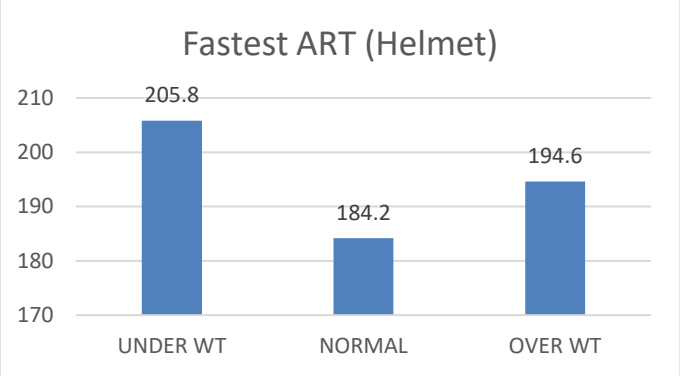


CHART NO.9

INTERPRETITION: TABLE NO. 9 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 9 indicates the mean value of fastest auditory reaction time with helmet of each BMI category

| Title | BMI | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound | | | F Value | P Value |
| SLOWEST ART WITH HELMET(MS) | UNDER WT | 488 | 289.2 | 129.3 | 129 | 847 | 259 | 973 | 0.981 | 0.907 |
| | NORMAL | 418.6 | 143.45 | 64.155 | 240.51 | 596.69 | 249 | 626 | | |
| | OVER WT | 462.2 | 289.6 | 129.5 | 102.6 | 821.8 | 285 | 975 | | |

TABLE NO. 10

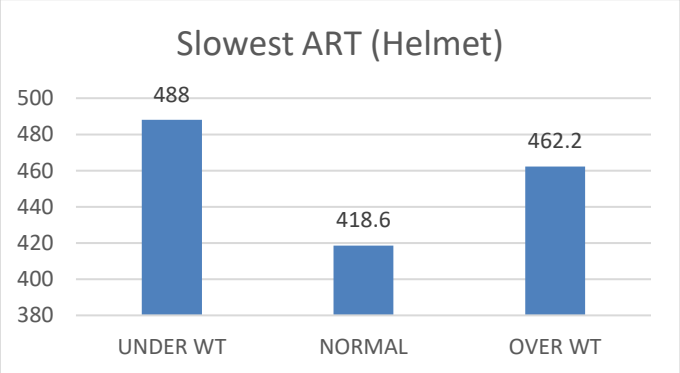


CHART NO. 10

INTERPRETITION: TABLE NO. 10 indicates mean, standard deviation, standard error 95 % confidence interval of mean for each category, f value and p value for mean visual reaction time. CHART NO. 10 indicates the mean value of slowest auditory reaction time with helmet of each BMI category.

**RESULT**

For Mean Visual Reaction Time test, Using ANOVA the mean difference for underweight category is 266.5±36.4 ms , normal category 230.7 ±18.4 ms and overweight category 237.1± 24.3 ms (P > 0.05).

For Fastest Visual Reaction Time test, Using ANOVA the mean difference for underweight category is 200±20.2 ms , normal category 189.8 ±16.8 ms and overweight category 193.2± 6.5 ms(P > 0.05).

For Slowest Visual Reaction Time test, Using ANOVA the mean difference for underweight category is 433.2±131 ms , normal category 306.2 ±42.3 ms and overweight category 354.2± 77.33ms (P > 0.05).

For Mean Auditory Reaction Time test, Using ANOVA the mean difference for underweight category is 265.5±9.3 ms , normal category 262.6 ±16.12 ms and overweight category 298.1± 77.7ms (P > 0.05).

For Fastest Auditory Reaction Time test, Using ANOVA the mean difference for underweight category is 201.2±13.6 ms , normal category 162.6 ±67.89 ms and overweight category 202.8± 9.9ms (P > 0.05).
For Slowest Auditory Reaction Time test, Using ANOVA the mean difference for underweight category is 425.8±84.9 ms , normal category 420.2 ± 221.0 ms and overweight category 912.2 ± 1139.2ms (P > 0.05).
For Mean Auditory Reaction Time test with helmet, Using ANOVA the mean difference for underweight category is 265.4±36.6ms, normal category 265.4 ± 42.95 ms and overweight category 259.9 ± 49.9ms (P > 0.05).
For Fastest Auditory Reaction Time test with helmet, Using ANOVA the mean difference for underweight category is 205.8±20.1 ms , normal category 184.2 ±39.77 ms and overweight category 194.6± 19.7ms (P > 0.05).
For Slowest Auditory Reaction Time test with helmet, Using ANOVA the mean difference for underweight category is 488±289.2 ms, normal category 418.6 ±143.45ms and overweight category 462.2± 289.6ms (P > 0.05).
Using ANOVA test, as P value is greater than 0.05 for all the above data so it is statistically not significant.

## DISCUSSION

Reaction time is the interval between onset of stimulus and response of that stimulus. In field of motorsports a quick reaction time plays a crucial role for overall performance [10]. Body Mass Index is accepted as a marker of adiposity in population based studies [10] . Studies previously conducted show the Body Mass index has effect on auditory and visual reaction time. Overweight & obesity are indicated by body mass index. Both are found to be associated with a host of medical conditions. Neurophysiological studies taken place previously showed the brain regions involved in cognition, memory, vocabulary, speed processing and reasoning are influenced by BMI [13].
This study was carried out to find if there is any influence of body mass index on formula car racers. For our study the BMI categories we found consisted only of the underweight, normal and overweight category. No one from obese category was there, this can be because the population was of national level formula car racers. 15 formula car racers 5 from each category were chosen for the study.
The normal category of BMI had quicker response than the underweight and overweight category for visual reaction time and auditory reaction time. In our study it was found out that Body mass index is been affected by Auditory and Visual Reaction Time. Also there was no significant difference found between auditory reaction time with and without helmet.
In underweights the reaction Time was increased than ones in normal category. Being an underweight can be result of poor fitness and poor health which may cause Nutrional deficiency, which can alter normal physiological properties of the muscle, this may lead to slower the motor response which might result in prolonged reaction time. Previously conducted studies have shown that there is poor cognition in underweight people, and it has been attributed majorly to preclinical dementia [14]. Study by Sabia et al suggests that both long-term obesity and long-term underweight are associated with lower cognitive performance, underweight category was associated with lower MMSE scores and executive function[16].
In overweight's, as well the reaction time was prolonged than the normal category Being overweight is associated with increased adiposity and decreased physical functioning which affects general health and can be a factor to prolonged reaction time. More the better physical fitness more better is muscle response and coordination[14]
Previous studies have also shown how elevated BMI affects cognitive and memory functions, A cross section study conducted by Cournot et al used word-list learning and Digit-Symbol Substitution Test resulted in lower cognition with elevated BMI [17]. Another study conducted by Michaud et al in their study used Mini-Mental State Exam for cognitive function, functional abilities assessed using Functional Activities Questionnaire, and behavioral symptoms by Neuropsychiatric Inventory Questionnaire ,high index BMI were both associated with slower progression of functional or cognitive declines results indicated that high BMI was significantly associated with slower progression rates .The exact reason for which dementia patients with high BMI have a slower rate of cognitive and functional declines is not known[18].
Various other factors are suggested such as obesity induced vascular disease secretions of adipose tissue like hormones, cytokines, growth factors affecting brain health. [14]
The vascular disease is likely to underlie the association between obesity and cognition, as elevated BMI is a risk factor for the vascular disease, which, is related to a higher risk of the cognitive impairment[3]. Increase in BMI can potentially lead to pathophysiologic changes like vascular changes, impaired insulin regulation, and reduced cardiovascular fitness which can impact cognitive functioning, thereby slowing the processing capability and leading to a longer reaction time[15] .Increase in BMI is result of increased weight which can be also due to water retention . The retention of salt and water could modify the process of axonal conduction time and alter the availability of neurotransmitter at the synaptic level; changes in either of these two processes might affect the sensorimotor coordination and the processing speed of the central nervous system [19].
Reaction time has been considered advantageous in many endurance-based motorsports, which includes karting, touring car racing and sports car racing yet very few racers focused on training for reaction time, which should be included as well. Also, most racers focused upon strength training, endurance training or any one component. As

motorsports needs a good amount of physical health it is important to focus on other aspects as well such as balance, agility, coordination. Circuit training and Plyometric training can also be included to enhance overall fitness. Individuals who exercise from moderate to intense have an increased rate of cerebral blood flow and it can improve cognitive functioning as there is also increase of necessary nutrients such as oxygen and glucose [(2)].

Also, we found out that difference among reaction time was not significant even though normal category had quicker reaction time, this can be due to the fact that reaction time is not solely affected by body mass index but there are also other factors affecting along with it such as gender, left or right hand, central versus peripheral vision, practice, fatigue, fasting, breathing cycle, personality types, exercise, and intelligence of the subject. [(1)]

## CONCLUSION

Body Mass Index (BMI) is not having effect on auditory and visual reaction time in formula car racers.

Normal category has quicker reaction time response than underweight and overweight category.

## LIMITATION OF STUDY

Small sample size

The study was conducted during the finale of race weekend due to which everyone had pressure to complete championship with good points as next year's sponsorship.

For this study only a simple reaction time test was done. Choice and recognition reaction time was not done.

Cognitive function is also one of the factors affecting reaction time and it was not assessed for reaction time.

## FUTURE SCOPE OF STUDY

To check the effect of exercise regimen on reaction time in formula car racers.

A comparative study on reaction time between formula car racers and salon car racers.

A study can be conducted to check choice and recognition reaction time in formula car racers.

A comparative study between male and female racers.

A comparative study between young and old car racers.

Study on effect of cognition on Reaction Time in formula car racers.

## CLINICAL IMPLICATION OF STUDY

This study shows us that Body Mass Index is not the only factor affecting Reaction time. An overall enhancement of training program is required including strength, endurance, balance, coordination, agility and vigorous training programs along with reaction time exercises for training auditory and visual reaction time.

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