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INFLUENCE OF BODY MASS INDEX AND WAIST – HIP RATIO ON VISUAL REACTION TIME IN PHYSIOTHERAPY STUDENTS: AN OBSERVATIONAL STUDY

Physiotherapy

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ABSTRACT

Background: Obesity being the leading cause of worldwide morbidity has adverse effects on the cognitive functions of an individual affecting the nervous system and thus visual reaction time. Reaction time represents the time taken by an individual to react to an external stimulus, thus measuring the information processing abilities in humans representing the concentration & coordination abilities of the person.

Methodology: 51 subjects were categorized into three groups based on Body Mass Index and 50 subjects into two groups based on Waist-Hip Ratio. Four different reaction times were assessed using the Deary Liewald Simple and Choice Reaction Time Test and Simon Task Test for Congruent and Incongruent Reaction Time.

Conclusion: The results revealed no significant influence of Body Mass Index and Waist-Hip Ratio on the Visual Reaction Time. However, a significant influence of high Waist-Hip Ratio was found on Congruent Reaction Time in Physiotherapy students (p-value = 0.0256).

KEYWORDS

obesity, visual reaction time, body mass index, waist-hip ratio, simple reaction time, physiotherapy students.

INTRODUCTION:

Reaction time (RT) is defined as an interval of time between the application of a stimulus and the initiation of appropriate voluntary response under the condition that the subject has been instructed to respond as rapidly as possible [1]. The RT involves the following 3 stages: a) Processing of the external stimulus b) Its decision making c) Formulating a response. Information processing in humans can be measured with the help of RT which represents the concentration & coordination abilities of the person [1][2].

As per WHO, "Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health." Across the globe, there is an increasing prevalence of overweight/obesity among the developing as well as the developed countries.

Quick RT is required in daily activities such as driving and while engaging in sports activities. Similarly in the field of Physiotherapy, RT is required while treating patients under intensive monitoring where the therapist is expected to critically analyze the situation and take swift actions. Customized patient care also needs prompt rehabilitation measures formulated on evidence-based practice. Due to the paucity of literature, the authors aimed to study the association between Body Mass Index (BMI) /Waist-Hip Ratio (WHR) and Visual Reaction Time (VRT) in Physiotherapy students using VRT tests.

2. MATERIALS AND METHODOLOGY:

Approval of the study was taken from the institutional ethics committee and all the subjects were provided with the consent form. 51 students were categorized into three groups based on BMI (underweight, normal, and overweight) and another 50 students were categorized into two groups based on WHR (normal and high). The study was an observational study design conducted in the research lab of K. J. Somaiya College of Physiotherapy. Four different computer-based VRTs were assessed for the subjects: Simple Reaction Time (SRT), Choice Reaction Time (CRT), Congruent Reaction Time (CongRT), Incongruent Reaction Time (IncongRT) using the a) Deary Liewald Simple and Choice Reaction Time Test b) Simon Task Test for Congruent Incongruent Reaction Time. Participants with a history of any chronic illnesses like diabetes mellitus, hypertension, neuromuscular disorders, psychiatric disorders, and addictions to alcohol, smoking, or tobacco were excluded from the research.

2.1 Description of Obesity Indices Assessment:

a) Body Mass Index (BMI):

$$\text{Body Mass Index } (kg/m^2) = \frac{\text{Weight (kgs)}}{\text{Height}^2 \text{ (m)}}$$

Underweight (BMI < 18.5 kg/m^2)
Normal (BMI =18.5 – 22.9 kg/m^2)
Overweight (BMI ≥ 23 kg/m^2)

b) Waist-Hip Ratio (WHR):

$$\text{Waist-Hip Ratio} = \frac{\text{Waist Circumference (cms)}}{\text{Hip Circumference (cms)}}$$

Normal WHR (< 0.90 for males, < 0.85 for females)
High WHR (≥ 0.90 for males, ≥ 0.85 for females)

2.2 Description of Visual Reaction Time Tests:

a) Deary Liewald Simple and Choice Reaction Time Test

Simple Reaction Time Test:

The subject was supposed to respond to the appearance of a cross in a white square on a computer screen placed in the center of the screen as quickly as possible. The cross remained on the screen until the space bar key was pressed, after which it disappeared and another cross appeared shortly after.

Choice Reaction Time Test:

Four white squares were positioned in a horizontal line across the middle of the computer screen. Four keys on a computer keyboard corresponded to the four different squares. The 'z' key corresponding to the square on the far left, the 'x' key to the second square from the left, the 'comma' key to the second square from the right, and the 'full-stop' key to the square on the far right. A cross appeared randomly in one of the squares and participants had to respond as quickly as possible by pressing the corresponding key on the keyboard. Each cross remained on the screen until one of the four keys was pressed, after which it disappeared and another cross appeared after a brief interval.

b) Simon Task Test:

A small '+' sign appeared as the gaze fixation point on the center of the screen throughout the trials.

Congruent trials in which the word 'Left' appeared in the rectangular box appearing on the left side of the gaze fixation point.

Incongruent trials in which the word 'Right' appeared in the rectangular box appearing on the left side of the gaze fixation point.

The participant was instructed to press the 'a' key corresponding to the word 'Left' and 'l' key corresponding to the word 'Right' on the keyboard when it appeared on the screen.

Table 1: Summary of Statistical Analysis

SR NO.	COMPARISON	MEAN	STANDARD DEVIATION	TEST	P - VALUE	SIGNIFICANCE
1.	Comparison between SRT of Underweight, Normal, Overweight BMI groups	Underweight: 287.76 Normal: 286.82 Overweight: 299.41	Underweight: 18.012 Normal: 19.686 Overweight: 24.498	One way ANOVA	0.1590	Not Significant
2.	Comparison between CRT of Underweight, Normal, Overweight BMI groups	Underweight: 461.47 Normal: 461.47 Overweight: 502.11	Underweight: 71.169 Normal: 54.045 Overweight: 62.700	One way ANOVA	0.1797	Not Significant
3.	Comparison between CongRT of Underweight, Normal, Overweight BMI groups	Underweight: 564.11 Normal: 568.411 Overweight: 589.29	Underweight: 87.265 Normal: 60.240 Overweight: 90.778	One way ANOVA	0.6249	Not Significant
4.	Comparison between IncongRT of Underweight, Normal, Overweight BMI groups	Underweight: 556.82 Normal: 552.82 Overweight: 582.52	Underweight: 83.741 Normal: 52.863 Overweight: 71.028	Friedman	0.4655	Not Significant
5.	Comparison between SRT of Normal, High WHR groups	Normal: 290.16 High: 295.4	Normal: 22.175 High: 27.816	Unpaired t	0.4650	Not Significant
6.	Comparison between CRT of Normal, High WHR groups	Normal: 477.28 High: 505.6	Normal: 64.785 High: 80.473	Mann Whitney	0.2216	Not Significant
7.	Comparison between CongRT of Normal, High WHR groups	Normal: 550.16 High: 602.72	Normal: 60.514 High: 96.670	Unpaired t	0.0256	Significant
8.	Comparison between IncongRT of Normal, High WHR groups	Normal: 549.76 High: 576.24	Normal: 55.987 High: 76.040	Unpaired t	0.1673	Not Significant

* SRT = Simple Reaction Time, CRT = Choice Reaction Time, CongRT = Congruent Reaction Time, IncongRT = Incongruent Reaction Time, BMI = Body Mass Index, WHR = Waist Hip Ratio.

3. RESULTS:

The data collected was analyzed using Graph Pad Instat software version 3.10. One-way Analysis of Variance test was used for the comparison of data between the three groups of BMI for the data which passed the normality tests and Friedman test was used for the data that did not pass the normality tests. Similarly, Unpaired t-test was used for the comparison of data between the two groups of WHR for the data which passed the normality tests, and Mann Whitney test was used for the data that did not pass the normality tests. The tests were performed at a 5% significance level. The results are summarized in Table 1. The analysis suggests that there is no significant difference between the VRTs of normal, underweight and overweight individuals for SRT (p-value = 0.1590) or CRT (p-value = 0.1797) or CongRT (p-value = 0.6249) or IncongRT (p-value = 0.4655) . Also, there is no significant difference between the VRTs of individuals with high and normal WHR for SRT (p-value = 0.4650) or CRT (p-value = 0.2216) or IncongRT (p-value = 0.1673). However, a significant difference was found between the visual reaction times of individuals with high and normal WHR for CongRT (p-value = 0.0256).

4. DISCUSSION:

The present study was aimed to explore the relationship between visual reaction time and obesity among young physiotherapy students. The CongRT and IncongRT measure selective attention, cognitive flexibility, and processing speed in humans. The cognitive flexibility involves the following 3 components: a) inhibition of irrelevant information, b) flexible switching from one task to another, and c) manipulation of working memory contents.

The probable hypothesis for a significant influence of high WHR on CongRT in Physiotherapy students are:

i. It has been proven that obesity increases the risk of Alzheimer's disease and dementia in later life as compared to individuals with normal weight [3].

O'Brien et al in their cross-sectional analysis demonstrated that women with higher BMI showed atrophy of the temporal lobes, frontal lobes, anterior cingulate gyrus, hippocampus, and thalamus based on computed tomography results in the central nervous system (CNS)[4].

The hippocampus and prefrontal cortex, which are particularly susceptible to obesity-related changes, are essential for learning and memory. These atrophic changes in the hippocampus volume have been consistent with a decline in memory performance [5]. Similar to the CNS, there is evidence that obesity- mediated increases in free fatty acids (FFA) and long-chain fatty acids (LCFA) alter normal lipid metabolism in the peripheral nervous system (PNS). Raised LCFA levels lead to increased Schwann cell mitochondrial β-oxidation that is accompanied by polyneuropathy [6]. Studies conducted on mice have demonstrated that the metabolic products of LCFA and LC-acylcarnitines, accumulate in peripheral nerves of mice and these bioactive lipids are associated with Schwann cell dysfunction, axonal degeneration, and polyneuropathy. Though the definite mechanisms of obesity-induced nerve and cognitive dysfunction need to be fully interpreted, it is clear that obesity and dyslipidemia converge at the CNS and PNS as FFA-induced lipotoxicity, resulting in inflammation, neurological dysfunction, and neurological degeneration. However, the exact time duration for the above changes to occur after the commencement of obesity and dyslipidemia are still not known and requires further elaborative research through cross-sectional studies over larger populations.

ii. Another hypothesis for the influence of WHR on CongRT may be related to the effects of sleep apnea. There is an abundance of literature highlighting the fact that increased BMI is related to an increased risk of obstructive sleep apnea in adults [7]. In adults, with obstructive sleep apnea have detectable cognitive deficits presumably due to hypoxemia in addition to the general effects of sleep disruption ultimately leading to attention deficits and poor memory performance [8].

iii. Like obesity, the increased reaction time in underweights could be due to the dysregulation in hormone secretion corresponding to that in anorexia, resulting in cognitive disorders [9]. Concentration in underweights may also be affected due to persistent thoughts about food and eating interfering with the ability to focus on other things [10]. However, comprehensive research on the mechanisms and changes in the CNS and PNS of the underweight individuals can throw better light on the above hypothesis.

Although it has been published in various articles that obesity affects the cognitive function [11], this relationship may not be significant for all tasks and obesity indices [12]. Akbar Moradi and Samad Esmaeilzadeh, in their research in 2017 found a significant relationship between VRT and Body Fat %. At the same time, no significant relationship was observed between VRT, BMI, and central obesity indices [13].

In 2014, Henneberg et all reported that body adiposity does not necessarily serve as a hindrance to neuromuscular reaction time performance [14]. On the contrary, cholesterol synthesis is crucial for correct myelination and development for the nervous system [15]. The results discussed above may be limited to young adults and the consequences of BMI / WHR on VRT in the older group may require long term follow up.

5. CONCLUSION:

There is no significant association between BMI and VRT. There is no significant association between WHR and VRT, except CongRT. There is a significant influence of WHR on CongRT.

Thus this study has been aimed to create awareness among physiotherapists, that the obesity indices may have an impact on their concentration and selective attention abilities in the later years of life. The students can be encouraged for weight loss programs and reaction time can be improved by practice [16].

5. SUGGESTIONS:

i. Such studies need to be conducted over multiple centers and expanded geographical areas.
ii. Longitudinal prospective study to identify changes in the relation between BMI and WHR with Visual Reaction Time with advancing age in the same subjects.
iii. Other obesity indices with higher and detailed evaluation like body fat analysis may be used.

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