International Journal of Research in Medical Sciences
Thankachan T et al. Int J Res Med Sci. 2025 Jun;13(6):2479-2482
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20251638

Original Research Article

The body mass index and reflex reaction connection: insights into upper limb reflexes in young adults

Tinu Thankachan[1], Riyas Basheer K. B.[1]*, Subhashchandra Rai[1], Reshma Kolar[2]

[1]Department of Physiotherapy, Tejasvini Physiotherapy College, Mangalore, Karnataka, India
[2]Department of Community Medicine, AJ Institute of Medical Sciences, Mangalore, Karnataka, India

Received: 03 April 2025
Revised: 07 May 2025
Accepted: 10 May 2025

***Correspondence:**
Dr. Riyas Basheer K. B.,
E-mail: riyas2423@gmail.com

ABSTRACT

Background: Reflexes are automatic responses to stimuli, enabling quick reactions through reflex arcs. Body Mass Index (BMI) influences various physical and cognitive functions, and deviations from optimal BMI may impact reflex reactions. This study aimed to investigate the correlation between BMI and upper limb reflex reaction in young adults aged 18-25 years, emphasizing the importance of maintaining a healthy BMI.
Methods: This observational, cross-sectional study involved 51 participants (14 females, 37 males) from an institution in Mangalore. Data such as height, weight, and reflex reaction time were collected. BMI was calculated using the WHO classification (2004), and upper limb reflex time was assessed using the Ruler Drop Test. Each participant underwent three trials, and the average distance was analyzed. Statistical analysis was performed using SPSS 21.0, applying Pearson correlation to evaluate relationships between BMI and reflex reaction ($p<0.05$).
Results: The study revealed a moderate negative correlation between BMI and upper limb reflex reaction time ($r = -0.437$). Participants with higher or lower BMI beyond the optimal range showed slower reflex responses. Males exhibited slightly quicker reflexes (28.25±6.18 cm) compared to females (30.25±7.20 cm).
Conclusions: Deviations in BMI negatively impact upper limb reflex response in young adults, highlighting the need for maintaining an optimal BMI for efficient neuromuscular functioning.

Keywords: Body mass index, Neuromuscular coordination, Reaction time, Reflexes, Ruler drop test

INTRODUCTION

Reflexes are vital, automatic responses to external stimuli that ensure survival and swift adaptation to environmental changes. Functioning through neural circuits called reflex arcs, these responses bypass conscious intervention, enabling instantaneous actions even before impulses reach the brain. Reflex arcs consist of highly attuned detectors, flexible synapses, and command neurons, forming the foundation of these rapid reactions. With age, reflex initiation undergoes changes, yet younger individuals typically display quicker and more pronounced reflex responses, highlighting their adaptability.[1]

Alongside reflexes, the rising global prevalence of obesity poses significant challenges to physical and cognitive health. Driven by rapid socioeconomic growth and sedentary lifestyles, obesity is classified using Body Mass Index (BMI), a widely accepted marker of adiposity. However, BMI, while practical for categorizing weight status based on height and weight, has notable limitations in assessing body composition.[2,3] For instance, individuals with high muscle mass or low muscle mass may receive misleading BMI classifications that do not accurately reflect their health risks. Obesity is not merely an issue of weight but is closely linked to chronic conditions such as cardiovascular diseases, type 2 diabetes, cancer, and

musculoskeletal disorders, often associated with intra-abdominal fat accumulation.[4,5]

Emerging research highlights the impact of obesity on cognitive and neural functioning. Psychomotor tests like reaction time assessments provide insights into cognitive processes, revealing correlations between obesity and impairments in attention, executive function, and memory.[6,7] The intricate relationship between BMI and reflex reaction time warrants investigation, as understanding these dynamics is crucial for developing targeted interventions to address obesity-related health challenges.

This study focuses on exploring the correlation between BMI and upper limb reflexes in young adults aged 18-25 years, a demographic poised at the intersection of peak reflex responsiveness and emerging health concerns. By examining reflex reaction time in relation to BMI, this research aims to bridge gaps in understanding and contribute to holistic approaches in health evaluation and intervention strategies.

METHODS

The study employed an observational, cross-sectional design to examine the relationship between body mass index (BMI) and upper limb reflex reactions among young adults. It was conducted at an Tejasvini Hospital Group of Institutions, Mangalore, over a duration of 7-8 months (January 2023-September 2023). A total of 51 participants, comprising 14 females and 37 males aged between 18 and 25 years, were selected using stratified random sampling to ensure a balanced gender representation. The inclusion criteria included young adults within the specified age range who were free from any injuries that could affect reflex performance. Participants with a history of surgeries involving the spine or upper extremities, musculoskeletal conditions causing pain or restricted mobility, medical conditions, or involvement in bodybuilding activities were excluded from the study. Ethical approval was obtained from the Institutional Review Board.

To assess BMI, participants' height and weight were measured using a stature meter and a Krups® weighing scale, respectively, and their BMI was calculated using the formula weight (kg)/height (m^2). BMI categories were determined according to the 2004 WHO classification, which includes underweight (≤18.5 kg/m^2), normal range (18–24.9 kg/m^2), pre-obese (25–29.9 kg/m^2), and obese (≥30 kg/m^2).[8]

Reflex reaction time was evaluated using the Ruler Drop Test. In this test, a wooden ruler (90 cm) was held vertically at one end by an instructor, and the participant attempted to catch the ruler when it was released unexpectedly. The distance in centimeters at which the ruler was caught was recorded as the reflex response.[9] Each participant performed three trials with a one-minute rest interval, and the average of the three measurements was used for analysis. Activities were conducted between 9:00 AM and 4:30 PM to control for potential performance variations caused by fatigue or time of day.

Data analysis was performed using SPSS 21.0 software. The Kolmogorov–Smirnov test was used to confirm the normality of the data distribution. Descriptive statistics, including mean, standard deviation, and percentage, were used to summarize the data. The Pearson correlation coefficient was employed to evaluate the relationship between BMI and upper limb reflex reactions, with a significance level of 95% confidence ($p<0.05$). By employing rigorous statistical methods, the study aimed to ensure the reliability and validity of its findings. This methodology facilitated an in-depth exploration of the link between BMI and reflex response time in young adults, offering valuable insights into the interplay between physical attributes and reflex functions.

RESULTS

The results indicate that the total sample of 51 participants (36 males and 15 females) had an average age of 21.17 years, with females being slightly older compared to males. The mean BMI for the total group was 22.09±3.90 kg/m^2, with males slightly higher than females. For hand reflex reaction time, the overall average was 28.84±6.49 cm, with males exhibiting slightly quicker reflexes compared to females (Table 1).

Table 1: Demographic data of the subjects.

Variables	Total (n=51)	Males (n=36)	Females (n=15)
	Mean±SD		
Age (years)	21.17±1.27	20.86±1.33	21.93±0.70
Height (cm)	166.61±8.09	170.31±4.92	157.73±7.30
Weight (Kg)	61.61±12.31	64.70±11.36	54.20±11.64
BMI (Kg/M^2)	22.09±3.90	22.26±3.86	21.68±4.10
Hand reflex reaction (cm)	28.84±6.49	28.25±6.18	30.25±7.20

The categorization of the total 51 sample's BMI shows 66.70% were normal 15.70% were underweight, 11.80% were overweight and 5.90% were obese (Figure 1). The correlation between BMI and hand reflex reaction of young individuals was performed by Pearson Correlation and it is statistically significant. From the table it can be assessed that there is a moderate negative significant

correlation between BMI and reflex reaction in both males and females (Table 2).

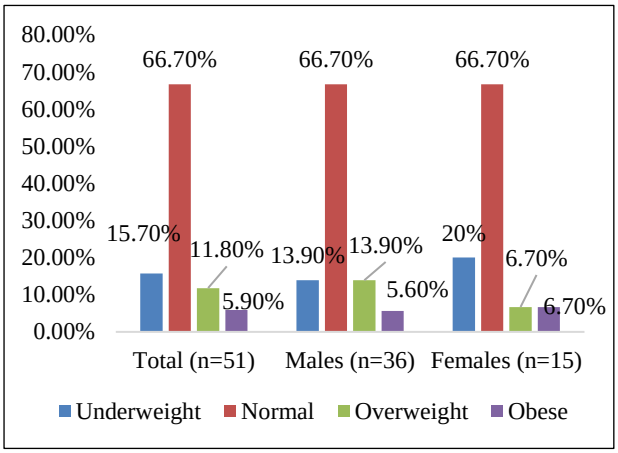

Figure 1: BMI Categorization of the sample.

Table 2: Relationship between BMI and reflex reaction.

Variables		Hand reflex reaction		
		Total sample	Male	Female
BMI	r value	-0.437	-0.462	-0.442
	Sig.	0.003*	0.003*	0.003*

*Test performed were Pearson Correlation and statistically significant (P<0.05)

DISCUSSION

The primary purpose of the current study was to evaluate the correlation between Body Mass Index (BMI) and upper limb reflex reaction in young individuals aged 18-25 years. Reflex reaction time was measured using the Ruler Drop Test, with each participant undergoing three trials to ensure reliability. The average of the three measurements was calculated for analysis.

The findings of this study reveal a statistically significant moderate negative correlation between BMI and hand reflex reaction time (Pearson correlation coefficient, r = -0.437, p<0.05). This indicates that as BMI increases or decreases beyond the optimal range, reflex reaction time is negatively impacted. Specifically, participants with higher or lower BMI values exhibited slower reflexes compared to those within the normal BMI range. The interpretation of the Ruler Drop Test results classified reflex responses as excellent (<7.5 cm), above average (7.5-15.9 cm), average (15.9-20.4 cm), below average (20.4-28 cm), and poor (>28 cm). Observations from this study suggest that maintaining an optimal BMI is essential for efficient reflex reactions.

Previous studies have explored similar relationships between BMI and cognitive functions, including reaction time. For instance, Narimani et al (2019) investigated the effects of adiposity on response time (RT) in young adult men, observing no significant correlation between BMI and reaction time. However, they noted that central adiposity could alter cognitive functioning pathways.[10] Conversely, the findings of Jyothi et al (2016) demonstrated a negative correlation between BMI and reaction time, particularly among runners, reinforcing the notion that higher BMI may impair reflex efficiency.[11]

Further evidence is provided by Skurvydas et al (2008), who examined reaction time in young men categorized into anthropometric groups based on their BMI. Participants with higher BMI values exhibited noticeably slower responses during joystick-controlled reaction-time trials.[12] This aligns with findings from Nagorao Deore et al (2012), who explored the connection between BMI and audio-visual reflex reaction time, reporting that increased BMI negatively affected sensory-motor coordination.[13]

The physiological basis for this correlation lies in the impact of adiposity on neural pathways responsible for reflex reactions.[14,15] Excess adiposity increases BMI, which may alter the conduction velocity of neural impulses, leading to delayed reflex responses.[15,16] Studies have also highlighted the influence of adiposity on central and peripheral nervous system functioning, suggesting that excessive body fat could interfere with optimal neuromuscular coordination.[17,18]

The current study contributes to this growing body of evidence by demonstrating that both males and females exhibit a moderate negative correlation between BMI and hand reflex reaction. This supports the notion that deviations from the normal BMI range whether due to underweight or overweight status impair reflex responsiveness.[19] Reflex reactions, which are primarily driven by automatic neural circuits, require optimal physiological conditions to function efficiently. As BMI deviates, neural pathways and muscular coordination may be compromised, resulting in declined reflex reaction performance.[20]

These findings have important implications for promoting healthier lifestyles among young adults. Maintaining an optimal BMI not only benefits physical health but also ensures efficient sensory-motor responses crucial for daily activities and athletic performance. Educational and healthcare institutions should prioritize interventions aimed at balancing body weight through regular physical activity and dietary modifications.

The study's limitations should be noted, including the relatively small sample size and the exclusive use of the Ruler Drop Test for reflex evaluation. Future research should explore larger, more diverse populations and incorporate advanced methods for assessing reflex reactions and neural conduction. Nonetheless, this study provides valuable insights into the correlation between BMI and reflex responsiveness, underscoring the importance of maintaining a balanced BMI for optimal cognitive and physical health.

CONCLUSION

The present observational study emphasizes that deviations in Body Mass Index (BMI) beyond the optimal range whether an increase or decrease negatively affect the reflex reactions of the upper limb. These findings highlight the importance of maintaining an ideal BMI to ensure optimal reflex performance, which is crucial for effective hand-eye coordination and daily activities. Maintaining a balanced BMI not only supports neuromuscular efficiency but also enhances overall physical functionality, reinforcing the value of a healthy and well-regulated lifestyle.

ACKNOWLEDGEMENTS

Authors would like to thank all the participants from the institutions for their unwavering support and active involvement throughout the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee (TPC/PT/2019B/21/2023)

REFERENCES

1. Sokolov EN, Nezlina NI. The conditioned reflex: Detectors and command neurons. Neuroscience and Behavioral Physiology. 2008;38:1-14.
2. Dhungana HN, Singh S, Tripathi P, Prakash J, Waseem SM, Tiwari N, et al. Visual reaction time and its relationship with sex, age & BMI in Northern Indian Children's. Res Revi: J Med Sci Technol. 2014;3(2):1-6.
3. Franklin DW, Franklin S, Wolpert DM. Fractionation of the visuomotor feedback response to directions of movement and perturbation. J Neurophysiol. 2014; 112(9):2218-33.
4. Esmaeilzadeh S, Farzizadeh R, Kalantari HA, Mahmoudi A, Dziembowska I, Kostencka A, et al. Is obesity associated with impaired reaction time in youth. Eat Weight Dis. 2020; 25(2):415-425.
5. Camponogara I, Volcic R. Grasping adjustments to haptic, visual, and visuo-haptic object perturbations are contingent on the sensory modality. J Neurophysiol. 2019;122(6):2614-20.
6. Nikam LH, Gadkari JV. Effect of age, gender and body mass index on visual and auditory reaction times in Indian population. Indian J Physiol Pharmacol. 2012;56(1):94-9.
7. Moradi A, Esmaeilzadeh S. Simple reaction time and obesity in children: whether there is a relationship. Environ Health Prev Med. 2017;22(1):1-6.
8. Garbeloto F, Correa U, Drews R, Tani G, Bastos F H. Effects of maintaining different body positions on attentional allocation of obese and non-obese women. Kinesiol. 2019; 51(2):271-5.
9. Nene AS, Pazare PA, Sharma KD. A study of relation between body mass index and simple reaction time in healthy young females. Ind J Physiol Pharmacol. 2011;55(3):288-91.
10. Narimani M, Esmaeilzadeh S, Azevedo LB, Moradi A, Heidari B, Kashfi Moghadam M. Association Between Weight Status and Executive Function in Young Adults. Medicina (Kaunas). 2019;55(7):363.
11. Jyothi S, Vernekar SS, Manishankar S, Jayalakshmi L, Vinothkumar S, Rashmi R. Correlation of audio-visual reaction time with body mass index & skin fold thickness between runners and healthy controls. Indian J Physiol Pharmacol. 2016;60(3):239-46.
12. Skurvydas A, Gutnik B, Zuoza AK, Nash D, Zuoziene IJ, Mickeviciene D. Relationship between simple reaction time and body mass index. Homo. 2008;60(1):77-85.
13. Deore DN, Surwase SP, Masroor S, Khan ST, Kathore V. A cross sectional study on the relationship between the Body Mass Index (BMI) and the Audiovisual Reaction Time (ART). J Clin Diagn Res. 2012; 6(9):1466-8.
14. Theofilou G, Ladakis I, Mavroidi C, Kilintzis V, Mirachtsis T, Chouvarda I, et al. The effects of a visual stimuli training program on reaction time, cognitive function, and fitness in young soccer players. Sensors. 2022;22(17):6680.
15. Ratcliff R, Thapar A, McKoon G. The effects of aging on reaction time in a signal detection task. Psychology Aging. 2001;16(2):323-41.
16. Munawar A, Aleem A. A comparative study of audio and visual reaction time in obese and non-obese subjects. Asian J Med Sci. 2021;12(4):43-7.
17. Mignardot JB, Olivier I, Promayon E, Nougier V. Obesity impact on the attentional cost for controlling posture. PLoS ONE. 2010;5(12):14387.
18. Carroll TJ, McNamee D, Ingram JN, Wolpert DM. Rapid visuomotor responses reflect value-based decisions. J Neurosci. 2019;39(20):3906-20.
19. Nikam LH, Gadkari JV. Effect of age, gender and body mass index on visual and auditory reaction times in Indian population. Indian J Physiol Pharmacol. 2012;56(1):94-9.
20. Kogan AB, Kuraev GA, Rovda LN, Sorokoletova LG. Participation of neurons from symmetrical parts of the sensomotor cortex in conditioned reflex activity. Zhurnal Vysshei Nervnoi Deiatelnosti Imeni I P Pavlova. 1978;28(3):566-72.

Cite this article as: Thankachan T, Basheer RKB, Rai S, Kolar R. The body mass index and reflex reaction connection: insights into upper limb reflexes in young adults. Int J Res Med Sci 2025;13:2479-82.