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Correlation Between Body Mass Index and Visual Reaction Time Among Obese and Non-Obese Young Adults Attending a Tertiary Care Academic Hospital: A Cross-sectional Study

Ishwarya Muralidharan Valyathodi[1], Sudha Durairaj[1], Devaki Perumal Rajaram[1], Parijatham Sadasivam[1], Bindu Krishnan[1]

1 Department of Physiology, Sree Balaji Medical College & Hospital, Chennai, Tamilnadu, India

Correspondence to: Dr. Ishwarya Muralidharan Valyathodi
Postgraduate, Department of Physiology, Sree Balaji Medical College & Hospital, No. 7, CLC Works Road, Chrompet, Chennai - 600044, Tamil Nadu, India.
TEL.: +91 99625 79212; E-MAIL: ishwaryamuralidharan25@gmail.com

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Abstract

BACKGROUND: Reaction time is an important indicator of psychomotor performance and central nervous system efficiency. Obesity has been associated with various metabolic and cardiovascular complications; however, its relationship with basic psychomotor functions such as visual reaction time remains inadequately explored, particularly among young adults.
AIM: To evaluate the correlation between body mass index (BMI) and visual reaction time (VRT) in young adults.
MATERIALS AND METHODS: This prospective cross-sectional analytical study was conducted among 385 apparently healthy adults aged 18-35 years. Body mass index was calculated using standard anthropometric measurements, and participants were categorised into BMI groups based on WHO criteria. Visual reaction time was assessed using an audio-visual reaction time apparatus. Normality was assessed using the Shapiro–Wilk test, and Spearman's rank correlation was used for statistical analysis.
RESULTS: A statistically significant positive correlation between BMI and visual reaction time was observed among obese participants ($\rho = 0.314$, $p < 0.001$). Obese individuals exhibited a median visual reaction time of 268 ms compared to 232 ms in normal-weight participants – a 36 ms (15.5%) prolongation.
CONCLUSION: Higher BMI was associated with prolonged visual reaction time among obese young adults, suggesting early changes in psychomotor performance related to obesity. Visual reaction time may serve as a simple, non-invasive tool to detect subtle neurofunctional changes associated with increased adiposity.

ORIGINAL ARTICLE

INTRODUCTION

Reaction time is a widely used measure of psychomotor performance, defined as the interval between the presentation of a stimulus and the appearance of an appropriate voluntary response. In the present study, visual reaction time ranged from 134 to 505 milliseconds among young adults aged 18-35 years, reflecting the efficiency of central information-processing speed and visual-motor coordination (Jain *et al.* 2015; Hülsdünker & Mierau, 2021). Measures of visual-motor reaction time have been applied in contexts such as driving performance and neurocognitive assessment, emphasising their practical relevance in activities requiring rapid visual-motor coordination (Penna *et al.* 2024).

The increasing prevalence of overweight and obesity has become a major public health concern worldwide, including in India. Recent nationwide data indicate that obesity prevalence in India reaches 40.3%, with southern regions reporting rates as high as 46.5%, and urban populations disproportionately affected. Consistent with these elevated regional rates, obesity constituted the largest BMI category in the present study, representing 43.6% (n = 168) of young adults aged 18-35 years attending a tertiary care hospital in Chennai (Venkatrao *et al.* 2020).

While the metabolic and cardiovascular consequences of elevated body mass index (BMI) are well documented, its potential impact on neurocognitive and psychomotor functions has received comparatively less attention (Rukadikar *et al.* 2023). Recent comparative studies have confirmed prolonged visual and auditory reaction times among obese adults, with obesity independently predicting delayed psychomotor responses even after controlling for potential confounders (Yılmaz *et al.* 2025). Obesity has been associated with chronic low-grade inflammation, altered neurotransmitter activity, impaired cerebral blood flow, and insulin resistance, all of which may influence information processing speed and motor response (Schmitt *et al.* 2023; Buie *et al.* 2019).

Evidence examining the relationship between body mass index and cognitive function remains variable, and the association between BMI and visual reaction time has not been extensively explored, particularly in young adult populations. Moreover, studies from Indian settings evaluating this relationship across different BMI categories are limited. In this context, the present study was undertaken to evaluate the correlation between body mass index and visual reaction time in young adults, and to determine whether this association varies across BMI groups. Among young adults aged 22–35 years, higher BMI has been shown to negatively predict general cognitive ability ($\beta = -0.15$, $p < 0.001$), with effects mediated through poor sleep quality and increased impulsivity (Lv *et al.* 2025). A recent systematic review and meta-analysis of 83,251 participants confirmed that obesity, as measured by waist-to-hip ratio, is associated with a 31% increased risk of cognitive impairment (OR 1.31, 95% CI 1.12–1.53, moderate certainty), reinforcing the link between adiposity and neurocognitive decline (Phirom *et al.* 2025).

METHODOLOGY

Study Design

This study was designed as a prospective, cross-sectional analytical study to evaluate the correlation between body mass index (BMI) and visual reaction time (VRT) in young adults.

Study Setting

The study was conducted in the Department of Physiology, Sree Balaji Medical College and Hospital, Chennai, a tertiary care teaching hospital with facilities for anthropometric assessment and reaction time measurement.

Study Duration

The study was carried out over a period of one year, which included participant recruitment, data collection, and statistical analysis.

Ethical Considerations

Prior approval was obtained from the Institutional Ethics Committee (IEC) of Sree Balaji Medical College and Hospital before commencement of the study. Participants were provided with detailed verbal and written information regarding the study in English or Tamil, and written informed consent was obtained. Participation was voluntary, confidentiality was ensured by coded identifiers, and participants were free to withdraw from the study at any time without any consequences.

Study Population

The study population comprised apparently healthy male and female individuals aged 18–35 years, including students and volunteers attending the hospital. Participants were categorised based on WHO BMI classification into the following groups:

- Underweight: BMI < 18.5 kg/m^2
- Normal weight: BMI 18.5–24.9 kg/m^2
- Overweight: BMI 25.0–29.9 kg/m^2
- Obese: BMI ≥ 30.0 kg/m^2

Inclusion Criteria

- Age between 18 and 35 years
- Both males and females
- Apparently healthy individuals
- Ability to understand the procedure and provide written informed consent

Exclusion Criteria

- Age above 35 years

Tab. 1. Descriptive Statistics of Study Participants (N = 385)

Variable	Mean ± SD	Median (IQR)	Min–Max
Age (years)	24.94 ± 5.20	-	18–35
Body Mass Index (kg/m²)	24.67 ± 5.78	24.11 (20.55–27.59)	14.76–41.64
Visual Reaction Time (ms)	248.83 ± 58.29	242 (210–276)	134–505

Descriptive characteristics of age, body mass index (BMI), and visual reaction time (VRT) presented as mean ± SD or median (IQR) as appropriate. BMI range: 14.76–41.64 kg/m^2; VRT range: 134–505 ms.

- Known cases of diabetes mellitus, hypertension, or thyroid disorders
- History of neurological disorders such as epilepsy, migraine, stroke, or neurodegenerative diseases
- Smokers and alcohol consumers
- Individuals on medications known to affect reaction time or cognitive function

Sampling Method

Participants were recruited using a convenience sampling method after screening for eligibility criteria. Recruitment was continued until the required sample size was achieved.

Sample Size Calculation

Sample size was calculated based on correlation coefficient analysis, assuming an anticipated correlation coefficient of 0.50, power of 80%, and a significance level (α) of 0.05 (two-tailed). The calculated minimum sample size was 385 participants, which was considered adequate to detect a statistically significant correlation between BMI and visual reaction time.

Data Collection Procedure

Anthropometric Assessment

Height was measured using a stadiometer to the nearest 0.1 cm, and weight was recorded using a calibrated digital weighing scale to the nearest 0.1 kg. Body mass index (BMI) was calculated using the formula:

$$\text{BMI} = \frac{weight\ (kg)}{Height\ (m^2)}$$

Participants were categorised into BMI groups accordingly.

Measurement of Visual Reaction Time

Visual reaction time was assessed using an audio-visual reaction time apparatus. Participants were seated comfortably in a quiet room and instructed to respond as quickly as possible to a visual stimulus (light signal) by pressing a response key.

Three readings were recorded for each participant, and the mean value was considered as the final visual reaction time. Reaction time was expressed in milliseconds (ms).

Data Management and Statistical Analysis

Collected data were coded and entered into Microsoft Excel and analysed using statistical software. Continuous variables were expressed as mean +/- standard deviation or median with interquartile range, as appropriate. Normality of BMI and VRT was assessed using the Shapiro–Wilk test. As both variables were not normally distributed, Spearman's rank correlation test was used to assess the relationship between BMI and visual reaction time. A p-value < 0.05 was considered statistically significant.

RESULTS

Participant Characteristics

A total of 385 apparently healthy young adults aged 18-35 years were included in the study. The mean age of the participants was 24.94 ± 5.20 years. The median body mass index (BMI) of the study population was 24.11 kg/m² (interquartile range [IQR]: 20.55-27.59), with BMI values ranging from 14.76 to 41.64 kg/m². The overall median visual reaction time (VRT) for the cohort was 242 ms (IQR: 210-276 ms).

The descriptive characteristics of the study participants, including age, BMI, and visual reaction time, are summarised in Table 1.

Tab. 2. Distribution of Participants by BMI Category (N = 385)

BMI Category	Frequency (n)	Percentage (%)
Underweight (< 18.5 kg/m²)	62	16.1
Normal weight (18.5–24.9 kg/m²)	104	27.0
Overweight (25.0–29.9 kg/m²)	51	13.2
Obese (≥ 30.0 kg/m²)	168	43.6

Distribution of 385 participants across WHO BMI categories: underweight (n = 62, 16.1%), normal weight (n = 104, 27.0%), overweight (n = 51, 13.2%), and obese (n = 168, 43.6%).

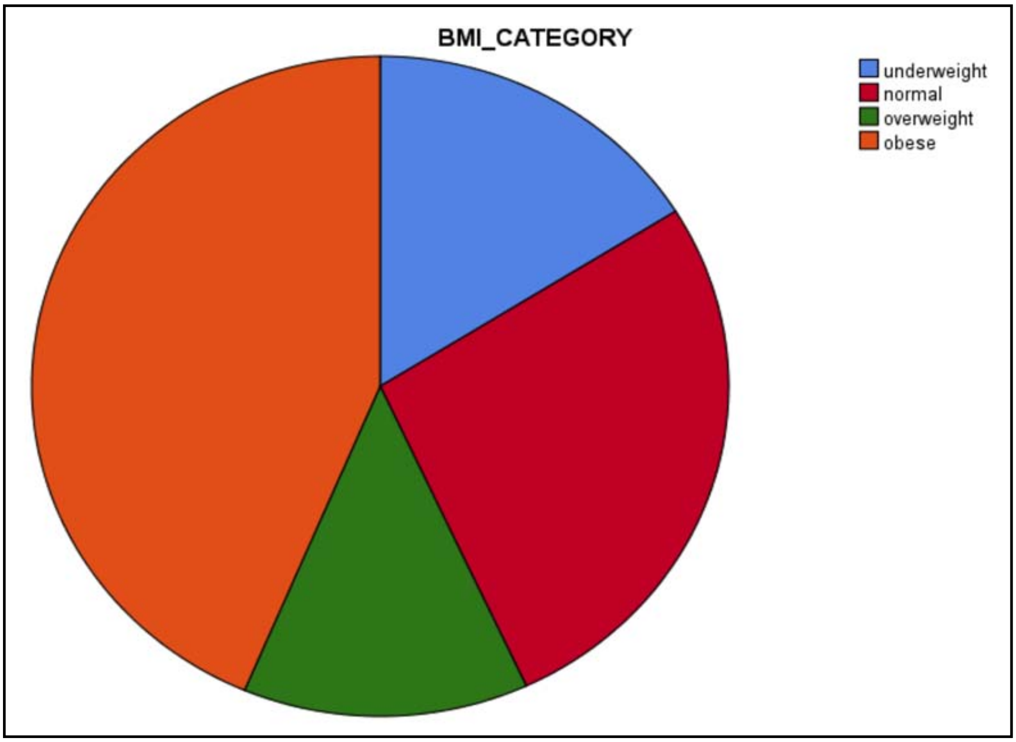

Fig. 1. Distribution of 385 Study Participants Across WHO BMI Categories
Pie chart showing proportion of participants in each BMI category. Obese participants (n = 168, 43.6%) constitute the largest group, consistent with high regional obesity prevalence in southern India (46.5%).

Distribution of Participants According to BMI

Based on World Health Organization BMI classification, participants were categorised into four groups. The obese group constituted the largest proportion of the study population (43.6%), followed by normal-weight (27.0%), underweight (16.1%), and overweight (13.2%) participants (Table 2). The distribution of participants across BMI categories is illustrated in Figure 1.

Normality Testing

Normality of the primary study variables was assessed using the Shapiro–Wilk test Table 3. Both Body Mass Index (BMI) and Visual Reaction Time (VRT) showed significant deviation from normal distribution ($p < 0.001$). Therefore, Spearman's rank correlation test was used for correlation analysis.

Distribution of Visual Reaction Time Across BMI Categories

Visual reaction time varied across BMI categories, with progressively longer reaction times observed at higher BMI levels. Underweight participants had a median VRT of 218 ms (IQR: 195–240 ms), while normal-weight participants demonstrated a median VRT of 232 ms (IQR: 205–258 ms). Overweight participants had a median VRT of 248 ms (IQR: 220–285 ms). The longest reaction times were observed among obese participants, with a median VRT of 268 ms (IQR: 210–305 ms) (Table 4).

Tab. 3. Shapiro-Wilk Test for Normality of Study Variables

Variable	Shapiro-Wilk Statistic	*p*-value
BMI (kg/m^2)	0.945	< 0.001
Visual Reaction Time (ms)	0.911	< 0.001

Shapiro-Wilk test results for BMI and VRT. Both variables deviated significantly from normal distribution ($p < 0.001$), justifying use of non-parametric statistics and median/IQR reporting.

Tab. 4. Distribution of Visual Reaction Time Across BMI Categories

BMI Category	n	Median VRT (ms)	IQR (ms)
Underweight	62	218	195–240
Normal weight	104	232	205–258
Overweight	51	248	220–285
Obese	168	268	210–305

Median VRT and IQR by BMI category. Progressive increase from 218 ms (underweight) to 268 ms (obese), representing 50 ms (23%) total difference. Within-category correlations shown in Table 5.

Tab. 5. Correlation Between BMI and Visual Reaction Time by BMI Category

BMI Category	n	Spearman's ρ	*p*-value
Underweight	62	–0.033	0.797
Normal weight	104	+0.073	0.459
Overweight	51	–0.110	0.441
Obese	168	+0.314	< 0.001

Spearman's rank correlation coefficients (ρ) and p-values for BMI-VRT relationship within each BMI category. Threshold effect: significant correlation only in obese group ($\rho = 0.314$, $p < 0.001$), with BMI explaining ~10% of VRT variance.

Correlation Between Body Mass Index and Visual Reaction Time

Spearman's rank correlation analysis revealed a group-specific threshold pattern (Table 5): a significant positive correlation emerged exclusively in obese participants ($\rho = 0.314$, $p < 0.001$), while underweight ($\rho = -0.033$, $p = 0.797$), normal-weight ($\rho = +0.073$, $p = 0.459$), and overweight groups ($\rho = -0.110$, $p = 0.441$) showed no significant associations.

Among obese participants (n = 168), the median visual reaction time was 268 ms (IQR: 210–305 ms), compared to 232 ms (IQR: 205–258 ms) among normal-weight participants (n = 104). This represents an absolute median prolongation of 36 ms, corresponding to a 15.5% increase in visual reaction time among obese individuals. BMI accounted for approximately 10% of the ranked variance in VRT in the obese group.

In contrast, no statistically significant correlation between BMI and visual reaction time was observed among underweight ($\rho = –0.033$, $p = 0.797$), normal-weight ($\rho = 0.073$, $p = 0.459$), or overweight participants ($\rho = –0.110$, $p = 0.441$).

The observed correlation of $\rho = 0.314$ in the obese group corresponds to a large effect size by contemporary methodological standards (Funder & Ozer, 2019), indicating both statistical and practical significance."

The association between BMI and visual reaction time is depicted using a scatter plot with locally estimated scatterplot smoothing (LOESS) (Figure 2). The plot demonstrates a clear upward trend in visual reaction time with increasing BMI among obese participants, while no consistent trend is evident in the other BMI categories.

Among obese participants, BMI showed a moderate positive correlation with visual reaction time ($\rho = 0.314$), accounting for approximately 10% of the variance in VRT.

DISCUSSION

In 385 young adults (ages 18-35, BMI range 14.76-41.64 kg/m²), BMI correlated with VRT exclusively in obese participants (n = 168, $\rho = 0.314$, $p < 0.001$, 10% variance explained). No correlations emerged in underweight (n = 62, $p = 0.797$), normal-weight (n = 104, $p = 0.459$), or overweight groups (n = 51, $p = 0.441$), indicating a threshold effect at BMI ≥30 kg/m². This effect size exceeds conventional medium thresholds in psychological research (d = 0.5), indicating

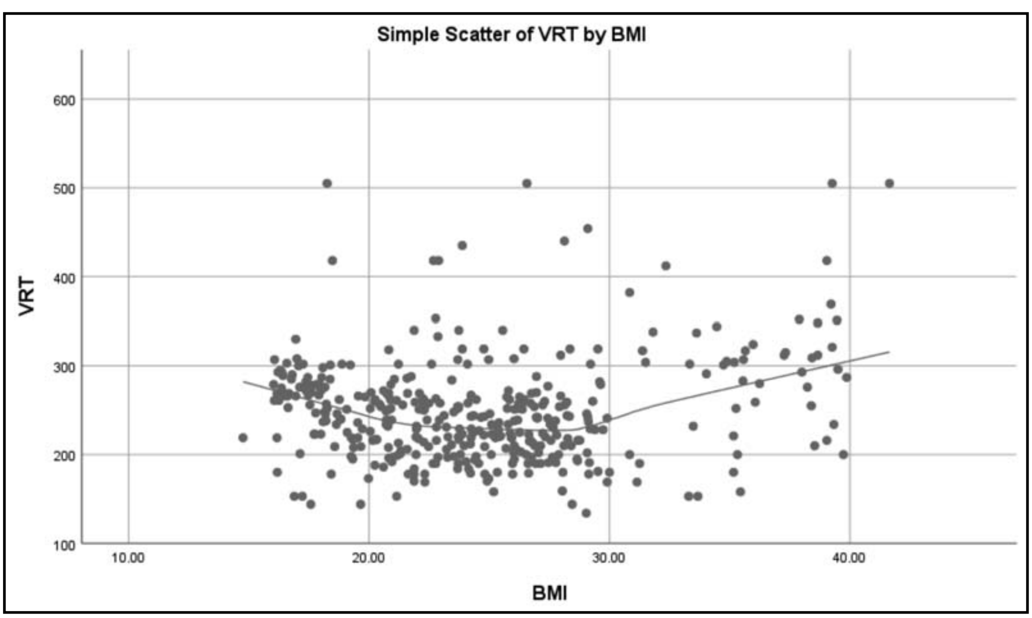

Fig. 2. Relationship Between Body Mass Index and Visual Reaction Time by BMI Category
Scatter plot with LOESS smoothing curves by BMI category (underweight = blue, normal = green, overweight=orange, obese=red). Upward trend visible only in obese category ($\rho = 0.314$, $p < 0.001$); other categories show flat trajectories (all $p > 0.44$).

a medium-to-large magnitude of association and suggesting clinically meaningful psychomotor slowing. Obese participants demonstrated a median visual reaction time that was 36 ms longer than that of normal-weight participants, corresponding to a 15.5% relative prolongation. In contrast, no significant association was observed between BMI and VRT in underweight ($\rho = -0.033$, $p = 0.797$), normal-weight ($\rho = 0.073$, $p = 0.459$), or overweight participants ($\rho = -0.110$, $p = 0.441$).

This magnitude of delay is not only statistically significant but also potentially clinically meaningful, as even modest increases in reaction time may adversely affect tasks requiring rapid visual-motor coordination, such as driving, occupational performance, and daily cognitive activities.

Visual reaction time is an indicator of psychomotor processing speed, integrating sensory perception, central neural processing, and motor response. The observed prolongation of VRT in obese individuals suggests a relative slowing of visual-motor processing with increasing adiposity. This finding is consistent with the concept that obesity may influence central nervous system function even in young adults, possibly before the onset of overt metabolic or neurological disease (Schmitt *et al.* 2023; Buie *et al.* 2019).

Several mechanisms may explain the observed association between obesity and delayed reaction time. Obesity is known to be associated with chronic low-grade systemic and neuroinflammation, which can adversely affect neuronal signalling and synaptic efficiency, and this has been proposed as a key link between excess adiposity and impaired brain function (Schmitt *et al.* 2023; Salas-Venegas *et al.* 2022). Mechanistically, obesity-induced hypothalamic neuroinflammation involves activation of the NF-κB/IKK-β pathway, Toll-like receptor 4 (TLR4) signaling, and microglial dysregulation, collectively impairing central nervous system processing speed and autonomic nervous system balance (Stathori *et al.* 2025). Additionally, obesity is frequently accompanied by insulin resistance and metabolic dysregulation, which have been implicated in altered central nervous system processing and cognitive dysfunction (Schmitt *et al.* 2023). Obesity is also linked to altered cerebral blood flow, which may impair the delivery of oxygen and nutrients to the brain and thereby affect information processing speed and motor response. A meta-analysis quantified this relationship, demonstrating that BMI is inversely associated with cerebral blood flow ($\beta = -0.31$, 95% CI -0.44 to -0.19), with obese individuals exhibiting global and regional hypoperfusion affecting frontal, temporal, parietal, cerebellar, hippocampal, and thalamic regions (Qiao *et al.* 2022). These changes may contribute to longer reaction times in individuals with higher BMI. Although the present study did not directly assess these mechanisms, the magnitude of VRT prolongation observed in obese participants is biologically plausible within the context of these established pathophysiological pathways. Recent evidence suggests these effects may operate through complex interactions; for instance, BMI-related cognitive impairments in young adults are mediated by sleep disruption ($\beta = 0.12$, $p < 0.001$) and increased impulsivity ($\beta = -0.16$, $p < 0.001$), which jointly explain cognitive decline (Lv *et al.* 2025), suggesting multi-factorial mechanisms beyond direct neuroinflammatory effects.The absence of a significant correlation between BMI and VRT in underweight, normal-weight, and overweight participants suggests that mild to moderate variations in BMI may not substantially affect basic psychomotor performance. The significant association observed exclusively in the obese group indicates a possible threshold effect, wherein neurocognitive or psychomotor changes become apparent only beyond a certain degree of adiposity. This group-specific finding highlights the importance of analysing BMI categories separately rather than relying solely on pooled data.

The proportion of variance in VRT explained by BMI in obese participants was approximately 10%, indicating a moderate association. This suggests that while BMI contributes to variation in visual reaction time, other factors such as physical activity, sleep quality, psychological state, and lifestyle behaviours may also play an important role. By established guidelines, a correlation of 0.314 represents a large effect size in psychological and behavioral research (Funder & Ozer, 2019), suggesting meaningful real-world implications even when BMI explains only a portion of VRT variance. These factors were not assessed in the present study and may account for the remaining unexplained variance. Accordingly, the observed association should be interpreted as contributory rather than causal, consistent with the cross-sectional design of the study.

Strengths and Limitations

A major strength of this study is the large sample size and inclusion of a narrow age range, which reduces the confounding influence of age-related cognitive decline. The use of standardised anthropometric measurements and objective assessment of visual reaction time further adds to the reliability of the findings.

However, certain limitations must be acknowledged. The cross-sectional design precludes any inference of causality between BMI and visual reaction time. Longitudinal evidence suggests bidirectional relationships between BMI and cognitive function, wherein higher BMI accelerates cognitive decline while preserved cognitive abilities may help maintain stable weight trajectories (Karlsson *et al.* 2021), underscoring the complex temporal dynamics that warrant prospective investigation in the context of psychomotor performance. Additionally, potential confounding factors such as physical activity levels, dietary habits, sleep patterns, and psychosocial stress were not evaluated. The use of a convenience sampling method may also limit the generalisability of the findings to the broader population.

Implications and Future Directions

Despite these limitations, the findings of this study have important implications. Visual reaction time is a simple, non-invasive, and inexpensive measure that may help identify early psychomotor slowing in obese young adults. Future longitudinal studies are required to determine whether changes in BMI over time influence reaction time and whether lifestyle interventions leading to weight reduction can improve psychomotor performance

CONCLUSION

This study demonstrates a significant positive correlation between body mass index and visual reaction time among obese young adults, indicating slower visual-motor responses with increasing BMI in this group. Obese participants exhibited a clinically meaningful prolongation in visual reaction time compared with normal-weight individuals. No significant association was observed in underweight, normal-weight, or overweight individuals. These findings suggest that obesity may be associated with early psychomotor slowing even in young adults, highlighting the importance of maintaining healthy body weight to preserve optimal neurofunctional performance.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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