

A cross-sectional comparative analysis of Visual Evoked Potentials in Obese Versus Non-Obese adult males in South India

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Abstract:

Background:

Obesity has been associated with various neurological changes. But its relationship with visual pathway remains inadequately explored. Visual evoked potentials (VEP) serve as an electrophysiological measure to evaluate the function of visual pathway. This study aimed to compare the VEP parameters between obese and non-obese adult males and to assess their association with body mass index (BMI).

Methods:

This cross-sectional comparative study included 60 adult males, comprising 30 obese and 30 non-obese participants. According to South Asian population criteria, obesity was defined as BMI >25 kg/m², while non-obese individuals had a BMI of 18.5–22.9 kg/m². Participants with neurological/visual disorders, diabetes, ocular surgery/trauma, hypertension, or relevant medication use were excluded. Demographic and anthropometric parameters were recorded. VEPs were elicited using a checkerboard pattern-reversal stimulus, and N75, P100, N145 latencies and N75–P100 amplitude were assessed for both eyes. Between-group comparisons were performed using independent *t*-test or Mann–Whitney U test as appropriate. Spearman's rank correlation was used to assess the association between BMI and VEP parameters.

Results:

The obese group had significantly higher BMI than the non-obese group (27.16 [26.05–28.60] vs 21.29 [19.50–22.34] kg/m², *P*<0.001). Left-eye N75 latency was significantly prolonged in obese participants compared with non-obese participants (88.62 [79.00–93.38] vs 75.00 [72.69–83.56] ms, *P*=0.023). No significant differences were observed between the groups in mean N75, P100, and N145 latencies or N75–P100 amplitude in the right eye. BMI was not significantly correlated with mean N75, P100, N145 latency, or N75–P100 amplitude in either group (all *P*>0.05).

Conclusion:

Obese adult males demonstrated a significant increase in left-eye N75 latency. However, this finding was not supported by similar changes in other VEP parameters. Also, BMI was not significantly associated with the mean VEP parameters. Overall, the findings in this study do not indicate a consistent change in visual pathway function associated with obesity.

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Introduction

Obesity has emerged as a major concern in public health owing to its invariable association with metabolic, cardiovascular and other systemic adverse effects (1). In South Asian populations, the Body Mass Index (BMI) ≥ 25 kg/m² is considered as an indicator of obesity (2). Globally, the prevalence of obesity was estimated around 2.5 billion in adults in the year 2022 (1). Increasing evidence suggests that obesity may be associated with alterations in brain structure and neurological function (3). However, the relationship between obesity and neurological processing of sensory information remains inadequately explored.

Visual evoked potentials (VEPs) are the electrophysiological responses generated following the visual stimulation. It is used to evaluate the functional status of the visual pathways. Amongst the assessed parameters, the P100 latency response

provides a measure of neural transmission and cortical processing of visual information (4).

Earlier studies have suggested that obesity may be associated with altered central nervous system (CNS) function (3,5). Several mechanisms including insulin resistance, systemic inflammation, metabolic dysregulation and oxidative stress are proposed play a vital role in the pathogenesis of obesity related neurological dysfunction (6). However, very few studies have evaluated the VEP parameters in obese populations. Furthermore, the data from South Indian populations remain limited.

Hence, this study was designed to compare VEP parameters between obese and non-obese adult males.

2. Aim and Objectives

Aim:

To compare the visual evoked potential parameters between obese and non-obese adult males.

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Primary objective:

To compare the VEP latencies and N75–P100 amplitude parameters between obese and non-obese adult males.

Secondary objectives:

- To assess the association between BMI and VEP parameters.

3. Materials and Methods

This study was a cross-sectional comparative study involving male participants aged ≥ 18 years. Participants were classified into two groups based on their BMI as per South Asian population criteria. Obese group was characterized by a BMI > 25 kg/m², and non-obese group was defined by a BMI 18.5–22.9 kg/m². Based on the mean and standard deviation difference in P100 latency reported in earlier study and with $\alpha = 0.05$ and 80% power, the sample size of 21 participants per group were required. Considering possible dropouts and non-usable recordings, 60 participants were recruited (n=30 in each group) (7). Participants with known neurological or visual defect, previous ocular surgery/ trauma, diabetes mellitus, other major illnesses likely to affect visual pathway function, known hypertension, or current use of antihypertensive or other medications were excluded. Following sanction from the Institutional Ethics Committee and securing written informed consent, the participants were recruited.

Demographic details, anthropometric parameters, including age, weight and height were recorded in all participants. BMI was calculated using the Quetelet index formula $[\text{Weight (kg)} / [\text{Height (m)}]^2]$.

VEP recording

VEP recordings were obtained using a checkerboard pattern. Black and white visual stimuli were presented at a reversal rate of 1 Hz and 15° visual angle. The 10–20 International System was used for placement of electrodes. With an active electrode at Oz and electrodes at Fz and Cz as reference and ground electrodes, respectively, the recordings were obtained using the Physiopac-PP4 system (Medicaid Systems, Chandigarh) with a 1000 Hz sampling rate. The P100 response was identified as the positive peak appearing at 100 ms approximately after stimuli presentation. VEP parameters including N75 latency, P100 latency, N145 latency, and N75–P100 amplitude for the right eye, left eye, and mean values if available were analyzed.

Statistical analysis

Normality of continuous data was checked using the Shapiro–Wilk test. Normally distributed variables are presented as mean $\pm$ standard deviation and non-normally distributed variables as median (interquartile range). Between-group comparisons were performed by independent-samples t tests/ Mann–Whitney U tests for parametric data and non-parametric data respectively. Associations between BMI and VEP parameters were assessed using

Spearman rank correlation. Statistical significance of data was defined by P value less than 0.05.

4. Observation:

Table 1. Demographic and clinical characteristics of non-obese and obese male participants.

Variable	Non-obese (n=30)	Obese (n=30)	P value
Age, years†	34.5 (28.0–38.8)	39.0 (29.3–46.0)	0.050
Height, cm	158.15 $\pm$ 6.63	160.93 $\pm$ 8.10	0.151
Weight, kg	52.37 $\pm$ 5.68	71.37 $\pm$ 8.30	<0.001
BMI, kg/m ² †	21.29 (19.50–22.34)	27.16 (26.05–28.60)	<0.001

Parametric values are presented as mean $\pm$ standard deviation and were analyzed using the independent-samples t-test.

† non- parametric data are presented as median (interquartile range) and were analyzed using the Mann–Whitney U test;

P<0.05 was considered statistically significant
BMI-body mass index; cm – centimeters; kg – kilograms; kg/m² – kilograms per square meter

Table 2. Visual evoked potential parameters in non-obese and obese male participants.

VEP parameter	Non-obese (n=30)	Obese (n=30)	P value
N75 latency, right eye (ms)†	74.12 (69.31–85.06)	82.50 (72.38–91.38)	0.109
N75 latency, left eye (ms)†	75.00 (72.69–83.56)	88.62 (79.00–93.38)	0.023
N75 latency, mean (ms)†	73.38 (70.75–86.22)	86.62 (73.06–92.88)	0.066
P100 latency, right eye (ms)†	105.50 (102.06–117.75)	117.75 (103.12–126.44)	0.131
P100 latency, left eye (ms)†	106.75 (102.31–119.94)	115.00 (104.50–125.50)	0.162
P100 latency, mean (ms)†	105.69 (102.78–121.66)	117.12 (104.19–124.78)	0.152
N145 latency, right eye (ms)	155.62 $\pm$ 14.04	155.55 $\pm$ 16.90	0.985

N145 latency, left eye (ms)	160.44 ± 13.32	157.47 ± 20.79	0.514
N145 latency, mean (ms)	158.03 ± 12.79	156.51 ± 17.92	0.707
N75–P100 amplitude, right eye (μV)†	7.17 (5.93–8.71)	6.17 (3.98–7.75)	0.080
N75–P100 amplitude, left eye (μV)	7.12 ± 2.17	6.38 ± 2.73	0.249
N75–P100 amplitude, mean (μV)†	7.23 (5.93–8.51)	5.89 (4.10–7.67)	0.112

Parametric values are presented as mean ± standard deviation and were analyzed using the independent-samples *t*-test.

† non-parametric data are presented as median (interquartile range) and were analyzed using the Mann–Whitney *U* test;

P < 0.05 was considered statistically significant
VEP- visual evoked potential; *N75*- negative peak occurring approximately 75 ms after stimulus; *P100*- positive peak occurring approximately 100 ms after stimulus; *N145*- negative peak occurring approximately 145 ms after stimulus, ms-milliseconds, μV – microvolts

Table 3. Correlation between BMI and mean VEP parameters.

VEP parameter	Non-obese ρ	P value	Obese ρ	P value
Mean N75 latency	0.172	0.362	0.119	0.532
Mean P100 latency	0.213	0.259	0.020	0.918
Mean N145 latency	0.161	0.396	−0.023	0.904
Mean N75–P100 amplitude	−0.183	0.333	−0.139	0.465

ρ, Spearman's rank correlation coefficient; *P* < 0.05 was considered statistically significant

VEP- visual evoked potential; *N75*- negative peak occurring approximately 75 ms after stimulus; *P100*- positive peak occurring approximately 100 ms after stimulus; *N145*- negative peak occurring approximately 145 ms after stimulus.

5. Results

5.1 Demographic and clinical characteristics

60 adult male participants (30 in each group) were included in the study. The demographic details of the participants in both groups are presented in Table

1. The groups were comparable with respect to age (34.5 (28.0–38.8) vs 39.0 (29.3–46.0), *P*=0.051) and height (158.15 ± 6.63 vs 160.93 ± 8.10 cm, *P*=0.151). Weight and BMI were significantly higher in the obese group compared with the non-obese group (71.37 ± 8.30 vs 52.37 ± 5.68 kg, *P*<0.001; 27.16 [26.05–28.60] vs 21.29 [19.50–22.34] kg/m², *P*<0.001).

5.2 Comparison of VEP parameters

The VEP parameters of the two groups are presented in Table 2. N75 latency in the left eye was significantly higher in the obese group compared with the non-obese group (88.62 [79.00–93.38] vs 75.00 [72.69–83.56] ms, *P*=0.023). However, no significant between-group differences were observed for right-eye N75 latency (*P*=0.109) or mean N75 latency (*P*=0.066).

Similarly, P100 latency did not differ significantly between the groups for the right eye (*P*=0.131), left eye (*P*=0.162), or mean P100 latency (*P*=0.152). N145 latency also showed no significant differences between the non-obese and obese groups for the right eye, left eye, or mean values (*P*=0.985, 0.514, and 0.707, respectively).

Also, N75–P100 amplitude had no statistically significant differences between the groups for the right eye (*P*=0.080), left eye (*P*=0.249), or mean amplitude (*P*=0.112).

5.3 Correlation between BMI and VEP parameters

The association between BMI and mean VEP parameters was assessed separately in the non-obese and obese groups using Spearman's rank correlation coefficient. No significant correlation was observed between BMI and mean N75 latency in either the non-obese (ρ=0.172, *P*=0.362) or obese group (ρ=0.119, *P*=0.532).

Similarly, BMI was not significantly correlated with mean P100 latency in the non-obese (ρ=0.213, *P*=0.259) or obese group (ρ=0.020, *P*=0.918). No significant correlations were observed for mean N145 latency or mean N75–P100 amplitude in either group (all *P*>0.05).

6. Discussion

The present study evaluated whether obesity was associated with changes in VEP parameters among adult males. Our principal finding suggests no significant difference is observed in the major VEP parameters between obese and non-obese participants, except for a significant increase of left-eye N75 latency in the obese group.

The significantly prolonged left-eye N75 latency in the obese group is notable. N75 represents an early cortical response to visual stimulation (4). However, an isolated difference in one eye may reflect biological variability rather than a generalized effect of obesity on visual pathway function. This difference was not accompanied by significant changes in right-eye or mean N75 latency. Furthermore, mean P100 latency and N75–P100

amplitude did not differ significantly between the groups, suggesting that the VEP measures were largely similar between the groups.

Our findings are consistent with the observations of Narra et al., who reported no significant difference in P100 latency between young obese males and controls (8). In contrast, Gupta et al. reported significant prolongation of VEP P100 latency among obese and overweight individuals, indicating possible alterations in visual pathway conduction (7). These contrasting findings may reflect differences in participant characteristics, BMI classification, sample size, VEP recording protocols, and the presence of metabolic or vascular confounding factors.

Several biological mechanisms, including chronic low-grade inflammation, oxidative stress, insulin resistance, and metabolic disturbances, have been proposed as contributors to neural dysfunction in obesity (9,10). However, these biochemical parameters were not directly evaluated in the present study and should therefore be regarded as possible biological explanations demonstrated by our findings.

Overall, the present findings indicate that no significant association was found between BMI and VEP parameters in either the obese or non-obese group. Future studies incorporating biochemical biomarkers and standardized VEP protocols are warranted. Studies involving larger sample sizes are also required to determine whether changes in body weight or blood pressure are accompanied by changes in visual neurophysiology.

7. Strengths and Limitations

Strengths:

Multiple VEP components were analyzed rather than P100 latency alone allowing a wide assessment of visual pathway function.

Limitations:

The study included only male participants of modest sample size, hence limiting the generalizability to females. Potential confounders such as physical activity, diet, genetic factors, and biochemical parameters like insulin resistance, inflammatory and oxidative stress markers were not assessed.

8. Conclusion

Although left-eye N75 latency was significantly higher among obese participants, it was not supported by significant differences in any other major VEP parameters in this cross-sectional comparative study of VEP parameters between obese versus non-obese males. BMI was not significantly correlated with any mean VEP parameter in both the group. Overall, the present findings do not support a consistent association between obesity and VEP parameters.

9. Declarations:

Informed consent: Obtained from all participants.

Conflict of interest:

The authors declare no conflict of interest.

Author contributions:

Dr. Arunkumar B: Conceptualization, study design, and data collection.

Dr. Karthiga J: Data analysis, interpretation of results, and manuscript preparation.

Both authors reviewed and approved the final version of the manuscript.

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