IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 7 Ser. 7 (July. 2024), PP 07-13
www.iosrjournals.org

Effect of BMI on Peripheral Nerve Conduction Among Young Healthy Adults – A Cross Sectional Study

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Abstract:
Introduction:*Components of metabolic syndrome are potential risk factors for nerve conduction defects or neuropathy. Obesity being one of the components of metabolic syndrome has definitive effect on nerve conduction. This study was taken up to assess the correlation of BMI with nerve conduction parameters in otherwise healthy individuals.*
Objectives:
1. To assess of motor and sensory nerve conduction in healthy young adults
2. To determine the effect of BMI on nerve conduction in healthy young adults.
***Materials and method:** A cross sectional study was taken up among fifty (50) healthy adults between the age group of 18-50 years. Written informed consent was obtained from all the participants. All the study participants were personally subjected to detailed history and clinical examination. Body Mass Index (BMI) was calculated and Nerve conduction study (NCS) was conducted on Median nerve of the study participants. The data were analyzed using SPSS 20.*
***Results:** Mean age of the study subjects were (26.16 ± 8.89) years. Mean BMI of the subjects was (23.38±3.77) kg/m^2. Mean motor latency of median nerve among participants with BMI > 22.9 kg/m^2 were significantly higher compared to participants with BMI ≤ 22.9 kg/m^2. Motor nerve amplitude and motor nerve conduction velocity (MNCV) and sensory nerve conduction velocity (SNCV) of median nerve was significantly lower among participants with BMI > 22.9 kg/m^2 compared to participants with BMI ≤ 22.9 kg/m^2. There was inverse correlation between motor and sensory nerve conduction velocity and BMI of the study participants.*
***Conclusion:** Higher BMI is associated with altered motor and sensory nerve conduction. Overweight and obese individuals though otherwise healthy, should be made aware about the impact of higher BMI on nerve conduction and overall health risks.*
Keywords:*Body Mass Index (BMI), Motor nerve conduction, Sensory nerve conduction.*

Date of Submission: 08-07-2024 Date of Acceptance: 18-07-2024

I. Introduction

Conduction of impulse through nerve depends on factors like age, sex, and various medical conditions. Motor nerve conduction is usually impaired in various clinical conditions like neurodegenerative disorders, endocrine and metabolic disorders like Diabetes Mellitus, Hyperthyroidism[1]. Components of metabolic syndrome are also potential risk factors for nerve conduction defects or neuropathy. Polyneuropathy is degeneration of peripheral nerves, characterized by symmetrical distal numbness and paresthesia, often accompanied with pain and weakness. It affects around 1% to 7% of the population. A definitive cause for polyneuropathy is lacking in 20-30% of patients[2]. Multiple studies revealed an association between metabolic syndrome and polyneuropathy[3,4]. Obesity being one of the components of metabolic syndrome, it has definitive effect on nerve conduction. Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. Obesity has become an epidemic, with over 4 million people dying each year as a result of being overweight or obese according to the global burden of disease[5]. Rates of overweight and obesity continue to grow in adults and children.

Obesity can affect motor nerve conduction by altering the metabolism and by creating a variety of co-morbid conditions such as insulin resistance, diabetes, hypertension, hyperlipidemia and hyperandrogenism, which can affect the neuron function. Lipids are major components of a nerve cell. Therefore, both deficiencies of fat (malnutrition) and excess adiposity (obesity) are expected to interfere in neuronal structure and functions.Body Mass Index (BMI) is good indicator of obesity. Assessing the correlation between BMI and nerve conduction will help us understand the effect obesity on nerve conduction.

Nerve conduction study is a very important electrodiagnostic technique to establish any conduction defects of the nerves. Conduction block is an early indicator of entrapment of nerve or neuropathies. In nerve conduction study parameters such as conduction velocity, latencies and amplitudes are recorded.

Studies performed to establish the correlation between BMI and nerve conduction velocity showed conflicting results. Some of the recent studies have demonstrated that velocity of nerve conduction and its amplitude decreases with increase in BMI[6,7]. However, other studies failed to establish any statistically significant correlation between nerve conduction and BMI in healthy obese individuals[8].Also nerve conduction may vary depending on the ethnicity in different geographical area. Therefore this study is taken up to assess the correlation of BMI with nerve conduction in otherwise healthy individuals.

II. Aims&Objectives

1. To assess of motor and sensory nerve conduction in healthy young adults
2. To determine the effect of BMI on nerve conduction in healthy young adults.

III. MaterialsAnd Method

Study design: Cross sectional study

Study type: Observational study

Study duration: One year May 2023 to April 2024

Study area/location: Department of Physiology, Agartala Government Medical College.

Study population: Fifty (50) healthy adults between the age group of 18-50 years in the premises of Agartala Government Medical College & GBP Hospital

Sampling procedure: Convenience type of sampling (non-probability) was used to select the participants for the study from among the study population who suitably fulfilled the selection criteria.

Inclusion criteria:
1. Healthy young adults between the age group of 18-50 years willing to participate in the study.

Exclusion criteria:
1. Young adults with history of Hypertension, Hypothyroidism or Hyperthyroidism.
2. History of Diabetes Mellitus
3. History of neurodegenerative disorder or neuropathy

Study tools:
1. **Stadiometer:**Bioplus ;height -200cm
2. **Weight Machine (Mechanical EQ-BR-9201):** Brand- Equinox, Weight Limit-130kg
3. **2/4 Channel portable RMS EMG.NCV.EP machine**

Study procedure: Data were collected from the participants after obtaining their informed consent as per the inclusion and exclusion criteria. Socio-demographic variables like name, age, sex, etcwere noted as per the case study format.

A pre-designed case study format was used to collect relevant information, demographic data, and Medical history. Motor and sensory nerve conduction study was conducted on median nerve of dominant hand.

1. Age was recorded from the birthdays by calendar to the nearest of the years(<6months and >6 months).

2. **Standing height**was recorded without shoes and with light clothes by a measuring stand with scale to the nearest of centimeters (<5mm and >5mm).

3. **Weight:**was recorded without shoes and with light clothes on a standard electronic weighing machine with a least count of 500grams.

4. **BMI** was calculated by the formula[9]: BMI= weight (kg)/{height(m)}^{2}

Asia Pacific Classification	BMI (kg/m²)
Underweight	<18.52
Normal Weight	18.5 - 22.9
Overweight	23 - 24.9
Obese	≥ 25

5. NCS: The nerve conduction recordings were performed using RMS EMG.NCV.EP machine. The subjects were allowed to lie down on a couch and relax fully to ensure good recordings. The area of the skin was cleaned thoroughly with spirit to remove dirt, dead cells and grease. The cup or disc electrodes (Ag AgCl) of 1 cm diameter filled with conducting jelly was fixed on the skin of recording area with transpore tape. These electrodes were connected to the oscilloscope through the preamplifier. After 10 min of rest and adaptation to the laboratory environment, electrodiagnostic tests were performed following the standard procedures. The recordings were performed with standard equipment settings of sensitivity 5 mV/division, sweep speed 5 ms/ division, stimulus duration 0.2 ms, low frequency filter 10 Hz, high frequency filter 5 KHz by using supramaximal strength of stimuli. Motor and sensory NCS were performed for median nerve in upper limb. The recording electrode, the reference electrode and the ground electrode were attached. The cathode of the stimulating electrode was placed proximal to the recording electrode. Recordings were taken only in the dominant side. The nerve was stimulated to record the muscle action potential and the following parameters were measured: Standardized distal latency in ms, amplitude of compound muscle action potential in mV (CMAP) and nerve conduction velocity in m/s.

Data analysis: Data were analyzed using SPSS 20. Descriptive statistics and other suitable statistical tests were used as per applicability. Data were expressed in terms of mean and standard deviation. Correlation was assessed between BMI and Nerve conduction parameters. A probability value less than 0.05 were considered as significant.

IV. Results

The study was conducted on 50 healthy adults between the age group of 18-50 years. Mean age of the study subjects were (26.16 ± 8.89) years. 33.3% of the participants were females and 66.7% of them were males. Demographic characteristics of the participants are shown in Table1. Mean BMI of the subjects was (23.38±3.77) kg/m². 9.8% of them were underweight, 41.2% were of normal weight, 19.6% were overweight and 29.4% were obese as shown in Figure 1.

Variables	Mean	Std. Deviation
Age (years)	26.16	± 8.89
Height (meter)	1.62	± 0.09
Weight (kg)	61.06	± 10.71
BMI (kg/m²)	23.38	± 3.77

Table 1. Demographic characteristics of the participants

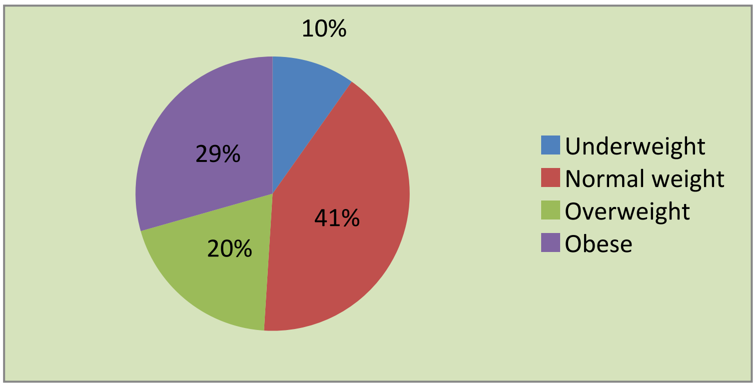

Figure 1. Distribution of the study subjects according to their BMI

Mean motor latency of median nerve among participants with BMI > 22.9 kg/m² were significantly higher compared to participants with BMI ≤ 22.9 kg/m². Motor nerve amplitude of median nerve and motor nerve conduction velocity among participants with BMI > 22.9 kg/m² were significantly lower compared to participants with BMI ≤ 22.9 kg/m². Sensory nerve conduction velocity of median nerve was significantly lower among participants with BMI > 22.9 kg/m². Nerve conduction parameters of the study participants are showed in Table2 and 3.

Parameters	Underweight	Normal	Overweight	Obese
Motor nerve latency (ms)	2.94 ± 0.27	3.0 ± 0.53	3.69 ± 0.25	3.61 ± 3.31
Motor nerve amplitude (mv)	11.56 ± 2.84	12.11 ± 3.48	8.4 ± 1.18	8.30 ± 1.50
Motor NCV (m/s)	56.92 ± 2.84	58.20 ± 4.02	52.99 ± 0.84	50.86 ± 1.79
Sensory nerve latency(ms)	2.28 ± 0.21	2.35 ± 0.24	2.5 ± 0.12	2.42 ± 0.47
Sensory nerve amplitude(mv)	82.84 ± 24.40	95.91 ± 37.87	99.66 ± 31.86	87.14 ± 45.06
Sensory NCV(m/s)	58.54 ± 6.55	59.85 ± 6.04	53.99 ± 1.61	51.42 ± 2.44

Table2. Nerve conduction parameters of the study participants

Parameters	BMI ≤22.9	BMI>22.9	P value
Motor nerve latency (ms)	2.99 ± 0.48	3.64 ± 0.25	0.015*
Motor nerve amplitude (mv)	12 ± 3.29	8.34 ± 1.36	0.001*
Motor NCV (m/s)	57.96 ± 3.81	51.71 ± 1.81	0.003*
Sensory nerve latency (ms)	2.34 ± 0.24	2.47 ± 0.38	0.16
Sensory nerve amplitude (mv)	93.40 ± 35.64	92.15 ± 40.06	0.779
Sensory NCV (m/s)	59.60 ± 6.03	52.45 ± 2.48	0.000*

Table3. Nerve conduction parameters of the study participants

Motor latency of median nerve among study participants had a significant positive correlation with BMI whereas amplitude and motor nerve conduction velocity had significant negative correlation with BMI. Sensory nerve conduction velocity had significant negative correlation with BMI. Correlation of nerve conduction parameters with BMI of the study participants are shown in Table 4.

Parameters of NCS (Median nerve)	BMI	
	Pearson correlation	P value
Motor nerve latency	0.49	0.000*
Motor nerve amplitude	-0.48	0.000*
Motor NCV	-0.67	0.000*
Sensory nerve latency	0.26	0.06
Sensory nerve amplitude	-0.004	0.97
Sensory NCV	-0.50	0.000*

Table 4. Correlation of nerve conduction parameters with BMI

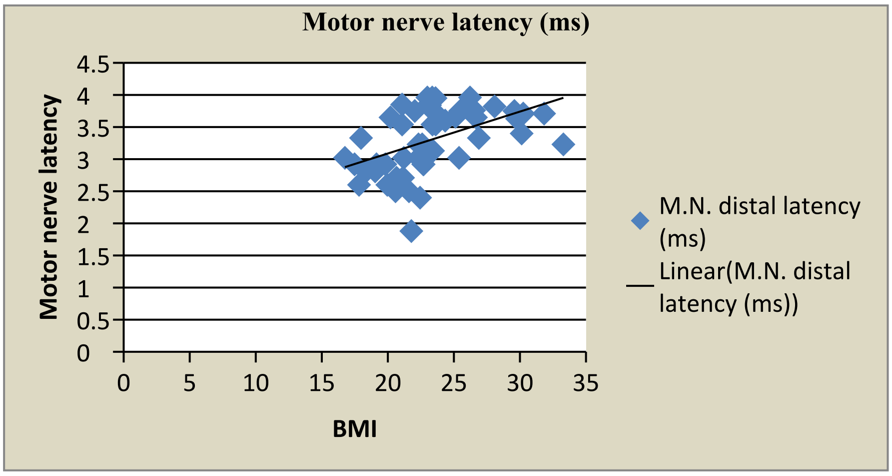

Figure 2. Correlation of motor nerve latency with BMI

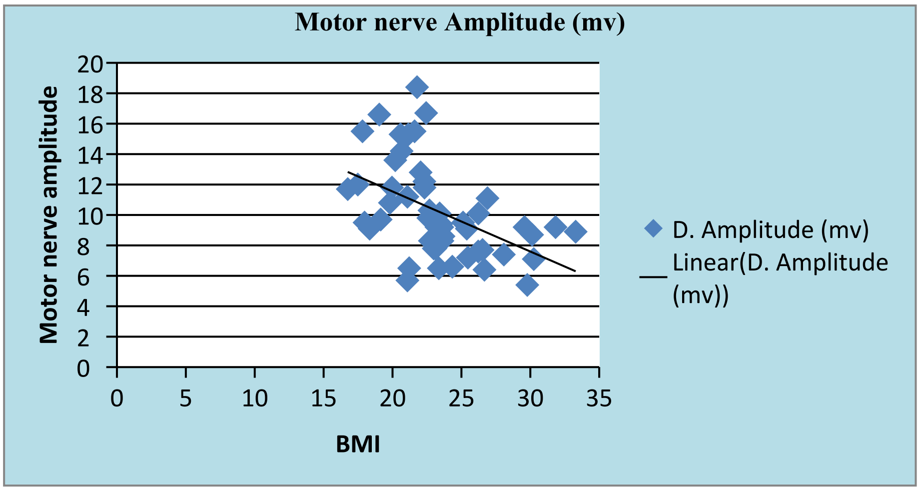

Figure 3. Correlation of motor nerve amplitude with BMI

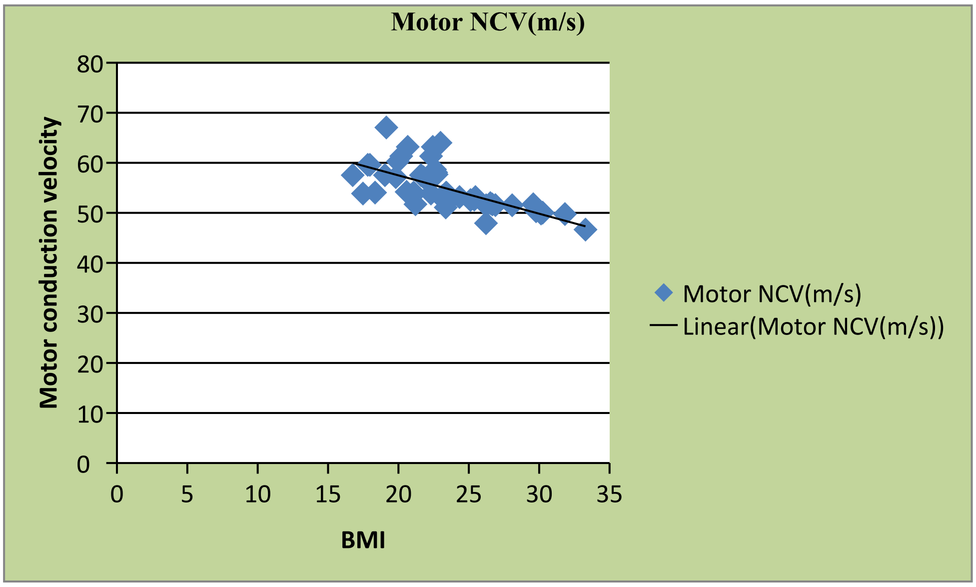

Figure 4. Correlation of motor nerve conduction velocity with BMI

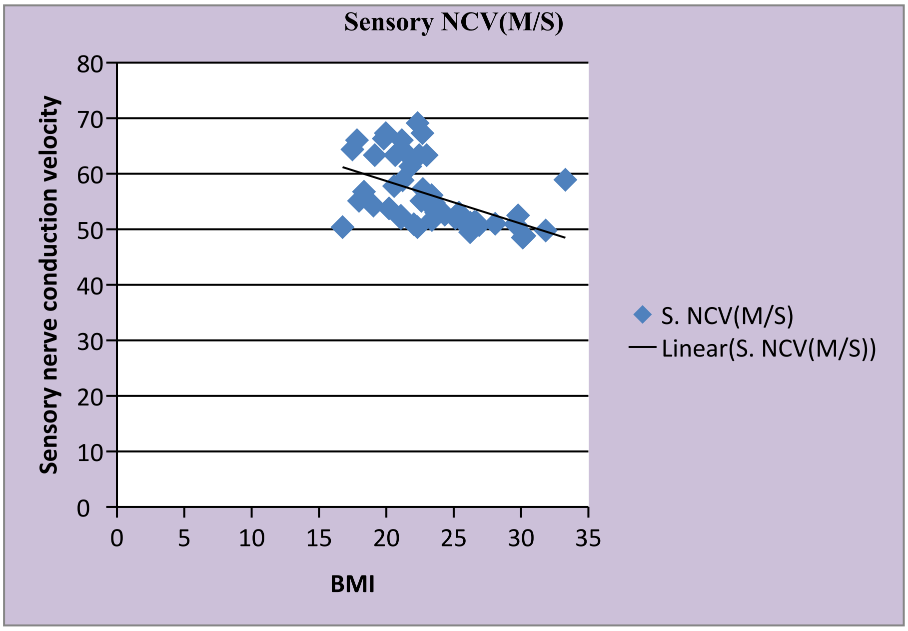

Figure 5. Correlation of Sensory nerve conduction velocity with BMI

V. Discussion

The study was conducted among fifty (50) healthy adults between the age group of 18 to 50 years. Motor nerve latency was significantly higher, whereas amplitude and conduction velocity were significantly loweramong overweight and obese people as compared to normal weight individuals. Sensory nerve conduction velocity was significantly lower among overweight and obese people as compared to normal weight individuals. There was positive correlation between motor nerve latency with BMI of the study participants. There was negative correlation between motor and sensory nerve conduction velocities with BMI of the individuals.

Various study conducted to assess the association between nerve conduction and increase in BMI showed similar results like the present study. In a study done by Chourasia H et al showed that the median motor nerve conduction had a significant inverse association with BMI. They explained that, this might be due to fatty subcutaneous tissue in the person with increasing BMI[10].

Another study conducted on one hundred seventy five healthy volunteers between ages of 18 and 66 years. There was prolongation of distal motor latency (DML) with increasing BMI. F- Wave minimum latency was also found to be significantly prolonged in ($P<0.05$) motor Tibial nerve. Motor as well as sensory conduction velocity showed slowing along increasing BMI[7].

Ali k et al. conducted a study to investigate the correlation between NCV & BMI. The Motor and sensory conduction velocity of median nerve were found to be significantly decreased in dominant hand of healthy pre-obese and obese subjects[11]. Bhandare JR et al concluded in their study that there was decrease in sensory nerve conduction velocities and amplitudes with increase in BMI[12]. Another study conducted on healthy obese Indian population showed that there were increase in motor nerve latencies, decrease in the amplitude of action potentials and conduction velocity in peripheral nerve fibers[13].

Obesity is a state of altered metabolic function. It can lead to various co-morbid conditions such as insulin resistance, diabetes, hypertension, hyperlipidemia and hyperandrogenism, which can affect the motor neuron function. Also in cases of obesity there is a disbalance between pro-inflammatory and anti-inflammatory cytokines. Excess of inflammatory cytokines can also be the cause of neurodegenration leading to neuropathy.

VI. Conclusion

Higher BMI is associated with altered motor and sensory nerve conduction. Overweight and obese individuals though otherwise healthy, should be made aware about the impact of higher BMI on nerve conduction and overall health risks.

VII. Acknowledgement

We are thankful to all the study participants for participating in the study. We also want to thank Medical Research Unit of AGMC & GBPH for supporting the study.

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