

Original Research

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Correlation between Mobile Phone Usage Metrics and Auditory Brainstem Response Parameters among Young Adults in North India

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ABSTRACT:

Background: The widespread use of mobile phones has raised concerns about their potential impact on the auditory system. Auditory Brainstem Response (ABR) testing can objectively assess auditory pathway neuronal conduction and detect small neurophysiological changes caused by prolonged mobile phone use.

Objective: To determine how mobile phone usage affects young adults' auditory brainstem response characteristics.

Method: A cross-sectional correlational study involved 68 youth. Mobile phone usage characteristics, including years used, daily calling duration, and total calling length (minutes, days), were recorded. ABR absolute and interpeak latencies of Waves I, III, and V were studied. Pearson correlation was used for regularly distributed variables and Spearman's rho for non-normally distributed variables.

Results: The daily duration of calls was positively correlated with Wave latency and Interpeak Latencies in the right ear's total duration, measured in minutes, and latency. Comparisons were made for total calling duration in days. No significant relationships were found between cellphone usage (years) and ABR features.

Conclusion: Higher daily and cumulative mobile phone exposure extended right-ear Wave I latency, suggesting peripheral auditory nerve conduction issues. Additional longitudinal studies are needed to prove causality.

INTRODUCTION

The use of mobile phones has increased exponentially over the past two decades. Concerns have been raised regarding the potential biological effects of radiofrequency electromagnetic fields emitted by mobile phones on neural tissues, particularly structures located in close proximity to the handset.

The auditory pathway is of special interest because mobile phones are typically used near the ear for prolonged periods. Auditory Brainstem Response (ABR) testing is a non-invasive electrophysiological technique used to assess neural conduction from the auditory nerve through the brainstem. Alterations in ABR latencies may indicate subtle dysfunction within the auditory pathway.

Several studies have investigated the association between mobile phone use and auditory function, with inconsistent findings. While some investigators have reported prolonged ABR latencies among heavy users, others have failed to demonstrate significant effects.

The present study was undertaken to evaluate the relationship between mobile phone usage characteristics and ABR parameters among young adults.

METHODS

Study Design: Cross-sectional analytical study.

Study Population: Young adult mobile phone users.

Sample Size: N = 68 participants.

Exposure Variables

1. Calling duration per day (minutes)

Outcome Variables

Right Ear (LonR) When Stimulus is given on the left ear and Potential recorded from the right ear Wave latency

- LonR I (ms)
- LonR III (ms)
- LonR V (ms)
- LonR I–III (ms)
- LonR I–V (ms)
- LonR III–V (ms)

Additional Right Ear Measures (When Stimulus is given on the Right ear and Potential recorded from the right ear) RonR

- RonR I
- RonR III
- RonR V
- RonR I–III
- RonR I–V
- RonR III–V

Statistical Analysis

Variables were assessed for normality. Pearson correlation was used for normally distributed variables, whereas Spearman's rank correlation was applied to non-normally distributed variables. A p-value <0.05 was considered statistically significant.

RESULTS

Participant Characteristics

The study included 68 participants. The average duration of mobile phone use ranged from approximately 5 to 10 years. Daily calling duration ranged widely among participants, indicating substantial variability in exposure. The correlation is seen in all the wave latencies and minutes in days with recording as follows:

When the sound stimulus is given in the left ear, and the recording is done in the right ear via I, III, V, and interpeak latencies.

When the sound stimulus is given in the Right ear, and the recording is done in the right ear via I, III, V, and Interpeak latencies.

CORRELATION BETWEEN CALLING DURATION IN YEARS AND DIFFERENT WAVE LATENCY

S.no.	Wave latency	Correlation efficient	Sign(2-tailed)
1	I	0.108	0.383
2	III	0.160	0.193
3	V	-0.052	0.671
	Interpeak latency		
4	I-III	0.077	0.531
5	I-V	-0.106	0.390
6	III-V	-0.123	0.429

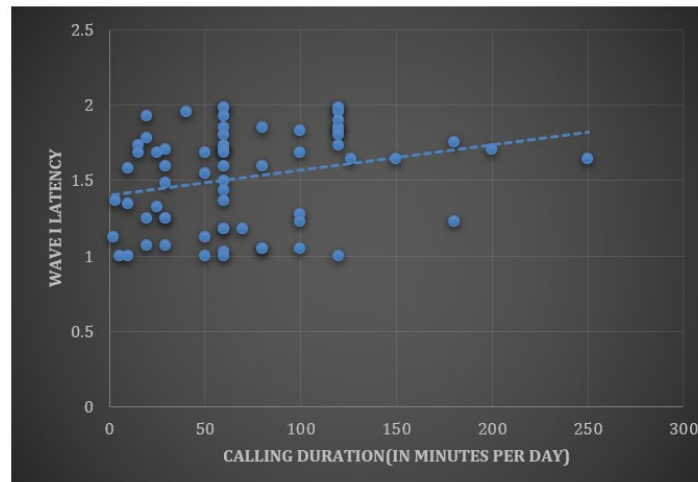
When the sound stimulus is given in the left ear, and the recording is done in the right ear via I, III, V, and interpeak latencies

CORRELATION BETWEEN CALLING DURATION PER DAY (IN MINUTES) AND DIFFERENT WAVES

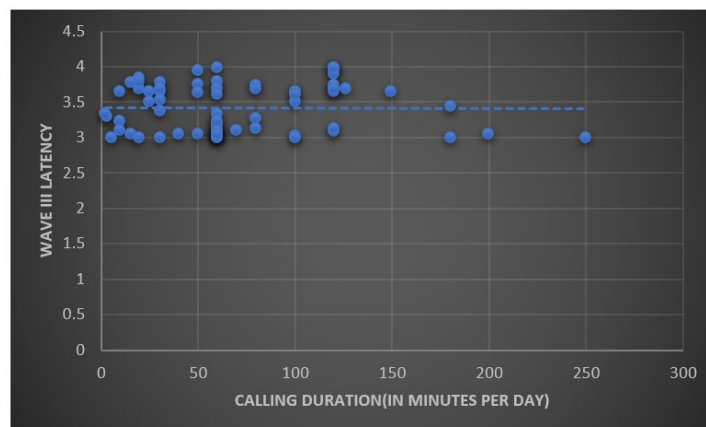
S.no.	Wave latency	Correlation efficient	Sign(2-tailed)
1	I	0.292	0.016
2	III	0.044	0.719
3	V	0.200	0.102
	Interpeak latency		
4	I-III	-0.227	0.063
5	I-V	-0.027	0.827
6	III-V	0.119	0.731

When the sound stimulus is given in the Right ear, and the recording is done in the right ear via I, III, V, and Interpeak latencies.

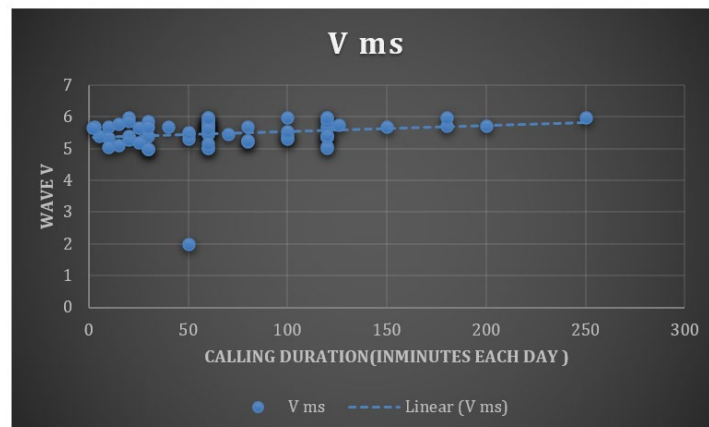
When the stimulus is given on the left side, and the potential is recorded in the right ear



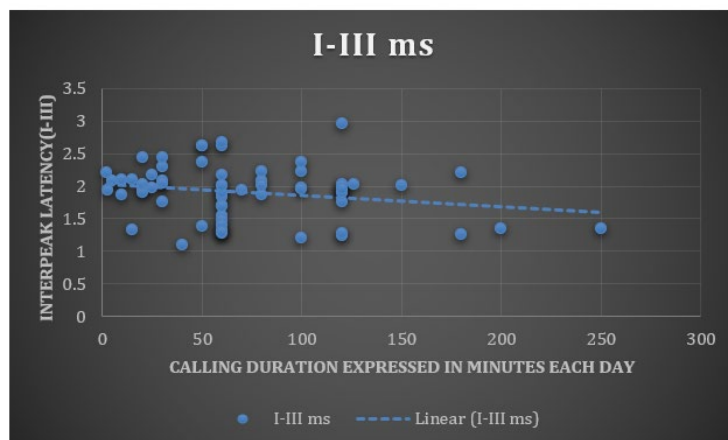
Correlation between Wave I Latency and Calling Duration expressed in minutes each day



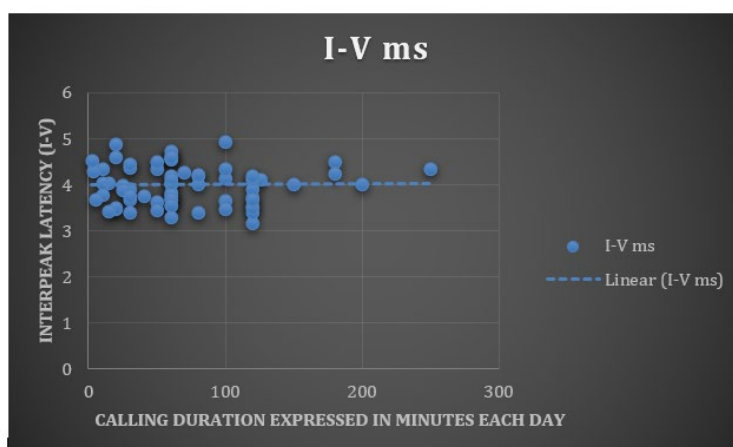
Correlation between Wave III Latency and Calling Duration expressed in minutes each day



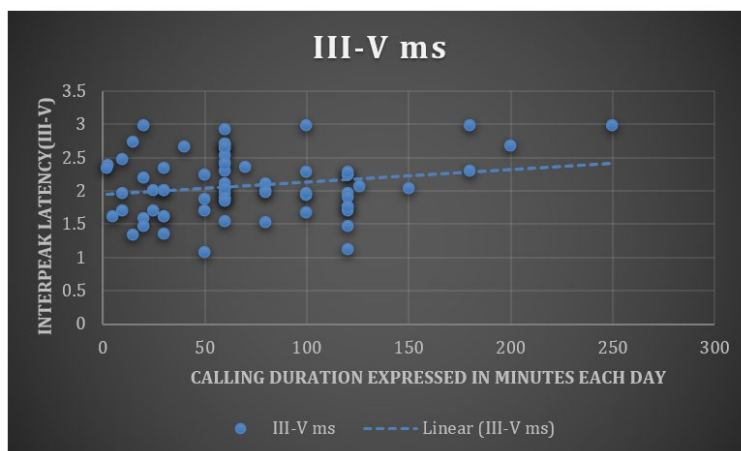
Correlation between Wave V Latency and Calling Duration expressed in minutes each day



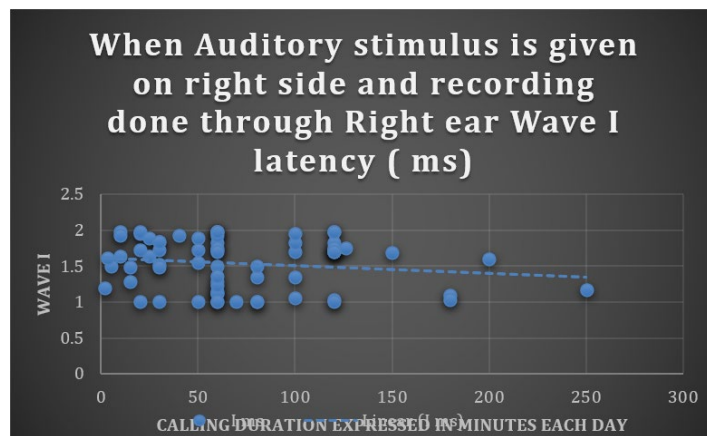
Correlation between I-III Latency and Calling Duration expressed in minutes each day



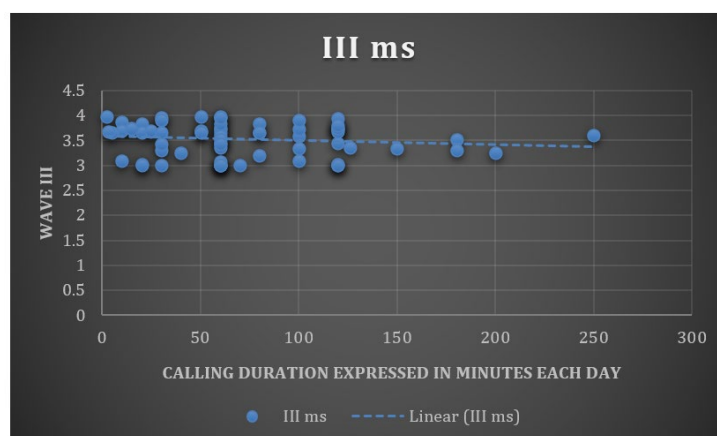
Correlation between Wave I-V Latency and Calling Duration expressed in minutes each day



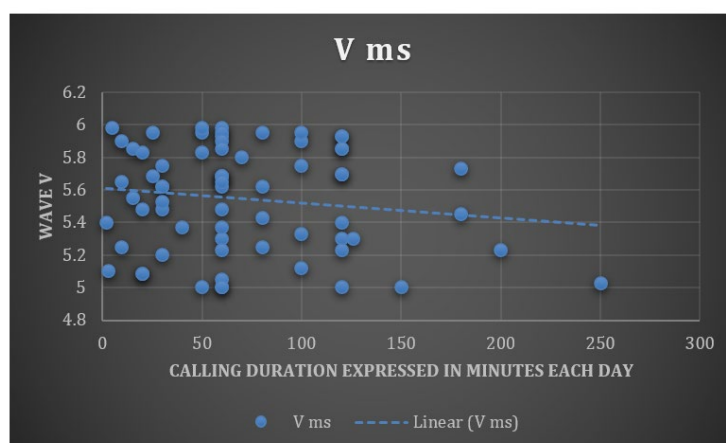
Correlation between Wave III-V Latency and Calling Duration expressed in minutes each day



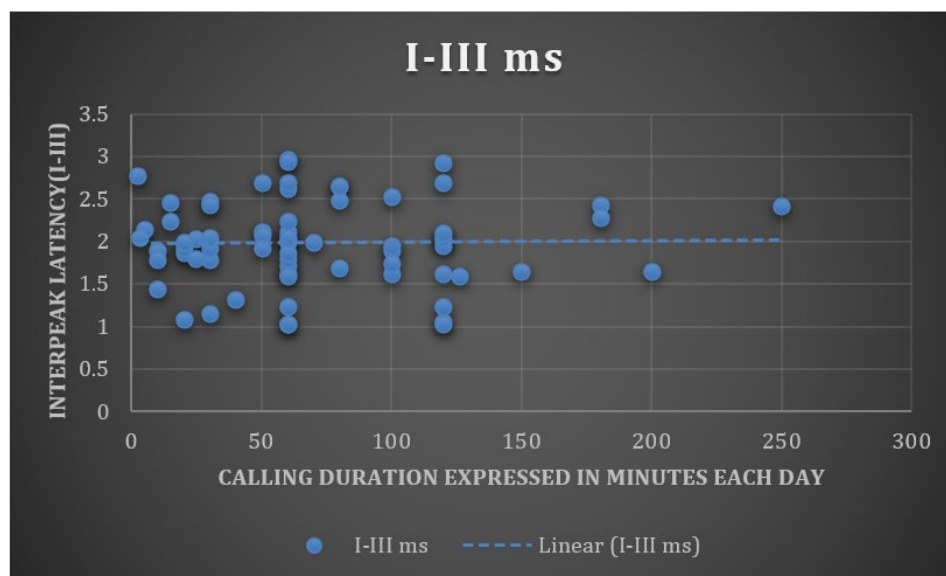
Correlation between Wave I Latency and Calling Duration expressed in minutes each day



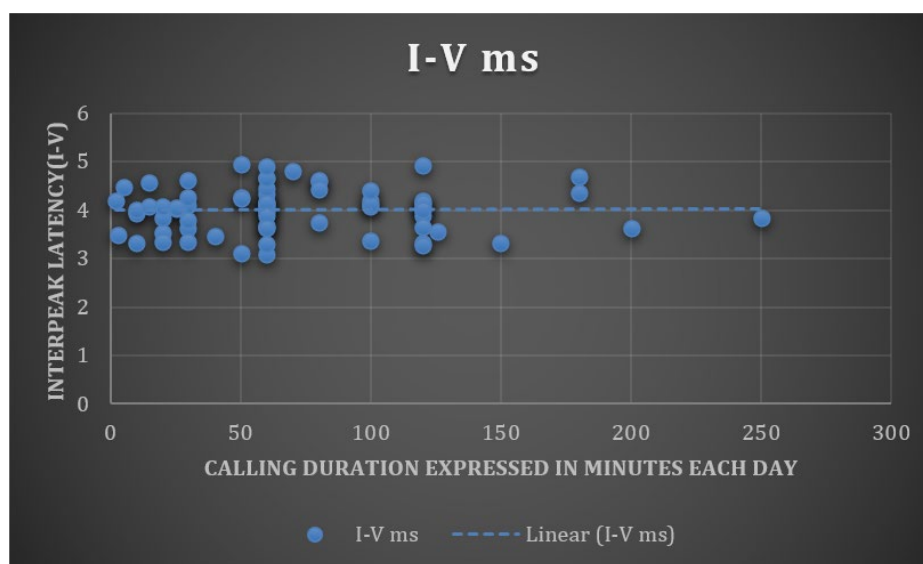
Correlation between Wave III Latency and Calling Duration expressed in minutes each day



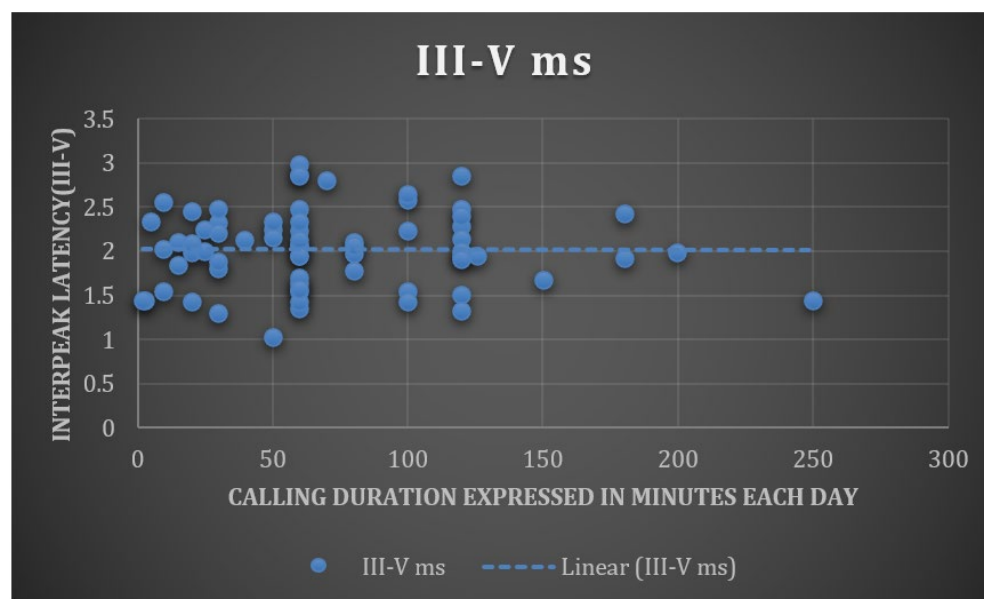
Correlation between Wave V Latency and Calling Duration expressed in minutes each day



Correlation between Wave I- III Latency and Calling Duration expressed in minutes each day



Correlation between Wave I-V Latency and Calling Duration expressed in minutes each day



Correlation between Wave III-V Latency and Calling Duration expressed in minutes each day

DISCUSSION

This study aimed to investigate the relationship between mobile phone usage characteristics and auditory brainstem response (ABR) parameters in young adults. The main finding was a statistically significant positive association between daily call duration and Wave I latency. A significant positive association was found between daily calling time and Wave I latency ($\rho = 0.292$, $p = 0.016$) indicating that extended mobile phone use was commonly associated with increasing Wave I latencies. The length of daily calls was not significantly correlated with Wave III latency, Wave V latency, and the interpeak latencies I-III, I-V, and III-V.

The first wave of the Auditory Brainstem Response (ABR) is generated in the distal part of the auditory nerve as a marker of peripheral auditory neuronal transmission. Prolonged latency of Wave I may be suggestive of slight alterations in auditory nerve function. Wave I has been identified as the first measurable component of the auditory brainstem response (Hall and Hood 1998) and is particularly sensitive to failure of the auditory nerve.^{1,2} The positive association between daily mobile phone use and Wave I latency may reflect a minor effect of prolonged mobile phone exposure on the peripheral auditory nerve conduction.

Significant effects were seen for Wave I delay but not for Waves III and V. Wave III is largely generated in the cochlear nucleus and superior olivary complex, and Wave V in the lateral lemniscus and inferior colliculus. The absence of robust associations with Waves III and V indicates that the electrophysiological changes that are recorded are likely to be localized to the peripheral auditory pathway and not the whole brainstem auditory system. This notion is further supported by the lack of significant correlations for interpeak latencies (considered markers of central auditory conduction).

Also, the present investigation did not find any significant correlations between length of cell phone use and ABR parameters. Wave I ($\rho = 0.108$) and Wave III ($\rho = 0.160$) both had weak positive associations, but none were statistically significant. Likewise, weak negative correlations were seen for Wave V and the interpeak latencies, although again these relationships were not significant. These statistics imply that the duration of mobile phone use in years may not be a good proxy for biological exposure. People may carry cell phones for similar periods of time but use them in quite different ways. Thus, the length of daily exposure might be a more important measure for exposure of the auditory system than the length of ownership alone.

The present findings are somewhat consistent with previous studies reporting slight hearing changes in heavy mobile phone users.

Oktay and Dasdag³ reported the results of auditory changes in frequent cellular phone users and concluded that long-term exposure may affect auditory function⁴. Panda et al. reported auditory changes in mobile phone users while Hegde et al. observed prolonged certain ABR features in those with increased mobile phone use.^{5,6} These studies support the hypothesis that electrophysiological measures can detect early brain changes even before the appearance of clinical signs of hearing loss.

The number of discoveries in Wave I is physiologically plausible. Since mobile phones are held close to the external ear and the auditory nerve, any potential consequences of exposure to radiofrequency electromagnetic fields are expected to be manifested in peripheral auditory structures before affecting more central auditory pathways. Thus, the significant association observed in Wave I but not in later ABR components may represent an early electrophysiological index of exposure.

However, the literature is still inconsistent. No significant effect of cell phone exposure on ABR parameters has been shown in several studies. Arai et al.⁷ did not find any significant changes in auditory brainstem responses (ABR) after mobile phone exposure and Stefanics et al.⁸ did not find any quantifiable differences in ABR after GSM exposure. Methodological heterogeneity, differences in exposure measurement, and variability in assessment of electrophysiological outcomes have led to inconclusive conclusions in systematic evaluations by Valentini et al. and Kwon et al.^{9,10}

The association coefficient for Wave I delay was moderate ($\rho = 0.292$), but statistically significant. The traditional understanding is that this means a small beneficial effect. Cell phone exposure therefore explains just a small amount of the variance in Wave I latency. There are probably a multitude of biological, environmental and genetic factors affecting auditory neuronal transmission. However, even small electrophysiological alterations may be meaningful as they can indicate early functional changes that occur prior to clinically detectable auditory dysfunction.

There are many strengths to this study. ABR is an objective, reproducible test of the integrity of the auditory system, and is less subject to participant bias than are subjective hearing tests. Moreover, the combination of different exposure indicators allowed the assessment of both exposure intensity and duration. The fact that the daily time of calling was more significantly correlated with the ABR characteristics than the duration of mobile phone ownership suggests that it is more important to evaluate the real exposure behavior than the duration of ownership.

Many limitations must be acknowledged. This is a cross-sectional design, thus no causal inference can be made. Data on mobile phone use were self-reported and subject to recollection bias. The study did not assess the preferred ear for phone use, handedness or the specific absorption rate (SAR) properties of certain gadgets. The large number of statistical comparisons made increased the probability of a type I mistake. The sample size may have been a limitation to discover weaker associations.

A significant positive association between daily mobile phone use and delay of Wave I was detected in the present investigation, suggesting that prolonged mobile phone exposure can affect the conduction of the peripheral auditory nerve. No significant connections were found for the central auditory conduction features and the duration of mobile phone use in years. The results suggest that the intensity of exposure may be more important than the duration of ownership in shaping auditory electrophysiological responses. Further longitudinal investigations with objective exposure measures and larger sample sizes are needed to clarify the therapeutic relevance of these findings.

LIMITATIONS

There are various limitations to the present study that should be addressed when interpreting the findings.

First, the cross-sectional study design limits the capacity to establish a causal association between mobile phone usage and ABR alterations. There were strong connections but it is not possible to say if the exposure to the cell phone itself caused the changes in auditory nerve conduction.

Second, the parameters of mobile phone use, such as daily calling time and time of use, were based on self-reported information. Such data are subject to recall bias and may not correctly reflect actual exposure. Objective measurements, such as call records or smartphone usage logs, could provide more credible estimates of cumulative exposure.

Thirdly, the study did not analyze parameters such as preferred ear for phone use, handedness, use of earphones or speaker mode, and specific absorption rate (SAR) values for individual mobile devices. These variables may change the degree of exposure of the auditory system and may potentially affect ABR parameters.

Fourth, some ABR variables were subjected to multiple correlation analyses increasing the probability of type I error. We found a statistically significant association between daily calling duration and Wave I latency, although we cannot totally rule out a false positive.

Fifth, the sample size might have restricted the power to detect weaker relationships between mobile phone exposure and ABR characteristics. Larger investigations may be needed to detect minor electrophysiological effects.

Finally, the observed correlation coefficient was rather weak, showing that exposure to mobile phones accounts for only a tiny amount of variability in ABR latencies. Other biological, environmental and lifestyle factors not analyzed in the current study might possibly modify auditory neural conduction properties.

Future prospective research with bigger sample size, objective exposure assessment, ear-specific usage patterns and detailed electrophysiological testing are needed to elucidate long-term implications of mobile phone use on auditory function.

SUMMARY

The current study examined the link between mobile phone usage features and auditory brainstem response parameters in young adults. A strong positive connection was found between daily calling duration and Wave I latency ($\rho = 0.292$, $p = 0.016$) indicating that greater daily use of mobile phones may be related with mild lengthening of peripheral auditory nerve conduction.

No significant relationships were found between the duration of mobile phone use measured in years and any of the absolute or interpeak ABR latencies. Similarly, no significant relationships were observed for Wave III latency, Wave V latency, or central auditory conduction parameters represented by interpeak latencies.

The results suggest that the intensity of exposure, as measured by the length of daily calls, may be more important than the number of years of ownership or use when considering possible auditory impacts of mobile phone use. The observed changes were limited mostly to Wave I latency suggesting that any potential impacts are likely limited to the peripheral auditory pathway rather than the central auditory brainstem components.

The connections found were minor, but the results indicate the need for more studies on the auditory impacts of long-term mobile phone use. Further large-scale prospective studies with objective exposure assessment and longitudinal follow-up are needed to determine the clinical significance of these electrophysiological changes and their possible implications for auditory health.

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Authorship Contribution-

Author 1: Dr. Ayushi Seth: Conceptualization, Investigation, data interpretation, and drafting of the manuscript

Author 2: Dr. Unaiza Husain: Data Interpretation

Author 3: Dr. Shweta Sinha: Drafting of the manuscript

30/10/2021

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ECR/526/Inst/UP/2014/RR-20 dt. 19.5.2020

No. Dean/2021/EC/2954

Dated: 29.10.2021

The Head
Department of Physiology
Institute of Medical Sciences
Banaras Hindu University

Dear Sir,

The Ethics Committee meeting was held on 29.10.2021 at 2:30 PM in the Chamber of the Dean, Faculty of Medicine, IMS for Ethical clearance of the MD/MS/DM/M.Ch/Ph.D/synopsis/Projects submitted by the following:

Name of the Student	Dr. Ayushi Seth
Synopsis Title	Assessment of brainstem evoked auditory potentials in Smartphone (UMTS-Universal mobile telecommunications services) users
Suggestions/Comments	-
Remarks	The Synopsis is approved by the Institutional Ethics Committee

This is for your information and necessary action at your end.


(DR. KIRAN GIRI)
MEMBER SECRETARY

Yours sincerely,


(PROF. V. BHATTACHARYA)
CHAIRPERSON OF THE ETHICAL COMMITTEE

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Participant's Consent - Full and detailed consent from the participant has been taken. The participant's identity has been adequately anonymized. If anything related to the participant's identity is shown, adequate consent has been taken from the participant. The journal will not be responsible for any medico-legal issues arising out of the issues of the patient's identity or any other issues arising from the public display of information.

Conflict of Interest Statement - None

Funding Statement - Not Applicable

REFERENCES

- [1] Goldstein R, Aldrich WM. Evoked Potential Audiometry: Fundamentals and Applications. Allyn & Bacon; 1999.
- [2] Hood LJ. Clinical applications of the auditory brainstem response. Singular; 1998.
- [3] Møller AR. Hearing: Anatomy, Physiology, and Disorders of the Auditory System, Third Edition. Plural Publishing; 2012.
- [4] Oktay MF, Dasdag S. Effects of intensive and moderate cellular phone use on hearing function. Electromagnetic Biology and Medicine [Internet]. 2006 Jan 1;25(1):13–21. Available from: <https://doi.org/10.1080/15368370600572938>
- [5] Panda NK, Modi R, Munjal S, Virk RS. Auditory changes in mobile users. Otolaryngology [Internet]. 2011 Feb 14;144(4):581–5. Available from: <https://doi.org/10.1177/0194599810394953>
- [6] Shenoy V, Hegde M, Kamath P, Rao R, Prasad V, Varghese B. Mobile phones: Its effect on hearing. Indian Journal of Otology [Internet]. 2013 Jan 1;19(3):122. Available from: <https://doi.org/10.4103/0971-7749.117480>
- [7] Maganioti AE, Chrissanthi HD, Charalabos PC, Andreas RD, George PN, Christos CN. Cointegration of event-related potential (ERP) signals in experiments with different electromagnetic field (EMF) conditions. Health [Internet]. 2010 Jan 1;02(05):400–6. Available from: <https://doi.org/10.4236/health.2010.25060>
- [8] Stefanics G, Kellényi L, Molnár F, Kubinyi G, Thuróczy G, Hernádi I. Short GSM mobile phone exposure does not alter human auditory brainstem response. BMC Public Health [Internet]. 2007 Nov 12;7(1):325. Available from: <https://doi.org/10.1186/1471-2458-7-325>
- [9] Valentini E, Ferrara M, Presaghi F, De Gennaro L, Curcio G. Systematic review and meta-analysis of psychomotor effects of mobile phone electromagnetic fields. Occupational and Environmental Medicine [Internet]. 2010 Sep 13;67(10):708–16. Available from: <https://doi.org/10.1136/oem.2009.047027>
- [10] Kwon M, Jääskeläinen SK, Toivo T, Hämäläinen H. No effects of mobile phone electromagnetic field on auditory brainstem response. Bioelectromagnetics [Internet]. 2009 Jul 16;31(1):48–55. Available from: <https://doi.org/10.1002/bem.20526>