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CONTENTS

AUDITORY AND NON-AUDITORY EFFECTS OF CONSISTENT-USE OF MOBILE-TELEPHONE IN IBADAN-OYO STATE, NIGERIA

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Abstract
Consistent exposure to sound generated by mobile phone have continued to pose threat on the human hearing functions. Adolescents are more likely than any other group to utilize the device for music playing functions, continued calls and other numerous functions. Thus, this study therefore, investigated the auditory and non-auditory effect of consistent-use of mobile telephone among adolescents in Ibadan Metropolis. The study adopted an ex-post facto research design. The sample of the study comprised 500 participants purposively selected. Data were analyzed using percentage, frequency and chi-square. The findings indicated that 11% of the participants had a notched hearing pattern, while 46.6% had a rising hearing pattern. 14.6% of the participants claimed having ear pain after the use of mobile phone for calls and other listening purposes, while 12.6 % claimed having headache after prolong use of mobile telephony for music playing functions. The findings indicated that a number of the participants experienced both auditory and non-auditory problems due to consistent exposure to noise emanated from mobile phone. Based on the findings, it was recommended that prolong use of mobile phone especially for listening purpose and music playing functions should be reduced. Also, awareness campaigns on the dangers of consistent-use of mobile telephone should be instituted.

Key words: *Auditory and non-auditory problem, Mobile telephone, Noise exposure, Music playing functions.*

Introduction

Hearing loss has emerged has a public concern especially among adolescents as approximately 36 million American young adults suffer from hearing loss due to the recent increase in technology usage particularly mobile phones with one in three developing their hearing loss as a result of exposure to noise (American Academy of Audiology, 2010). In 2006, nearly one in five adolescents and young adults ages 12-19 suffered from hearing loss, most of these youths suffer from bilateral high-frequency hearing loss caused by noise exposure (National Adolescents and Young Adult Health Information Centre, 2014). The incidence of hearing loss is worse in developing countries, with Nigeria at the forefront. The problem is that the prevalence of smart phones, cell phones, headphones and ear buds is unloading a daily assault on human hearing, and for some people the damage being inflicted today would not be evident for years. Constant usage of mobile phones has been found to have endangering effects on the health status of human as it has been linked to brain cancer, insomnia and more importantly, hearing loss. (Youssuf Mansour and Abdulsalam 2016).

Public mobile telephony history began in the 1940s after the World War II; although primitive mobile telephones existed before the war, these were specifically converted two way radio used by the government or big corporation, with calls patched manually into landline telephone network (Farley, 2005). Specifically, the concept of cell phones began in 1947, when researchers looked at mobile car phones and realized that by using small cells (range of service area) with frequency reuse, they could increase the traffic capacity of mobile phones substantially (Thanga, 2010). However, at that time, the technology to do so was not available. The introduction of smart phones has introduced a number

of features such as internet browsing, gaming, video calls and so on. Cell phones have different uses for different people, but sending text messages and taking pictures or video are the most popular activities among mobile owners (Pew Research Centre, 2015) as well as for numerous listening purposes.

The last decade has seen an increase in the use Personal Music Players (PMPs) with around 200 million PMPs sold in Europe between 2004 and 2007 alone (Green Facts, 2008). However, in the last five years there has been a plunge in the sales of PMPs as they are now being replaced by multi-functioning high end mobile phones as these mobile phones also do a lot than serve as a device for communication. The music playing function from these mobile phone devices have become so sophisticated in the sense that they produce the same decibel of sound and musical quality as instruments used in concerts, parties and poise as much harm to human health and their hearing functions. The inclusion of entertainment features in mobile phones such as the music playing features, gaming functions, video calls and a bottomless barrel of mobile application that creates wide array of choices for users have made this device not just a tool for end-to-end communication but a means for continued entertainment. The multiplicity of functions of the modern mobile phone have made the devices even more addictive, enticing and compelling for users especially adolescent who are still in the quest for self-identity and have a lot of free time on their plate to navigate these devices.

Excessive exposure to noise exposure and a single exposure to extremely intense sound, causes damage to the auditory system and results in poor auditory function, termed noise-induced hearing loss. The hearing loss is usually slow in onset but progresses relentlessly for as long as the exposure continues. Indeed, the harmful effects may continue long after noise exposure has ceased; as they are irreversible (WHO, 2015). Noise induced hearing loss in humans commonly begins in high frequency sounds around 4 KHz, regardless of the frequency content of noise and this noticeable with the dip-notch specifically at 4KHz on the audiogram. With continued exposure, the threshold at 4 KHz worsens and the hearing loss spreads to involve higher and lower frequencies (Barbara and Harding, 1999). Exposure to moderate-intensity noise for several minutes or hours initially results in a Temporary Threshold Shift (TTS) only (Barbara et al, 1999). If thresholds are measured after the individual has been away from the noise for 18-24 hours, his/her thresholds will have returned to pre-exposure levels.

According to WHO (2015), the damage caused to the cochlea by loud sounds occurs by two means; Mechanical destruction; Regular exposure to loud sounds causes the hair cells to lose rigidity and thus their ability to work effectively. This change occurs over time until the sensory cells are eventually destroyed and are no longer able to carry out their function. Intense metabolic activity at cellular level; A higher level of energy is required by hair cells during periods of intense exposure to loud sounds. The consequent increased consumption of oxygen generates raised levels of free radicals in the cochlea. The ear's antioxidant defense mechanism is unable to cope with these levels and free radicals cause death of cell.

Global System for Mobile Communication (GSM) and Code Division Multiple Access (CDMA) mobile phones operate in the range of about 800 to 900 MHz (Prajapati, Bhikhu, Gami and Thakor, 2015). The volume of the sound emitted by mobile devices varied from manufacturer to manufacturer, and it is difficult to estimate. Fligor and Cox (2004) tested some devices by different manufacturers and style of headphones. The researchers found that free field equivalent sound pressure levels measured at maximum volume control setting ranged 91 dB (A) to 121 dB (A). Consistent use of Personal Music Playing Functions (PMPFs) through the use of mobile phone has been observed as one of the causative or health-risk factors causing hearing loss among users across the globe.

In 2013, the findings of a study conducted in South Korea concluded that excessive Smartphone use can cause physical health-related problems such as blurred vision and pain in the wrists or neck (Kwon, Lee, Won, Park, Hahn, Xinyu, and Kim, 2013). Similarly, headache complaints were significantly higher among high Smartphone users than the low Smartphone users, with a high prevalence of analgesic use among mobile phone compared to non-users (Demirci, Demirci and Akgonul, 2016). Although no official diagnostic criterion for Smartphone addiction, however when an individual utilizes the device to the extent that it disturbs daily life, such person can be said to be Smartphone addicted. In severe cases, consistent exposure to noise from mobile phone has been suspected to result in adverse conditions like

tinnitus and in more sensitive individuals, non-ionizing electromagnetic radio frequency radiation generated by mobile phones have been linked to symptoms like headache, dizziness, fatigue, memory impairment, sleep disorders, anxiety, myalgia, arthralgia, tearing, hearing loss, and but research data are limited especially in developing countries like Nigeria.

These identified problems and deficient research on the auditory and non-auditory effect of mobile telephone have not only made it difficult for researchers, scholars to engage in meaningful study in this area but also left a huge gap in the literature on hearing loss. Hence, this study is designed to examine the auditory and non-auditory effects of mobile telephone in Ibadan, Oyo State Nigeria.

Purpose of the Study

The main purpose of the study is to determine the auditory and non-auditory effects of consistent-use of mobile telephone users in Ibadan, Oyo State.

Research Questions

The following research questions were raised to guide the study;

1. What are the hearing patterns of consistent mobile phone users?
2. What is the prevalence of Adolescents with Ear pain problem due to consistent-use of mobile phone?
3. What is the prevalence of headache (other associated) problem due to consistent-use of mobile phone?
4. Are there any association between gender differences and the effects of mobile phones usage on hearing?

Research Design

An expost facto research design was adopted for this study. This is because the independent variables already exist and requires no manipulation.

Population

The main population for this study was mobile phone users residing in Ibadan North and Akinyele Local Government.

Sample and Sampling Technique

The five hundred participants (male and female) involved in this study were randomly selected from chosen areas of Ibadan North and Akinyele Local Government. 150 (30%) respondents were sampled within Ring road, 250 (50%) from Agbowo, 50 (10%) from Sango area and 50 respondents (10%) from Agodi gate (see table 1).

Instrumentation

The following instruments were utilized for data collection:

1. Otoscope
2. Audiometer (Maico ST 20 Model)
3. Auditory and Non Auditory Effect of Mobile Telephone Questionnaire

Otoscope

It is a hand held device with a light source and a magnifying simple low power with a disposable plastic ear specular. It is used to view through the ear canal down to the tympanic membrane (ear drum) in order to rule out presence of ear wax or any other pathology of the outer ear that may affect audiometric performance.

Maico ST 20 model audiometer

It is used to determine the auditory performance of participants across 250Hz to 8000Hz frequency and -10dB to 100dB intensity level. Maico (ST20) screening audiometer has a sound generating source, an amplifier to increase the intensity signal, interrupter switch, Headphones and an on and off switch. Audiogramme which is a graphical representation of hearing ability was used to determine the auditory performance of the people across frequency and intensity. It also indicates how an individual perceives sound signal. An "O" is used to represent responses for the right ear and "X" is used to represent responses for the left ear.

Auditory and Non Auditory Effect of Mobile Telephone Questionnaire

The questionnaire used was self developed scale to elicit responses from the respondents. The research scale has six sections including Section A: Demographic Information, Section B: Use of mobile phones, Section C: Mobile phones, Auditory and Non-Auditory Effects.

Method of Data Analysis

The data collected in the study were analysed using

descriptive statistics of frequency counts and percentage and inferential statistics of chi-square.

Procedure

A total of 532 questionnaires were distributed to the participants in selected areas of Ibadan North and Akinyele Local Government but only 500 copies were retrieved. Informed consent of all participants was obtained by attaching a consent form to the questionnaire which was to be duly signed by all willing participants. The participants had no history of disease. Also, all participants were asked to fill out their information on gender, age, daily smartphone usage, average number of hours spent on smartphone per day, the number of smartphones used, and purpose for which the smartphone is used. Participants who indicated poor auditory performance which can be traced to the use of mobile telephone usage, where clerked and further assessed using an Otoscope to assess their auditory canal and state of their tympanic membrane. After otoscopy, audiometry was performed to assess their air conduction and bone conduction.

Results

Table 1: Sex Distributions of Respondents

Sex	Frequency	Percentage
Male	239	47.8
Female	261	52.2
Total	500	100

239(47.8) male and 261(52.2) female respondents were involved in the study

Table 2: Age Distributions of Respondents

Age (In years)	Frequency	Percentage
18 and below	200	40
19-45	250	50
46 and above	50	10
Total	500	100

200 (40%) respondents were within the ages of 18 and below, while 250 (50%) within 19 and 45, and 50 (10%) respondents within the ages of 46 and above. At Least About 88% of the respondents have been using their mobile phone between 4-6years. Only 10 (just 2%) of them have only used their mobile phone for less than six 6 months while 29.5% have been using their phone for the minimum of a year.

Answering the Research Questions

Research Question 1: What are the hearing patterns of consistent mobile phone users?

Table 3: Frequency distribution showing the hearing pattern of mobile phone users

Hearing Pattern	Frequency	Percentage (%)
Flat	210	42
Notched	55	11
Rising	233	46.6
Slopping	2	0.4
Total	500	100

Table 4: Frequency distribution showing degree of hearing of mobile phone users

Degree of Hearing	Frequency	Percentage (%)
Normal Hearing	200	40
Mild Hearing loss	23	4.6
Moderate Hearing loss	14	2.8
High Frequency Hearing loss	226	45.2
Low Frequency Hearing loss	37	7.4
Total	500	100

Data from table 3 above revealed that 210(42%) participants hearing pattern was flat, 55(11%) with a Notched hearing pattern, 233(46.6%) with a rising hearing pattern and 2 (0.2%) with slopping pattern. Pure-Tone Audiometry result indicated that 200(40%) participants were within the range of normal hearing, 23(4.6%) with mild hearing loss, 14(2.8%) with moderate hearing loss, 226(45.2) with high frequency hearing and 37(7.4%) with low frequency hearing loss.

Research Question 2: What is the prevalence of adolescents with Ear pain problem due to consistent-use of mobile phone?

Table 4: Frequency distribution showing the prevalence of Ear pain among constant users of mobile telephony

Items	YES		NO	
	Frequency	%	Frequency	%
After using mobile phone for calls and other listening purposes do you normally feel pain in your ear	77	15.4	423	84.6

Table 4 reveals that only 73 (14.6%) of the respondents constantly feel pain in their ears after the use of mobile phone for calls and other listening purposes, while 427 (85.4%) do not experience such pain.

Research Question 3: What is the prevalence of Adolescents with headache (other associated) problem due to consistent-use of mobile phone?

Table 5: Frequency distribution showing prevalence of adolescents with headache and other related problem due to mobile phone usage.

Items	YES		NO	
	Frequency	%	Frequency	%
After using telephone for calls and other listening purposes, do you normally have headache	63	12.6	437	87.4
I feel irritated(disturbed) when using mobile phones	57	11.4	443	88.6

Table 5 indicates that 63(12.6%) of the respondents experience headache after the use of mobile phones, while the majority (437) 87.4% do not experience such even after the use of mobile phone. Also, 57 (11.4%) feel irritated (disturbed) when using mobile phones for calls, while 443 (88.6%) do not feel irritated after mobile phone use.

Research Question 4: Are there any association between gender differences and the effects of mobile phones usage on hearing?

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.070[a]	2	.079
Likelihood Ratio	5.161	2	.076
Linear-by-Linear Association	2.152	1	.142
N of Valid Cases	438		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.34.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	-.111	.080	-1.472	.143[c]
Ordinal by Ordinal	Spearman Correlation	-.120	.080	-1.596	.112[c]
N of Valid Cases		438			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.
c. Based on normal approximation.

There is no significant association (p>.0.05) between the respondents' gender and diagnosis of hearing loss. This implies that gender was not associated significantly with hearing loss diagnosis and as such whether the adolescents sampled in Ibadan metropolis are male or female was neither a significant determinant nor interrelated with diagnoses of hearing loss

Discussion of Findings

Research Question 1: What are the hearing patterns of consistent mobile phone users?

The results of the findings showed that 46.6% had a rising hearing pattern and 45.2% with high frequency hearing loss. The findings of this research work corroborated the study of Philip, Bhandary, Aroor and Pratap (2017) in which there was a significant difference between the experimental group who used mobile phone for more than 1 hour per day with their result showing significant absence of OAE in high frequency loss compared to the control group – a dominant feature of a rising hearing pattern. The findings were also similar to the study of Das, Chakraborty and Mahanta (2017) which showed a significant difference in average air conduction and bone conduction frequencies between the exposed and non-exposed ear of a frequent mobile phone user.

Research Question 2: What is the prevalence of Adolescents with Ear pain problem due to consistent-use of mobile phone?

The findings of the study revealed 73 (14%) respondents as having constantly felt pain after long hour usage of mobile telephone and 85.4% (427) do not experience such. This showed that majority of participants do not feel any pain in their hearing organ owing to the use of mobile phone. This study is in line with findings of Mohan and Prashant (2014) which shows there is little to no correlation between the use of mobile phone and ear pain, where about 18% participants had ear ache from the use of the device.

Research Question 3: What is the prevalence of Adolescents with headache (other associated) problem due to consistent-use of mobile phone?

The findings revealed that just a few participants witness headache after the use of mobile phones while the vast majority do not experience such. Specifically, 63 (12.6%) constantly experience headache as result of consistent usage of mobile telephone and 437 (87.3%) do not experience such. Also, 57 (11.4%) feel disturbed and irritated when using mobile phones for calls, while 443 (88.6%) do not. This study is in line with the findings of Muralikrishna (1995) that admitted that loud noise is capable of causing annoyance, physiological problems, poor human performance, sleeplessness and thereby inducing the people to become restless, loss concentration and presence of mind during their activities. Also, the study correlates with the findings of Alghamdi and Taha (2014) conducted among primary care attendees in 2014 were only 15% of the

participant were found having headache among subjects tested.

Research Question 4: Are there any association between gender differences and the effects of mobile phones usage on hearing?

From the findings of this study, it can be said that there was no significant association gender and diagnosis of hearing loss. The result of this finding is similar to the study conducted among adolescent users of music playing devices in Iran which shows that the history of hearing impairment among female and male was similar (Ansari, Rostami, Maleki, Hassan, and Kourosh, 2014). This study shows that gender does not have an effect on the hearing function of mobile phone users and any noticeable difference is rather endogenous. The finding of the study also correlates with that ofPhilip et al. (2017) were hearing loss was equally present in both male and female users of mobile telephone.

Conclusion

Over the years, mobile phones have become devices of entertaining value. With the infusion of multiple functions such as games, radio, internet browsing among others; these portable devices have become more enticing. Surfing through variety of features of these nifty devices, users listen to music and radio programmes and watch videos while others make long hour calls in an attempt to 'make time go faster'. However, prolonged sound exposure from mobile may be capable of causing damage to the auditory function. Headache, sleep disturbances are some of the most common non-auditory effects of mobile telephone have also been linked to consistent usage of mobile telephone; these conditions can affect the productivity of mobile telephone users. Although this study could not establish a direct link between conditions like headache and other associated conditions, longitudinal studies into the use of hands-free devices and the effect of high-frequency hearing loss have shown that all these have a deterring effect on the human hearing organ and the general well-being of the affected. Prolong exposure to the sound generated from the device are particularly harmful. For a better understanding, control measures on the risk of consistent-use of mobile phone on hearing pattern further research is needed on the long-term auditory and non-auditory effect of consistent mobile phone usage. The impact of mobile telephone on hearing as well its non-auditory effect should be consistently monitored through longitudinal studies.

Recommendation

Based on the findings of the study, it is therefore necessary to recommended as follows:

1. While using mobile phones and hands free for phone calls and other listening purposes, users should be encouraged to avoid tuning up to high volume, for this will damage the sensitive hair cells which must be perfect for normal auditory functions.
2. Rigorous campaign should be set up by governmental agencies and other related institutions as well as NGOs to educate mobile phone users on the dangers of consistent usage of the device, and the consequent implication on auditory functions
3. The general public should be encouraged to always go for hearing assessment to determine their hearing pattern and sensitivity on regular basis so as to detect early, any changes along their auditory performance.
4. Prolong use of the device for listening purposes should be avoided and users should make use of hands-free minimally (such as earpiece) to keep the device away from the head as mobile phones have been found to generate electromagnetic radiation which long term effect has been found to include loss of hair cells in the ear, high-frequency hearing loss as well as absence of OAE.

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