Original Article

Prevalence, Awareness, and Factors Associated with Noise-induced Hearing Loss in Occupational Motorcyclists in Southwestern Nigeria

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ABSTRACT

Background: There is generally a lack of awareness among professional motorcycle riders on the risk of noise-induced hearing loss; due to a variety of factors, they are exposed to by the nature of their job. This study, therefore, aimed to determine the prevalence, awareness, and factors associated with noise-induced hearing loss among motorcycle riders in Ido-Ekiti, Ekiti State, Nigeria. **Methodology:** A cross-sectional descriptive study was conducted between February and March 2019 among 420 motorcycle riders in Ido-Ekiti, Ekiti State, Southwestern Nigeria. Data analyses were performed using the SPSS software version 20. $P \leq 0.05$ was considered as statistically significant. Three hundred and sixty of the total of 420 consented for pure-tone audiometry which was done to assess their hearing thresholds. **Results:** Majority of the respondents had at least a secondary level of education. About 14.5% of the total study population had hearing loss, among which 15% also reported an accompanying ear discharge. All of the respondents did not have any history of hearing loss before they started the occupation. More than half of the study population was aware of noise-induced hearing loss and was able to link it to their profession. None of the study participants used a hearing aid, but 17.9% reported using ear mufflers and 16.2% used earphones while riding. **Conclusion:** Majority of our respondents had secondary school education and 14.5% of the total study population reported hearing loss, among which 15% also reported an accompanying ear discharge. Furthermore, more than half of the study population was aware of noise-induced hearing loss and was able to link it to their profession, whereas 50% agreed that their occupation placed them at risk of hearing loss.

KEYWORDS: *Hearing loss, motorcyclists, noise, occupation, sensorineural*

INTRODUCTION

Hearing loss is a frequently encountered problem arising from a variety of etiological causes. A common etiology appreciated in the day-to-day settings is noise exposure, which over time can ultimately impact our ability to hear. Perpetual exposure to loud noises can result in high-frequency sensorineural hearing loss. Since the 19th century, motorcycles have been around as a mode of transport, and more recently have been associated with precarious levels of noise-induced hearing loss.[1] In Ekiti state, motorcycle riding is a major source of livelihood for many individuals who are unable to secure government jobs. This risk originates from two sources, namely the motorcycle engine and the wind rushing past a motorcycle rider's ears. In this article, we intend to shed light on the hazard of hearing the loss in occupational motorcyclists with a focus on its mechanisms and methods to mitigate its occurrence.

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METHODOLOGY

Study area

The study was conducted in Ido-Osi Local Government Area (LGAs) of Ekiti State in Nigeria, which was located in the South western part of the country. Ekiti

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State has 16 LGAs and three senatorial districts: Ekiti South, Ekiti Central, and Ekiti North senatorial districts. Ido-Osi is one of the LGAs in Ekiti North senatorial district of the state its headquarters is in Ido town. There are 11 other communities in Ido-Osi LGA in addition to Ido town which is the headquarter of the LGA.

A cross-sectional descriptive study was conducted between February 2019 and March 2019 among 420 motorcycle riders in Ido-Ekiti, Ekiti State, Southwestern Nigeria. A sound level meter was used which read more than 80 dBA at different points in the parks as well as when selected number of the participants were riding their motorcycles. Noise levels in excess of 91 dBA were recorded for motorcycles traveling at 75 mph.

A simple random sampling technique by balloting was performed from the list of motorcycle riders in the motorcycle riders' parks in Ido-Ekiti. A pretested semi-structured self-administered questionnaire was designed to collect the data which was entered into the computer software and analyzed using the SPSS software version 20 (SPSS Version 25, IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). $P \leq 0.05$ was considered as statistically significant. The pretest was done in Ado-Ekiti, State capital of Ekiti State to test for its viability and reliability using 10% of sample size.

A minimum sample size was calculated using the formula for cross-sectional study,

$$N=\frac{Z^2pq}{d^2}$$

The prevalence of existing noise-induced hearing loss among motorcycle riders was assumed at 50%[2] and a bound on error of ±5%, precision level of 0.5, and confidence level of 95%. An upward adjustment for 10% to account for nonresponse and inappropriate entries, gave a sample size of 420 motorcycle riders for the study.

Three communities were selected of the 12 communities that formed the LGA by simple random sampling using the table of random numbers. The communities selected were Ido-Ekiti, Ifaki-Ekiti, and Usi-Ekiti.

Ido-Ekiti has 6 parks, Ifaki-Ekiti has 4 parks, and Usi-Ekiti has 1 park. The research was conducted using motorcyclists from all the parks. The selection of participants from each pack was done using random sampling technique.

Those subjects who had history of hearing loss or found to have hearing loss on examination were asked to do Pure Tone Audiometry (PTA). The PTA result was used to confirm and classified the degree of hearing loss in each one of them. 360 of 420 motorcyclists consented for PTA to assess their hearing thresholds. The PTA was done in the audiology booth in our department. The pure tone average was calculated using the average air-bone gap at four different frequencies (500, 1000, 2000, and 4000 Hz). All had pure tone audiogram which showed the characteristic notch at 4 kHz.

The pretested semi-structured self-administered questionnaire was designed and used to collect the data which was entered into the computer software analyzed using the SPSS software version 20. Descriptive statistics were presented using frequency tables and charts. Quantitative variables such as age were summarized as a mean and standard deviation. Pearson Chi-square was used to compare two variables, and the level of significance was set at 5%.

The ethical clearance was obtained from Federal teaching hospital Ido-Ekiti (FETHI) Research Ethics Committee. The aim of the study was explained to the participants; and an informed consent of each willing participant was sought and obtained.

Results

The study revealed the maximum response rate among adults between the ages of 20–34 with least response

Table 1: Age distribution of respondents

Age group	Frequency *n*=420	Percentage
15-19	15	3.6
20-24	173	41.2
25-29	67	15.9
30-34	105	25.0
35-39	38	9.0
40-44	8	1.9
45-49	7	1.7
50 and above	7	1.7

Table 2: Educational status of respondents

Level of education	Frequency *n*=420	Percentage
Primary	23	5.5
Secondary	188	44.8
Graduate	172	40.9
None	37	8.8

Table 3: Self-reported hearing loss *n*=420

Variable	Yes	%	No	%
Presence of hearing loss	61	14.5	359	85.5
Hearing loss associated with discharge *n*=61	15	24.6	46	75.4

Table 4: Awareness of Noise induced Hearing loss

Variable	Yes	%	No	%
Are you aware of presence of noise in your park?	210	50	210	50
Are you aware that noise can cause hearing loss?	270	64.3	150	35.7
Are you aware that your job exposes you to hearing loss?	210	50	210	50
Are you aware that a person with hearing loss is at risk of RTA?	330	78.6	90	21.4

Table 5: Factors Associated with Noise induce hearing loss *n*=420

Variable	Yes	%	No	%
Use of hear muffler	75	17.9	345	82.1
Listens to music with hear-piece while driving	68	16.2	352	83.8
Hearing assessment done before?	30	7.1	390	92.9
Is it important to have hearing assessment done?	75	17.9	345	82.1
Would you want to test your hearing	45	10.7	375	89.3
Do you use hearing aids	0		420	100
Had RTI from your work before?	53	12.6	367	87.4
Are you hypertensive	45	10.7	375	89.3
Have you measured your BP before?	202	48.1	218	51.9
Ringing sensation in the ear	60	14.3	360	85.7
Previous injury in the ear?	23	5.5	397	94.5
Relative with earing problem	53	12.6	367	87.4
Period of exposure	<8.5 h	%	>8.5 h	%
Time of exposure/day	83	19.8	337	80.2

Table 6: Relationships between factors associated with noise-induced hearing loss and the prevalences

Variable	Hearing Loss		χ^2	*P*
	Yes *n* (%)	No *n* (%)		
Use of hear muffler				
Yes	19 (25.3)	56 (74.7)	8.594	0.003
No	42 (12.2)	303 (87.8)		
Listens to music with hear-piece				
Yes	17 (56.7)	13 (43.3)	46.220	<0.001
No	44 (11.3)	346 (88.7)		
Hearing assessment done before				
Yes	5 (11.1)	40 (88.9)	0.791	0.373
No	56 (16.2)	289 (83.8)		
Important to have hearing assessment done				
Yes	9 (12.0)	66 (88.0)	0.469	0.494
No	52 (15.1)	293 (84.9)		
You would want to test your hearing				
Yes	10 (22.2)	35 (77.8)	2.406	0.121
No	51 (13.6)	324 (86.4)		
Had RTI from your work before				
Yes	22 (41.5)	31 (58.5)	35.579	<0.001
No	39 (10.6)	328 (89.4)		
You are hypertensive				
Yes	18 (40.0)	27 (60.0)	26.350	<0.001
No	43 (11.5)	332 (88.5)		
You have measured your BP before				
Yes	22 (10.9)	180 (89.1)	4.137	0.042
No	39 (17.9)	179 (82.1)		
Ringing sensation in the ear				
Yes	26 (43.3)	34 (56.7)	46.800	<0.001
No	35 (9.7)	325 (90.3)		
Previous injury in the ear				
Yes	11 (47.8)	12 (52.2)	21.738	<0.001
No	50 (12.6)	347 (87.4)		
Relative with hearing problem				
Yes	13 (24.5)	40 (75.5)	4.832	0.027
No	48 (13.1)	319 (86.9)		
Period of exposure				
< 8.5 h	6 (7.2)	77 (92.8)	4.434	0.035
≥ 8.5 h	55 (16.3)	282 (83.7)		

*Emboldened P are significant at 0.05 level

Table 7: Frequency table showing average hearing threshold (dB) of 360 Subjects screened at higher frequencies

Hearing threshold	Audiometer *n* (%)	χ^2	*P*
< 25	117 (32.5)	0.026	0.987
25-40	107 (29.7)		
> 40	136 (37.8)		
Total	360 (100.0)		

χ^2: Chi square test

rates observed in extremes of ages, i.e., both young and the elderly [Table 1]. The major bulk of respondents were those who had at least a secondary level of education [Table 2]. About 14.5% of the total study population reported hearing loss, among which 15% also reported an accompanying ear discharge [Table 3]. An encouraging observation noted was that more than half of the study population was aware of noise-induced hearing loss and was able to link it to their profession [Table 4]. While 50% agreed that their occupation placed them at risk of hearing loss, 78.6% also reported being aware of the risk of road traffic accident (RTA) associated with hearing loss [Table 4]. While 17.9% agreed to the importance of having a hearing assessment done, only 7.1% had one done prior which were all normal. None of the study participants used a hearing aid, but 17.9% reported using ear mufflers and 16.2% used earphones while driving [Table 5]. Although 48.1% of the participants had their blood pressure recorded before only 10.7% were diagnosed hypertensive. Among the study participants, 14.3% reported tinnitus, 5.5% had prior ear injury (hearing was not affected), and 12.6% had relatives with hearing impairments. An alarming 80.2% of the study population used motorcycles for >8.5 h/day.

Among the various factors associated with the prevalence of noise-induced hearing loss, a few were found to be significantly linked. About 56.7% of those who listened to music with earpieces reported the hearing loss ($P < 0.001$), whereas 25.3% of those who used ear mufflers had a hearing impairment ($P = 0.003$) [Table 6]. 41.5% of the study group who had hearing loss reported road traffic injury (RTI) ($P < 0.001$). 40% of respondents who had hearing loss were hypertensive ($P < 0.001$), whereas only 10.9% had their blood pressure measured before ($P = 0.042$). The proportion of the study population that had hearing loss had significantly associated tinnitus in 43.3% ($P < 0.001$), previous injury to ear in 47.8 ($P < 0.001$), and 24.5% had a relative with hearing difficulty ($P = 0.027$) [Table 6]. Noise levels in excess of 91 dBA were recorded for motorcycles travelling at 75 mph. About 16.3% of the respondents that had an occupational exposure to motorcycle associated noise for >8.5 h reported hearing loss as compared to 7.2% in people with <8.5 h of exposure to motorcycle associated noise ($P = 0.035$). 32.5% (117) of the participants had normal hearing, whereas 37.8% (136) had >40db hearing threshold [Table 7].

Discussion

Noise-induced hearing loss continues to be recognized as one of the leading causes of hearing loss.[1] The World Health Organization enlists that as many as 250 million people globally have impaired hearing of moderate to high severity.[1] Among these, the top causes of hearing loss are noise, age and ear infection.[2] A short blast of loud noise is known to induce not only notable sensorineural hearing loss but can also lead to significant pain, tinnitus, and hyperacusis. This usually requires exposure to a noise level > 120–155 dB.[3] In addition to the hearing damage, exposure to loud noise can cause other adverse, including an impact on metabolism, cognition, sleep, blood pressure, cardiovascular system, mental health, and overall quality of life.[4-6]

Occupational hearing loss is a well-recognized hazard in many industries. Motorcyclists, who drive motorcycles as an essential component of their job, are referred to as occupational motorcyclists. Hearing handicap in occupational motorcyclists is a problem most eminently seeming to affect professional riders,[7] in particular, racing riders[8] and police officers.[9,10] Exposure to high noise levels may not always be overt and appreciated in all occupations such as airport ground crew.

There are several mechanisms by which excessive noise induces hearing loss mainly divided into direct mechanical damage of inner ear cochlear structures and metabolic causes. Metabolic causes may include overstimulation of inner ear structures by potentially hazardous substances such as nitric oxide damaging hair cells, oxygen-free radicals destroying membranes, and low magnesium concentrations that weaken hair cells.[11,12]

An important source of noise is "wind noise" produced by wind rushing past a rider's ears. Studies reveal an excessive wind noise around the helmet of a motorcyclist, amounting up to 90 dB (A) at a speed of 60 km/h and increasing linearly to as high as 110 dB (A) at a speed of 160 km/h.[13] Our own study recorded Noise levels in excess of 91 dBA for motorcycles traveling at 75 mph.

On an average, the noise levels increase by 2 dB (A) for every 10 km/h increase in speed for a roadster motorcycle and 2.5 dB (A) for the faired motorcycle. The wind noise results for a faired motorcycle are on an average 1.5 dB (A) higher than the equivalent roadster motorcycle.[14]

An interesting fact is that although helmets are deemed inevitable for ensuring the protection and safety of a

motorcycle rider, they tend to enhance the noise to which a rider is exposed. A study conducted by Jordan *et al*. on nine different types and qualities of motorcycle helmets revealed the most important source of noise to be the base of a helmet between the chin bar and the neck of the rider. In addition, the study revealed different extents of noise exposure with different helmet designs. While full face helmets exposed a rider to an average noise level of 103.6 dB (A) at 120 km/h, open face helmets exposed the rider to a lower noise level of 98.5 dB (A) at the same speed.[15]

A self-administered, self-assisted questionnaire was used to collect data from 420 motorcycle riders in Ido-Ekiti to study the prevalence, awareness, and factors associated with noise-induced hearing loss. The results revealed a maximum response rate among adults between the age group of 20 and 34 with least response rates observed in extremes of ages, i.e., both young and the elderly [Table 1]. A study conducted by Toppila *et al*. on the relationship of age with noise-induced hearing loss revealed a causal relation of age with noise induced hearing loss with elderly participants being more susceptible than younger ones.[16,17]

The major bulk of respondents in the study were those who had at least a secondary level of education [Table 2]. Although the level of education has no direct link with hearing loss, it is awareness of this potential issue that leads to reporting among the educated ones, especially in occupational settings that highlight this concern and encourage employees to report. About 14.5% of the total study population reported hearing loss, among which 15% also reported an accompanying ear discharge [Table 3]. Although no proper validation exists between self-reported and measured hearing loss in the clinical setting, a large-scale epidemiological study conducted by Sindhusake *et al*. revealed that both a question about hearing and the use of Hearing Handicap Inventory for Elderly-Screening appeared sufficiently sensitive and specific to indicate an estimate for the prevalence of hearing loss.[18]

An encouraging observation noted was that more than half of the study population was aware of noise-induced hearing loss and was able to link it to their profession. While 50% agreed that their occupation placed them at risk of hearing loss, 78.6% also reported being aware of the risk of RTA associated with hearing loss [Table 4]. This is similar to the finding the study by Jordan *et al*.[19] Among the various factors associated with the prevalence of noise-induced hearing loss, a few were found to be significantly linked. Although 48.1% of the subjects had their blood pressure recorded before only 10.7% were diagnosed hypertensive [Table 4]. About 40% of respondents who had hearing loss were hypertensive ($P < 0.001$), whereas only 10.9% had their blood pressure measured before ($P = 0.042$) [Table 5]. Although various population-based longitudinal cohort studies have established no association between the risk of hearing loss and blood pressure or hypertension,[20] other studies revealed a link between hypertension and the progression of hearing loss. One such study was conducted by Kiely *et al*. in 2012 to show a speedier decline in hearing function in hypertensive patients.[21] Another study conducted by Brant *et al*., 1996 in Baltimore, US linked higher systolic blood pressure with hearing loss in the generally healthier participants.[22]

Our data showed that although 17.9% agreed to the importance of having a hearing assessment done, only 7.1% had one done prior [Table 4]. Although hearing assessments are universally recommended for neonates and elderly, no set guidelines have been established for regular screening in various occupational settings; although they are encouraged by many employers and health committees.

None of the study participants used a hearing aid, but 17.9% reported using ear mufflers and 16.2% used earphones while driving [Table 4]. 56.7% of those who listened to music with earpieces reported hearing loss ($P < 0.001$), while 25.3% of those who used ear mufflers had a hearing impairment ($P = 0.003$) [Table 5]. Using headsets >70%–80% of the maximum volume settings has been established to be linked to hearing impairment in the long run,[23] and although not directly causal, it may serve as a compounding factor in the long run especially for motorcyclists that employ it for effective communications. A study conducted by Abel and Spencer on various types of noise attenuation means for the prevention of hearing loss revealed earplugs to be an effective method for noise reduction with ear foam plugs providing the highest level of attenuation and ear hi-fi plug yielding the lowest level of attenuation.[24]

Among the study participnts, 14.3% reported tinnitus, 5.5% had prior ear injury, and 12.6% had relatives with hearing impairments [Table 4]. The proportion of the study population that had hearing loss had significantly associated tinnitus in 43.3% ($P < 0.001$), previous injury to ear in 47.8 ($P < 0.001$) and 24.5% had a relative with hearing difficulty ($P = 0.027$) [Table 5]. An alarming 80.2% of the study population reported using motorcycles for more than 8.5 h/day [Table 4]. 16.3% of the respondents that had an occupational exposure to motorcycle associated noise for >8.5 h reported hearing loss compared to 7.2% in people with <8.5 h of exposure to motorcycle associated noise ($P = 0.035$) [Table 5]. The recognized tendency of noise to cause hearing loss has prompted various legislative assemblies to limit the number of hours of noise exposure. A study conducted by Metidieri *et al*. demonstrated that hearing loss began and predominated at frequencies of 3,

4, and 6 kHz and eventually progressed to 8, 2, 1, 0.5, and 0.25 kHz. The study also pointed that regulatory standards limit the exposure to continuous noise of 90 dB to no more than 4 h and a maximum level of 85 dB for a full 8-h working period.[25] In accordance with this 80.2% of our subjects who reported exposure to motorcycle associated loud noise for >8.5 h were well above the recommended time and 16.3% of these already depicted signs of hearing impairment [Tables 4 and 5]. Table 6 of our study comprehensively shows the relationships between factors associated with noise-induced hearing loss and the prevalence.

Our study also revealed that 32.5% (117) of the participants had normal hearing, while 37.8% (136) had >40 dB hearing threshold [Table 7]. Hearing loss is more than 40 dB in adults is defined as disabling hearing loss according to the WHO.

Conclusion

Majority of our respondents had secondary school education and 14.5% of the total study population reported hearing loss, among which 15% also reported an accompanying discharge. Furthermore, more than half of the study population was aware of noise-induced hearing loss and was able to link it to their profession, while 50% agreed that their occupation placed them at risk of hearing loss. None of the study participants used a hearing aid, but 17.9% reported using ear mufflers and 16.2% used earphones while driving which prone them to RTI.

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Conflicts of interest

There are no conflicts of interest.

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