HEALTH EFFECTS OF NOISE EXPOSURE LEVELS AMONG INSTRUMENTALISTS IN PENTECOSTAL CHURCHES IN PORT HARCOURT CITY, NIGERIA

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ABSTRACT

BACKGROUND: Noise is everywhere in our daily lives and becomes very important as it affects our health. Religion is an integral part of daily lives and the use of acoustic and electronic instruments in worship. With the increase in sophistry of these instruments come their attendant untoward effects on the auditory organs of the body. This study was to assess noise exposure levels amongst instrumentalists in Pentecostal churches in Port Harcourt City, Nigeria.

MATERIALS & METHODS: Following ethical consideration, 216 consenting respondents from 30 churches in Port Harcourt were recruited by table of random numbers. Structured close ended interviewer administered questionnaire incorporating the Hearing Health Quick Test (HHQT) was used to access demographic data. Hearing assessments were also performed using tonal audiometry. The data were entered and analyzed using SPSS version 20.0 and presented using descriptive and inferential statistics.

RESULTS: Most 90.28% and 37.96% of respondents were male and within the 39-45 year-old age range respectively. Also, 80.56% of respondents were aware that loud music can cause permanent hearing loss. The prevalence of NIHL and Tinnitus was 39% and 38% respectively; and only 19% used Hearing Protection Devices (HPD). Statistically significant risk of NIHL was observed in musicians who had experienced tinnitus, played only amplified instruments and Music experience greater or equal to 10 years ($p=0.001$).

CONCLUSION: Gospel instrumentalists are exposed to noise in the course of their duties which have significant effect on their hearing. Use of Hearing Protection Devices (HPD) as a personal protective equipment is encouraged just as health education of this group of workers is necessary.

KEY WORDS: Noise, Sound Pressure Level (SPL), Instrumentalists, Noise Induced Hearing Loss (NIHL)

NigerJmed2019: 63 -72

INTRODUCTION

Noise is simply a non-rhythmic sound that is meaningless, unwanted and could be harmful due to its commonly loud nature, and have been judged to be unpleasant, undesired and disruptive to hearing.[1] Ambrose Bierce had called it, "A stench in the ear; an undomesticated music."[2] The detrimental significance of noise in our environment has earned the term noise pollution, signifying the hazardous effect loud sound have on the human auditory anatomy and epidemiology and the immeasurable consequences seen in our modern day environment.[3] According to the World Health Organization (WHO), hearing loss as a result of noise exposure presents a serious Public Health problem with an estimated 1.3 billion people worldwide suffering from this condition and an estimated 10% currently exposed to harmful noise levels.[4] Primary sources could come from industrial machineries, traffic due to incessant use of vehicle horns, and excessive exposure to Loudspeakers presently experienced in many religious houses due to advancement in music technology and equipment.[5]

The use of acoustic means of worship, which was very rampant in the olden times, where congregants clap hands and sing songs without any form of electronic amplification is becoming old fashioned, as the need for amplification of voices and musical instrument is now generating more noise and becoming detrimental to the hearing of worshippers and the musicians who play these instruments.[6,7]

The primary result of this has been poor knowledge in the use and operation of these equipment at safe levels, likewise poorly

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acoustically treated auditoriums which produce excessive noise such as echo and reverberation; the continuous reflection of sound, that blur speech, resulting in a poor and ineffective communication between the preacher and the listeners.[8,9] The auditorium is meant for understanding speech, and when this is not achieved, the church erroneously opt for buying more loudspeakers to enhance audibility, instead of consulting a trained acoustician or audio engineer to deal with the poor speech intelligibly, and in the process increase in loudness of the already poor sound quality being experienced results.[10]

In a 2010 cross sectional study by Phillips *et al.*, the prevalence of NIHL observed amongst 329 student musicians excessively exposed to loud sound was 45%.[11] Another cross-sectional study conducted amongst 125 musicians in Iran observed a unilateral and bilateral hearing loss of 42.4% and 19.2% respectively.[12]

Also, 51% of the respondents reported a history of tinnitus after performance while 28% reported a history of ear pain, and only 2% of the participants indicated they ever use devices that could protect their hearing.[12] A Norwegian survey conducted in 2011 amongst 111 active musicians observed a hearing loss in 37.8% of the musicians and a 20% prevalence of chronic tinnitus.[13]

A study conducted by O'Brien *et al.* with orchestra musicians in Australia observed that 43% of respondents reported hearing loss. The study also reported a significant increase in hearing loss amongst musicians who reported playing more than two hours per day of personal practice.[14] A research conducted amongst 109 musicians from three major German orchestras using questionnaires and audiometry observed that more than 50% of the musicians were found to have permanent hearing shift,[15] whereas a similar study in 2010 in Poland amongst 63 musicians reported a NIHL prevalence of 46%.[16] A lower prevalence of 25.7% was recorded in a study by Mendes *et al.*, with reason been that a higher prevalence of the musicians took preventive measures for hearing loss as a lifestyle by their acceptance and use of hearing protectors.[17]

Another important reason for excessive increase in the Sound Pressure Level (SPL) for most churches is loud background or ambient noise.[9,18] This is the noise level already in the auditorium due to the location of the church or simply other electronic gadgets like the Heating, Ventilating, and Air Conditioning (HVAC) equipment which could include ceiling or standing fans, stage or auditorium lighting systems, *et cetera,* as they also produce some level of noise.[19] Although not much but in unison, they can generate noise levels of at least 10-25 dB, in addition to what is already present.[20] Another contributor to the excessive SPL is the noise coming from outside the church auditorium, from traffic, street, or parking lot that finds their way via the auditorium's walls, doors and windows, and thus increasing further the ambient noise.[21]

The principle of Signal-to-noise ratio (SNR) ensures that the sound technician or engineer sets the audio signal above the noise level, but in a case that the noise becomes excessively loud, the volume of the loudspeakers (the signal) is raised above the noise level, which cumulatively makes the sound in the auditorium becoming excessively too loud and unsafe for the ears.[22] Proper room acoustic can minimize this sort of problem and enhance hearing at a very nominal sound pressure level.[23]

With the surge of religious houses, especially in Nigeria, more than 80% of the population attending these services are exposed to noise above 75dBA, as many churches have their operating SPLs at very dangerous levels of 90-105 dBA with sustained exposure, where hearing damage occurs in minutes.[24-26] The human ears are very delicate and prolonged exposure to sound pressure levels above 85dBA will cause damage to hearing.[27] And since most worship services praise sections are usually between 20-30 minutes at most, majority of people have escaped the side effects of prolonged exposure to loud SPLs. Some who stayed longer than that period have experienced Temporary Threshold Shift (TTS), a temporary loss of hearing that return after few hours and sometimes days, but could become permanent if exposure is done on a regular basis.[28] Some, especially musicians are now experiencing tinnitus's, a ringing or buzzing sensation in the ears even when there is no sound.[29,30]

Pouryaghoub *et al.,* in their study conducted amongst 125 professional musicians with at least five years of work experience in Tehran, Iran

observed a 51% prevalence of tinnitus during performance.[12] In another study conducted amongst professional pop/rock/jazz musicians in Israel, results show that regular exposure to amplified music was related to hearing loss and symptoms of tinnitus.[31] Also, the musicians' experience and years of playing were positively correlated with a greater effect of hearing loss (r = 0.47, $p = 0.002$).[31]

Worship services run in both daytime and sometimes throughout the night during weekly or monthly vigils and noise of very high levels are generated in these meetings aided by sophisticated sound reinforcement equipment with deafening projected SPLs of intensities of over 95dBA, with some hanging on rooftops.[32-35] A Port Harcourt study involving 30 churches reported SPLs higher than the safety permissible limits of sound, with a mean SPL of (98.4 ± 3.1dB) for Pentecostal churches and (96.3 ± 6.8 dB) for catholic churches at services lasting between 2-7 hours, in auditoriums with no acoustically designed measures to minimize high sound pressure levels on the musicians or congregants.[36] This study therefore aims to determine the health outcomes of noise exposure levels amongst instrumentalists in Pentecostal churches in Port Harcourt city, Nigeria.

MATERIALS AND METHODS

Study area: Port Harcourt, 'the Garden City' of Rivers State, nestled in the Niger Delta region of Nigeria has an estimated population of 1,865,000. The city lies between latitudes 4°49′27″N and longitudes 7°2′1″E with an area of 360 km^2 and an Urban land mass of 158 km^2.[37] With the huge presence of multinational firms, the city is considered a major industrial centre in terms of Gross Domestic Product and foreign exchange revenue from crude. The city like most of Nigeria is very 'religious' and the economy of the area has somewhat enhanced the proliferation of religious centres of all denominations. The Pentecostals indulge in high percussion acoustic instruments which produce sound levels way above 85dB.

Study design/population: This was a descriptive cross sectional study with instrumentalists ranging from drummers, guitarist, saxophonists, keyboardist, flutist, etc. There are more than 1,500 churches of different denominations in Port Harcourt with the youth making up a substantial population of the music units. There are at least three service sessions per week in most Pentecostal churches and they come with generous music renditions. This is aside all-night and weekly church 'programmes'.

Inclusion Criteria for Church selection

- Pentecostal church auditorium with a Roof, Wall and Floor
- Church with a membership capacity of at least 100 persons
- Church that uses electronic means of sound amplification during worship services

Inclusion Criteria for Instrumentalist Selection

- A gospel instrumentalist that plays any type of musical instrument with electronic or acoustic sound amplification
- A gospel instrumentalist that has been playing the musical instrument for a period not less than one year
- A gospel instrumentalist of at least 18 years of age.

Sample size and sampling method: This was determined using the Fischer formula $n = Z^2pq/e^2$ with allowance for non-response to arrive at a sample size of 216. Selection of churches was from a free and open access online database called *gospelph* containing a total number of at least 6000 churches from 23 locations in Port Harcourt Metropolis serving as the sampling frame. Pentecostal churches were selected by use of table of random numbers to arrive at the sample size of 30.

Selection of instrumentalists: In each of the Pentecostal churches selected, an approval letter was sought for and gotten from the church leadership to interview respondents. In each selected church, all the instrumentalist present at the time of interview were selected until the minimum sample size was reached. The study participants involved gospel musicians playing any type of musical instruments.

Study instruments: A structured, close ended, self- / interviewer- administered and pre-tested questionnaire was used. The questionnaire probed socio-demographics, awareness of Noise Induced Hearing Loss (NIHL), attitude and practice towards NIHL. **A Pure-Tone**

Audiometry 'Hearing Test®' application was used. Pure-tone Audiometry (PTA) is the gold standard for hearing screening for people >4 years of age. A major feature of the software is in its ability to assess hearing threshold within the frequency band 125 Hz to 8 kHz in relation to the reference sound levels (dB), segmented into five different readings: *Normal hearing loss, Mild hearing loss, Moderate hearing loss, Severe hearing loss and Deafness*. A walk-through survey was carried out in each of the selected Pentecostal churches in order to measure their Sound Pressure Levels (SPLs) and ascertain if they had acoustically treated or reflective walls, speaker positioning and also if instrumentalist use Hearing Protection Devices (HPDs) . The Sound Pressure Levels in the auditoriums of the selected churches was measured using the validated Keuwlsoft's Sound Pressure Level Meter.

Study procedure/data collection: Data were collected thus: ***For the churches -*** The sound pressure levels produced by the auditorium loudspeakers were measured using the Keuwlsoft's Sound Pressure Level Meter at different standing distances, the closest and the farthest respectively. The first reading which represents the "Highest SPL" was during the Praise and Worship session and the second reading which represents the "Lowest SPL" was during the sermon, and the average was recorded.

This procedure was repeated twice for validity. Since the movement of the choir microphones towards the speakers can generate extraneous noise called *feedbacks*, care was taken not to measure at this particular time, and should it occur during the worship service, those readings were discarded. Where possible, the measuring instrument was placed away from walls and reflective surfaces to enhance accuracy of measurement. The maximum permissible SPL for 8 hour duration is 85dBA.

For the gospel instrumentalist - a self-administered questionnaire was used to obtain socio-demographic information, awareness, music exposure, hearing difficulty and relevant risk factors. The Hearing Health Quick Test (HHQT) validated tool designed by the American Academy of Audiology (AAA) was also used to access self-reported hearing problem.

Data analysis: Data were entered into Microsoft Excel® version 2010 where it was coded and cleaned. Data analysis was conducted using ANALYSIS in the *Epi-Info v7.02* and the *Statistical Package for Social Sciences (SPSS) v20*. Categorical data were presented in the form of frequencies and percentages (%) and summary statistics in means and standard deviations (*SD*) with results presented in tables and charts. Chi-square (^{2}) and Student t-test analysis were also applied when comparing difference in proportions and means. Bivariate analysis was performed (using a two-by-two contingency table) to determine the odds of risk (using odds ratio, ORs). All ORs were reported with their 95% CI, and a *p-value* ≤ *0.05* was considered statistically significant.

Ethical considerations: Ethical clearance was sought for and gotten from the University of Port Harcourt, Port Harcourt, Rivers State Research Ethics Committee. Signed informed consent was obtained from the selected Pentecostal churches and all participants. Confidentiality was maintained by ensuring that the questionnaires did not bear participants names.

Study limitations: There was apprehension from the instrumentalists that it was a Government measure to control them with attendant consequences. They were reassured and told that it was purely for academic purposes.

RESULTS

A total of 216 instrumentalists were incorporated in the study with a 100% response rate with due written consent granted by participants for study participation.

Table 1: Socio-demographic characteristics of respondents

Characteristics	Frequency n=216	Percentage (%)
Age Range (*intervals of 7*)		
18-24	40	18.52
25-31	64	29.63
32-38	20	9.26
39-45	82	37.96
>45	10	4.63
Mean	***33.10 ± 8.47 years***	
Range (Min, Max)	***(18, 48) years***	
Sex		
Male	195	90.28
Female	21	9.72
M/F Ratio	***9.3:1***	
Marital Status		
Single	134	62.04
Married	82	37.96
Educational Level		
Primary	0	0.00
Secondary	50	23.15
Tertiary	166	76.85

Figure 1: Auditorium Sound Pressure Level (SPL) Measurement

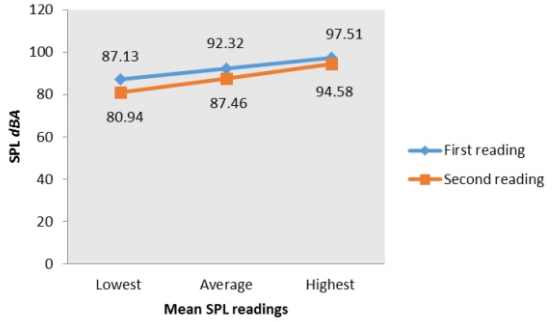

Table 2: Auditorium Loudspeakers reading

Characteristics	Frequency n=30	Percentage (%)
Average number of Loudspeakers		
Mean ± SD (Range)	*14.53 ± 8.15 (8-30)*	
Loudspeakers at headline		
Yes	22	73.33
No	8	26.67
Instrumentalist wearing HPD		
Yes	4	13.33
No	26	86.67
Type of instrumentalist (n=4)		
Drummer	4	100.0

Table 3: Awareness of Noise Induced Hearing Loss (NIHL)

Characteristics	Frequency n=216	Percentage (%)
Aware that loud music can cause permanent hearing loss		
Yes	174	80.56
No	42	19.44
Knowledge of the safe recommended sound pressure level of music playing or listening		
Yes	61	28.24
No	155	71.76
Can mention it (n=61)		
Mentioned Correctly (85dBA)	*21*	*34.43*
Mentioned Wrongly	*40*	*65.57*
Aware that people should wear a hearing protecting device if the noise or sound level exceeds harmful levels		
Yes	145	67.13
No	71	32.87
Know a musician with hearing problem		
Yes	30	13.89
No	186	86.11
How they feel about it (n=30)		
Sad	*20*	*66.67*
Indifferent	*10*	*33.33*
Church implements Volume Levels and Hearing Safety precautions		
Yes	59	27.31
No	95	43.98
Don't know	62	28.70

Table 4: Respondents' exposure to music

Characteristics	Frequency n=216	Percentage (%)
Length of playing a musical Instrument		
0-5 years	62	28.70
6- 10 years	60	27.78
11-15 years	31	14.35
16 - 20 years	32	14.81
> 20 years	31	14.35
Mean	***12.0 ± 8.50 years***	
Frequency of playing music instrument		
More than twice a week	92	42.59
Twice a week	41	18.98
Once a week	21	9.72
Once a month	42	19.44
Sparingly/Rarely	20	9.26
If Music is Job or Leisure		
Job	20	9.26
Leisure	83	38.43
Both	113	52.31
If other employment is noisy if music not Job (n=83)		
Yes	*20*	*24.10*
No	*63*	*75.90*
If church the only place played		
Yes	124	57.41
No	92	42.59

Table 5: Music Exposure of respondents

Characteristics	Frequency n=216	Percentage (%)
Use Personal Stereo Player		
Yes	144	66.67
No	72	33.33
Hearing preference (n=144)		
Normal	*124*	*86.11*
Slightly Loud	*20*	*13.89*
If thought music should be loud		
Yes	62	28.70
No	154	71.30
Group thou ght should be effective in educating musicians and churches on NIHL (n=321) (*Multiple response*)		
Health Professionals	121	37.69
Sound Engineers	111	34.58
Celebrity Musicians	61	19.00
Government Agencies	28	8.72

Table 6 : Self-Reported Hearing difficulty (*Ranked*)

Characteristics n=216	Percentage (%)
Feel that people are mumbling or not speaking clearly	38.43
Find it difficult to follow a conversation in a noisy restaurant or crowded room	24.54
Experience difficulty understanding soft or whispered speech	23.61
Have difficulty understanding speech on the telephone	19.44
Find myself asking people to speak up or repeat themselves	14.35
Find men's voices easier to understand than women's	14.35
I hear better with one ear than the other	13.89
I have had a relative (by birth) with hearing loss	13.89
Find it difficult to understand a speaker at a public or religious meetings	9.72
Experience difficulty following dialog in the theater	9.26
I have a hearing problem that cause me to feel embarrassed when I meet new people	9.26
I feel handicapped by my hearing problem	4.63
My hearing problem cause me to visit friends, relatives, or neighbors less often than I would like?	4.63

Table 7: Prevalence of Hearing impairment using the HHQT® tool

Characteristics	Frequency n=216	Percentage (%)
May have a hearing problem (=3)	60	27.78
A hearing Test is suggested (=6)	134	62.04
No hearing Loss (<3)	22	10.19
Mean	***7.93 ± 5.12***	

Figure 2: Prevalence of NIHL using pure tone audiometry

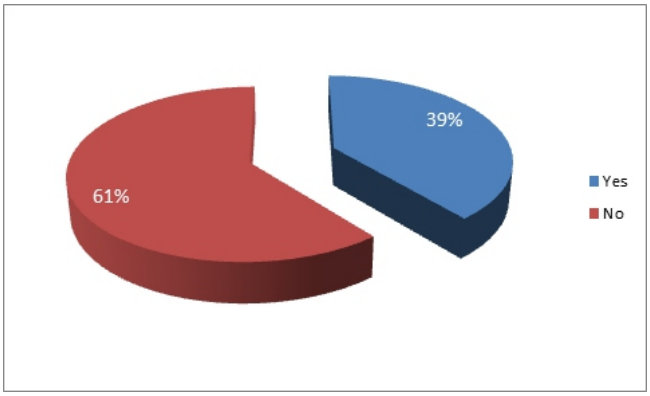

Table 8: Association between Socio-demographic characteristics and prevalence of NIHL

Socio-demographic characteristics	Noise Induced Hearing Loss *(Pure Tone Audiometry test)*		Total	*df*	χ^2 *(p-value)*	OR (95% CI)
	Yes *Freq (%)*	No *Freq (%)*				
Age						
> 35	56 (65.88)	48 (36.64)	104 (48.15)	1	16.50 (*0.001*)*	3.34 (1.88-5.92)
≤35	29 (34.12)	83 (63.36)	112 (51.85)			
Total	**85**	**131**	**216**			
Mean ± SD	*36.24 ±7.90*	*31.07 ± 8.22*			*4.58*$^{\mu}$ *(0.001)**	
Sex						
Male	84 (98.82)	111 (84.73)	195 (90.28)	1	10.11 (*0.001*)*	15.14 (1.99-115.05)
Female	1 (1.18)	20 (15.27)	21 (9.72)			
Total	**85**	**131**	**216**			
Marital Status						
Married	43 (50.59)	39 (29.77)	82 (37.96)	1	8.62 (*0.003*)*	2.42 (1.37-4.26)
Single	42 (49.41)	92 (70.23)	134 (62.04)			
Total	**85**	**131**	**216**			
Educational Status						
Tertiary	75 (88.24)	91 (69.47)	166 (76.85)	1	9.18 (*0.001*)*	3.30 (1.47-7.57)
Secondary	10 (11.76)	40 (30.53)	50 (23.15)			
Total	**85**	**131**	**216**			

**Statistically significant (p<0.05) $^{\mu}$ student t-test*

Table 9: Association between frequency of playing music instrument and the prevalence of NIHL

Frequency of playing music instrument	Noise Induced Hearing Loss *(Pure Tone Audiometry test)*		Total	*df*	*Fisher's exact p*
	Yes *Freq (%)*	No *Freq (%)*			
More than twice a week	52 (61.18)	40 (30.53)	92 (42.59)		
Twice a week	21 (24.71)	20 (15.27)	41 (18.98)		
Once a week	11 (12.94)	10 (7.63)	21 (9. 72)	4	*0.001* *
Once a month	0 (0.0)	42 (32.06)	42 (19.44)		
Sparingly/Rarely	1 (1.18)	19 (14.50)	20 (9.26)		
Total	**85**	**131**	**216**		

**Statistically significant (p<0.05)*

Table 10: Association between frequency of playing music instrument and self-reported prevalence of Tinnitus

Frequency of playing music instrument	Self -reported prevalence of Tinnitus		Total	*df*	*Fisher's exact p*
	Yes *Freq (%)*	No *Freq (%)*			
More than twice a week	51 (62.20)	41 (30.60)	92 (42.59)		
Twice a week	21 (25.61)	20 (14.93)	41 (18.98)		
Once a week	0 (0.0)	21 (15.67)	21 (9.72)	4	*0.001* *
Once a month	10 (12.20)	32 (23.88)	42 (19.44)		
Sparingly/Rarely	0 (0.0)	20 (14.93)	20 (9.26)		
Total	**82**	**134**	**216**		

**Statistically significant (p<0.05)*

DISCUSSION

The average sound pressure level (SPL) recorded were above the recommended level of 85 dBA set by the Occupational Health and Safety Administration (OSHA) and International Standards Organization (ISO), with the highest and lowest SPL being 97.51 ± 8.16 dBA and 87.13 ± 12.38 dBA; a level that could cause hearing damage in 30 minutes. Similar results have been observed in a prospective cross sectional study in Port Harcourt city Nigeria which recorded an average SPL measurement of 98.4 ± 3.1 dBA in Pentecostal churches.[36] In another study by Silva & Cabral, it was observed that the noise exposures amongst the priest's and congregants were way over the recommended limits with SPLs of 95.4 to 99.5 dBA. All measurements in the four-worship analysis observed exceeded the recommended levels of 85 dBA.

As observed in the Port Harcourt study,[36] none of the auditoriums was acoustically designed or treated, although in this present study, about 33.33% of the selected Pentecostal churches have auditorium acoustically treated walls, which probably could mean an improvement on auditorium acoustics after the study was conducted in 2017. Auditorium acoustics is a developing science in Nigeria and is fast gaining popularity.[9] The church auditorium is a space meant for listening and acoustics provide the enablement for clearer understanding of the spoken word, often referred to as speech intelligibility, as it impacts on both the congregants and the building. Similar studies from other countries have observed a more improved auditorium acoustic, such as Switzerland, [38] Spain, [39] Italy, [40] and Poland. [41] A contemporary church in Brazil while conducting an acoustic evaluation observed that the auditorium acoustic was in line with the music and speech intelligibility requirements which were consistent with those proposed by the standards for speech auditoria.[21] Also, Moamar and colleagues in evaluating acoustical performance of Several Churches in Jordan observed an acceptable acoustic treatment.[42]

This study showed a statistical significant age dependent increase in NIHL from 34.12% in those lower than 35 years to 65.88% in 35 years and greater. Mean ages was also statistically significantly higher amongst the hearing loss group. These findings are consistent with earlier studies.[43-46] Although the question arises whether this increase is owing to long exposure due to music experience with age and not necessarily due to biological increase in age as shown and so a multivariate logistic regression was conducted which showed no statistical significance difference of NIHL with age.

The prevalence of NIHL using pure tone audiometry measurement was 39.35%, which was lower than a twofold prevalence found in an earlier study conducted by Emmerich *et al*. which found a prevalence of more than 50.0% in a population of 109 musicians and Pawlaczyk-Luszczynska *et al*. who reported 46%. This increase might be "due to the focus of these studies on "classical orchestral musicians who are "usually exposed to sound at equivalent continuous A-weighted sound pressure levels of 81−90 dB for 20−48 h per week. Similar result from the present study was found in a Norwegian Study of active musicians with a NIHL prevalence of 37.8% amongst musicians that share similar characteristics with instrumentalist in the present study.[13] Lower hearing loss prevalence ranging from 12% -26% has also been observed[12,17,47] which may have been because the participants from these studies were selected from music academies which may have strict adherence for the use of hearing protection devices.

An important finding of this study was the difference in the prevalence of subjective complaints (using the Hearing Health Quick Test (HHQT) checklist) and objective symptoms (using the pure tone audiometry results). Prevalence of NIHL was higher in the HHQT checklist compared to the audiometry testing (62.04% as against 39.35%) which was statistically significantly different (^{2}=*22.24; p=0.001*). According to Schaette & McAlpine, reasons may be that early signs of cochlear damage caused by excessive exposure to regular noise may not be detected by pure-tone audiometry,[48] which motivated the use of other forms of hearing assessments in the present study; although the inability to examine respondent's ears medically by an audiologist limits the study from verifying this. A high prevalence of Tinnitus was indicative in this study with a prevalence of 37.96%. It is also the most frequent hearing complaints amongst respondents in this study having varying degrees

of hearing loss, which is similar to studies by Amorim *et al*. and Santoni & Fiorini. Despite the huge prevalence, only 9.26% had indicated ever going for a hearing test or evaluation, which was in contrast to the high number (80.56%) of respondents that are aware that loud music can cause permanent hearing loss. Findings are in contrast to a study conducted by O'Brien *et al*. amongst Australia's professional musicians where annual hearing tests was compulsory.

In the present study, the general knowledge of the safe recommended sound pressure level of music playing or listening of 85 dBA was very poor, as only 9.72% knew correctly the exact value, despite the higher prevalence of awareness. This proves the saying that awareness may not necessarily lead to knowledge.

In the present study, "the levels of hearing loss were higher in people with Ten years or more (≥10 years) of playing experience. This finding was consistent with previous studies and indicated the dose-response effect.[6,16,53]" It is also obvious according to Schmidt *et al*. and Torija *et al*. that the duration of exposure can play a key role in increasing risk levels for developing hearing loss.

The present study also found a statistically significant association between exposure to amplified music and hearing loss, as respondents that play only amplified instrument were 3.50 times more likely to experience hearing loss compared to those interchanging between acoustic and amplified instrument (OR=3.50; *p=0.001*; 95%CI: 1.92-6.38). Studies by Axelsson *et al.* and Halevi-Katz *et al*. showed similar findings. Poissant *et al*. study showed that even a few hours exposure of loud sound increased the risk among trumpet players; emphasizing the fact even a short exposure to amplified music can cause long lasting damage to hearing loss, which is supported by a study by Juman *et al*.

While it will be justifiable to take into account the risk of hearing loss and tinnitus resulting from noise exposure to seeing musicians increase the use of hearing protection devices, the present study did not reflect this. Despite the fact that majority of the respondents (80.56%) are *aware that loud music can cause permanent hearing loss*, only 18.98% said they ever use HPD. Study findings was similar to a study which observed that despite extremely high exposures to sounds, the use of hearing protection in musicians was very low, recording a prevalence of 18% of the musicians saying they use hearing protection, while the remaining 82% said they use hearing protectors only occasionally.[16,51]

The 81.02% of respondents that do not use HPD expressed several reasons for doing so. The most expressed reason for not using HPD is that they do not think they listen or play at loud music levels, which clearly defines their ignorance of risk and also agrees with the Transtheoretical Model of Behavioural Change (TTM), a *model that describes the need for people to change their lifestyles as a result of exposure to risk like a hearing practice that is unhealthy and detrimental.*

The reason is also in agreement with a study by O'Brien *et al*. where 17% of the study participants were clearly ignorant of the risk of excessive exposure to loud SPLs. Some others had said they have considered it not very necessary, and also were not aware of it.

Interestingly, some expressed the opinion that only a drummer should wear one, while the rest simply said the cost was so much and they also do not like using it. It would seem to be justified they have mentioned reasons for the non-use, notwithstanding, the risk associated remains, such as the existing hearing loss and tinnitus found in the present study. According to Laitinen *et al.*, it is more advantageous for musicians to wear hearing protectors as early as possible before symptoms appear.

CONCLUSION

Tinnitus was high amongst participants in this study which is probably a reflection of the musicians' poor use of personal protective equipment. Also, instrumentalists in the study are at increased risk of developing NIHL as their long periods of play in Pentecostal auditoriums chronically expose them to loud noise. It is recommended that the calibration of sound in these places should be according to accepted standards. Also, intensive and sustained health education amongst this group of workers especially on the use of PPE cannot be over emphasized.

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