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Exposure to Excessive Sound Volume: A Major Challenge in the South-Western Nigeria Church Auditoria

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Authors' contributions

This work was carried out in collaboration between both authors. Author SI designed the study, wrote the protocol and managed the analyses of the study. Author OSA wrote the first draft of the manuscript, managed the literature searches and performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

The study examines the exposure to excessive sound volume as a major challenge to grapple with in church auditoria in South-western Nigeria. This exposure to excessive sound has become a source of noise pollution and it is dangerous to human health. Data for this paper were gathered through participant observation of musical acoustics in worship auditoria using a Virtual Instrument; a Sound Pressure Level mobile application installed on a mobile phone for sound volume measurement. The equivalent noise level using A-weighting was taken for twenty minutes per day, this was observed for the three different worship services at different dates and time in each of the selected church auditoria during each worship service. The LAeq, T, of each musical session was calculated. Findings show that the worshippers are exposed to average noise levels of 90.29 dB (Threshold of Pain) at every worship service which is higher than the recommended 60dB for normal human ear by World Health Organization (WHO). It was also observed that all the selected church auditoria lack appropriate acoustic treatment which led to sound reflections and severe echo. The paper concludes that the culture of noise pollution has become a social phenomenon in the Nigerian society especially, in church auditoria where loud musical sound is arrogated to power and

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domination of space. This paper recommends that acceptable optimal standards for sound production either in enclosures or in open spaces be emphasized by the Nigerian local, state and federal governments to effectively control noise for human and societal wellbeing.

Keywords: Exposure; excessive sound; volume; church auditoria.

1. INTRODUCTION

Musical acoustics is concerned with how musical sounds are generated, transmitted, received and perceived. In this connection, discussions on acoustics as the science of musical sounds, its impact on church auditorium and the human hearing sensations coupled with the legitimacy and the illegitimacy of loud musical acoustics, form the basis for this paper. Connecting musical instrument acoustics to its practical uses in church auditoria and other activities such as liturgical and emotional values in worship services in a worship situation, the Clergy, the congregation and the choir engage in intra-action and inter-action through the emanating musical sound inside and outside the church auditoria.

The socio-cultural phenomenon of musical sound especially, with high wattage of volume, more so that musical acoustics relates with human in a particular cultural environment where such sound is produced and directly absorbed in all manners of low, middle and high frequencies. Although, previous researches by scholars such as [1] had focused on digital sound production, [2] on human voice production but, these papers examine the intensity of such musical sound vis-a-vis the sound producing environment and the effects on human health. In the area of musical sound production and reception through the knowledge of acoustics and psychoacoustics of music, in this connection, research questions such as: (i). what are the challenges of musicologists, church musicians and performers of music, regarding the issue of high volume of musical sound? (ii) what is the decibel unit of musical sounds produced, propagated ad perceived in the selected church auditoria? (iii) what are the effects of high volume of musical sounds on the health of congregants and the non-congregants in the selected church auditoria?

2. METHODOLOGY

There are ten identified church auditoria in south western Nigeria, five Orthodox and five Pentecostal churches. Six of these church auditoria were purposively selected and considered for this paper based on musical practices and the structure of these church auditoria. The research rests principally on participant observations, other relevant materials were sought for from the internet, libraries and archives, articles from published journal, books, newspaper, magazines and periodicals. In order to get to an accurate judgement, measurements of church auditoria volume in conformity with decibel (dB) of musical sound emanating from the selected auditoria, devices such as Sound Meter dB and A4 DaTuner were applied for sound measurement and expression of finding in frequency (*f*) and decibels (dB).

This study adopted descriptive research method using the quantitative and qualitative designs. The tool for data collection were participant-observation, oral interviews and questionnaires on church congregants, pastors, choristers and sound engineers. The study population comprised eleven interviewees, and 959 questionnaires in six churches – three Orthodox and three Pentecostal – using A4DaTuner to measure the sound pressure level in each church auditorium.

2.1 Concept of Loudness of Musical Acoustic in Church Auditoria

On the loudness concept of musical instruments acoustics [3] writes that recent shifts in the aesthetic value of audio loudness is a symptom of broader shifts in attitudes about social harmony and techniques for managing musical sounds and musical acoustics in an auditorium. As a result of Africans cultural attachment to loud sound which is usually displayed when two Africans are engaged in an argument or receiving a phone call, anyone standing few meters away could hear such conversations very audibly. In this connection, [4] opines that in Africa, sound is arrogated to power and the louder the sound, the more powerful the producer of such sound. Sound has often been used as a channel to oppress, intimidate, challenge and even to create undue attention. This cultural factor is practiced anywhere; in the

theatre, concert hall, film house, church and even in the hospital where there should be minimal noise generation so as not to disturb patients on admission. Emielu Austin [5] opines that it is interesting to think for a while about the notion of a sound being “not loud enough” or being “too loud”, because it appears that these two phrases do not refer to the same concept.

Based on Aldred concept [6], it can be deduced that a sound is not loud enough if it is not easily audible and difficult to make sense of it. Thus this notion of loudness as observed by Vorländer M. [7] is similar to intelligibility, rather than acoustical factor, this is a relative notion which holds that sound intelligibility depends on the acoustical environment and background noise, other sources and reverberation. There are at least two different notions as given by Sandell GJ. [8] regarding loudness, a relative notion related to intelligibility, and a more absolute one related to an unpleasant or even painful feeling. It is worthy to note that it can also be said that a sound is too loud in the sense of intelligibility. For example, a television volume when it becomes an impediment to audibility to a particular conversation in a room, so the notion of loudness is multiform, and therefore cannot be mapped to a singular sound volume situation. It could therefore be submitted that the notion of loud musical sound in church auditoria is an emotion factor as worshippers are emotionally attached to church auditorium musical instruments acoustics. Submitting on this, [9] state that loudness of musical instruments acoustics is not only about objective properties of the external world, but also about our cultural world or more precisely about the effect of sounds on our organism. In addition to this, [10] puts it that:

> Many listeners have subconsciously felt the effects of over-compressed songs in the form of auditory fatigue, where it actually becomes tiring to continue listening to the music. ‘You want music that breathes. If the music has stopped breathing, and it’s a continuous wall of sound, that will be fatiguing’ says Katz. ‘If you listen to it loudly as well, it will potentially damage your ears before the older music did because the older music had room to breathe.

Sreedhar’s opinion above suggests an equilibrium position in the musical instruments sound production. The balancing of the high, middle and the low frequencies should produce a well breathing and lively musical sound with no tiring or boring effects on the listeners.

Moreover, [11] maintains that sounds are perceived through hearing, hearing is achieved through the ear and the ear has a threshold of what volume of musical instruments sound it can accommodate. Any sound beyond what the threshold of human ear can take is considered as dangerous to human health. On this note, [12] asserts that:

> Sound is considered noisy when it is played at excessive volume with distortion of pure signals. It then becomes unpleasant to human ear. A major distinction between sound and noise is that sound is regarded as noise when it becomes a source of inconvenience to the conveniences of man and animal. Noise pollution is not unique or peculiar to developing countries alone; it is a common occurrence and of highest magnitude in most of the advanced countries.

In another subject relating to the perception of musical instruments sound, [13] observes that sound perception in terms of combination of tones especially, when two tones that are close in frequency are played at the same time; beats generally are heard at a rate that is equal to their frequency difference. In other words, when the frequency difference exceeds what the human ear can tolerate, the beat sensation disappears and musical tone roughness appears and this is when musical sound turns to noise. [14], as expressed by the Place Theory of Sound Perception (PTSP), is of the opinion that the sound processing performed by the ear and the brain is extremely complex, and difficult because it involves subjectivity of hearing, listening, understanding and comprehension of musical sounds.

2.2 Musical Acoustics Production, Transmission and Reception in Auditoria

The process of sound production, transmission and reception in church auditoria depends largely on the acoustic factors of such auditoria. Acoustics therefore is seen as the scientific study of the behavior of sound production, transmission, reception and the effects of sound in a given space. [15] defined acoustics in simple term as the movement of sound in the air when he states that “Sound is essentially the movement of air in the form of pressure waves which radiates from a source and radiates in all directions”. Enendu, LOM [16] writes that the waves of sound travel across the air to generate

a wavy flow to provide a sound perception. Sound production, transmission and reception in church auditoria should be managed to arrive at a decibel of musical instruments sound that should be within the threshold of human ear. Schmuziger N. [17] opined that identification of noise hazards in a church auditorium may expose worshippers to excessive sound volume which may be too dangerous to the health of worshippers. Assessment of Sound Level Meters (SLM) according to [18] has four principal grades of precision as shown in Table 1.

> The prima impartial standard used for the description of such acoustic quality of a church auditorium is the Reverberation Time (RT) which measures the duration of the decay after extinction of the musical instruments sound source above an active span of 60db. The subjective parameter related to the RT is the impulse of the perception of the reverberance. In practice, it is easier to differentiate between the perceived reverberance during the musical phrase and the perceived reverberance once the musical phrase is over. [19] opines that the Reverberation Time (RT) of the room is directly related to fundamental sound while the former is more related to the early decay time and often calculated over a decay of 10 or 15dB. [20] gives the reasons why reverberation time (RT) is the first standard used for the description of the acoustics of a church auditorium is that it is the only standard that does not vary with the source and receiver positions.

2.3 The Sensation of Loudness

The human ear has a limited power to musical instruments sound reception in terms of loudness and volume level. [21] writes on the sensation of hearing that:

> When pressure fluctuations reach the human ear, this occurs in a certain frequency region, and do not fall below a minimum sound level. The lowest frequency for which a vibration process is still perceived as a tone is approximately 16 Hz. This corresponds to a C_o which is included in the 320 register of some large organs. For yet lower frequencies, the ear can already follow the temporal process of the vibrations, so that a unique tonal impression can no longer be formed.

From the above submission, Barron's position is clearly understood that it is likely that hearers of musical sound can lose tonal registration and impression if certain musical sound is higher in volume than the human threshold of hearing. In this context, Sessler, Schultz and Watters [22] submits that:

> This so-called threshold of hearing depends in large measure on frequency. The ear responds with most sensitivity to tones in the frequency range between 2,000 and 5,000 Hz. In this range, the minimum required sound level is the lowest. For higher frequencies, but even more so for lower frequencies, the sensitivity of the human ear is reduced, so that in these regions significantly, higher sound pressure levels are required for a musical tone to become audible.

Watter's position is slightly different from Rigden's. If the so-called threshold of hearing depends largely on the measurement of frequency, the ear will respond to the most sensitive sound is a generalized statement and of course, is not binding on all sound hearers. Hearing musical sound, either at low, middle or high frequencies, it will affect the threshold of hearing if the volume is grater or higher that what the human hear can tolerate. Baron MJ [23] in his submission categorically states that:

> The same tendency is evident when at higher intensity of tones of different frequencies are compared in relation to their impression of loudness. The sound pressure level as an objective measure of existing physical excitation is by no means equivalent to the loudness as a subjective measure of sensation.

Table 1. Sound Level Measurement grades of precision

	Type/Description	Tolerance
0	**Laboratory reference meter**	+ 0.4dB
1	**Precision**	+ 0.7dB
2	**General purpose**	+ 1.0dB
3	**Survey**	+ 1.5dB

(Sabine: 2002, p. 213)

From Patynen's submission, it is deduced that objectivity and subjectivity factors in musical sound perception cannot be ruled out. The impression of musical sound loudness is not a general concept, what is loud to 'A' might not be loud to 'B' in terms of musical instruments sound productions.

In a supportive argument, [24] views the sensation of loudness of musical instruments sound as experienced in worship auditorium from a different position to Sessler, Schultz and Watters [25] and [26]. Sivian BJ [27] argues that the high level of musical acoustics in church auditoria could be likened to a musical sound in a disco hall in loudness. Ikibe's opinion was based on his experience at the Redeem Christian Church of God, Kwara Provincial Council. The level of loudness of the musical production was high and this triggered the secularization of the dance steps of the choir which made the ladies to shake their buttocks in the manner of a disco hall dance as observed at Winners' Chapel, Ilorin and Saint Peter's Cathedral Church, Ake, Abeokuta.

2.4 Musical Instruments Acoustics and Noise in Church Auditoria

The human experience of sound production especially in terms of musical instruments and other sound sources from the environment are common because these are partly endowed with our living in Africa and particularly Nigeria. Musical instruments sound emanation from church auditoria has become a menace to the society because churches are built within the environment where people live and church services hold in form of Bible study, prayer meeting and other crusades from Monday through Sunday; these are usually accompanied with variant of musical noises that constitute a nuisance to the society. The nonchalant attitude and insensitivity of the church musicians due to lack in musical experiences and other technicalities involved in playing musical instruments might have been responsible for this. Every musician needs to possess the musical skill to play musical instruments at the minimal volume level especially, if such musical instrument is amplified, this is required to avoid evidential productions of musical sound and noise simultaneously. Gaver, WW [28] submits that:

> Musical sounds are extremely variable in their complexity and can range from a near sine-wave form of a single instrument or voice to the highly complex mixed sounds of a performing dance band. Each instrument has a different tonal texture for each note produced.

Gracyk, ND [29] provides the peak power of various selected musical instruments found in church auditoria in the in Table 2.

The above table compares the frequency range of the various musical instruments found in the selected church auditoria. Gomery, DK [30] concluded that the immediate volume level of sound determines the activeness and relations to the sound energy which could be perceived as either music or noise. It is comprehended that noise cannot be exonerated from musical instruments sound especially in church auditoria because it is considered as a means of communication and domination of space. However, [31] comments on the nature of the process in which a decaying band of noise gives information based on the acoustical quality of the sound producing environment when he writes that:

> There are types of noise that are undesirable and sometimes it is difficult to tell whether it is the unpleasant musical sound or noise or only a carrier of information. The noise of an automobile conveys considerable information on how well it is running. A particular musical sound, even if noisy to one might be another one else's communication. A high-fidelity system can produce some beautiful sounds deemed very desirable by the sound producer, but to a neighbor this might not be considered beautiful at all. Sometimes it isn't easy to distinguish between information and noise.

In this connection, [32] opines that a particular musical sound is likened to the enharmonic position of a musical sound on the organ or piano to have two names. Likewise, a particular sound can be informative, communicative and be noisy. The determination of this sound is based on individual perception of such sound as subjective or objective.

2.5 Musical Instruments and Sound Level Measurement (SLM) in Church Auditoria

Measurement of sound level in church auditoria has to do with sound pressure level (SPL) which

Table 2. Peak power of musical instruments

Musical Instrument	Peak Power Watts dB
Bass Drum	22
Snare Drum	25
Pipe Organ	8
Electronic Keyboard	10-15
Cymbals	10
Trumpet	1.3
Saxophone	0.3
Conga Drum	5-7
Talking Drum	16-20
Omele Drum	5

can only be determined by use of Sound Meter Reader (SMR) that is commonly used, as postulated by McAdams, S et al. [33] in the measurement of noise pollution research or investigation. It should be noted however, that reading from a sound meter does not ascertain the possibilities of accurate facts on how sound is perceived by individual because perception of sound is subjective especially in Africa where sound is arrogated to power and affluence as noted by [Nagata M 34] who argues that if two individual engage in an argument, the public always have the notion the higher voice between the two is winning the argument. Technically, volume is referred to as sound-pressure-level and is measured in units called decibels (dB). Subjectively, one decibel (1dB) is the smallest difference in loudness that the human ear can supposedly perceive. Objectively, at sixty decibels (60Db), the loudness of sound is still perceivable as scientifically approved by the World Health Organisation (WHO).

McAdams, S et al. [35] posits that in a church auditorium, the perceived sound consists of directly primary radiated sound from the source and reflected sound various surfaces of the hall especially, walls and ceiling. This reflected musical sound is usually confused reverberation because, the perceived sound consists of both primary and reflected sounds, [36] posit that the primary sound determines the perceived volume level because this is appreciably louder in the sense that sound becomes softer in proportion to the square of the distance travelled and the reflected sound travels a much longer distance, and sound is partly absorbed and diffused by the reflecting surface. Arising from the above argument, it is opined that reflected sound normally plays a negligible role in the actual perceived volume level. Rosch, D.T [37] complements this by stating that primary sound and reflected sound are essentially two separately arriving sounds of different volume levels. In other words, this could be regarded as fundamental and residual musical sounds.

Commenting on another characteristic of hearing, [38] writes that the combined sounds are perceived as being only as loud as the louder of the two sound-sources. The louder sound determines the apparent volume level; the less loud sound does not add appreciably to the perceived volume level. Rosch demonstrated this in a room with four speakers, one in each corner with each speaker playing with unequal volume levels, the sound seemed to be heard as coming from the direction of the loudest speaker as a result of the differences in volume as small as a few decibels. It became obvious that the other speakers were sounding as if they were switched off. In everyday life, most sound-environments are full of sound-absorbing objects and materials and, because one is usually close to the sound source, reflecting surfaces are proportionally much farther away. Therefore, the ear is conditioned to hear a relationship of primary to reflected sound in which the volume of the reflected sound is much lower than the primary sound.

This apparent relationship between the volume of direct and reflected sound must be preserved in order to make musical instruments acoustics in church auditoria natural. The main factor for this reason, as provided by Georg von Békésy [39] is because one is quieter, calmer, more relaxed, and more concentrated than usual during a church praise and worship session because perception of subtle musical sound is realized; therefore, the proportionate volume level of reflected sound relative to primary sound is not noticeable. Fig. 1 expresses the flowing order of sound measurement level as propounded by Brown, SD [40] using the Place Theory of Sound Perception (PTSP).

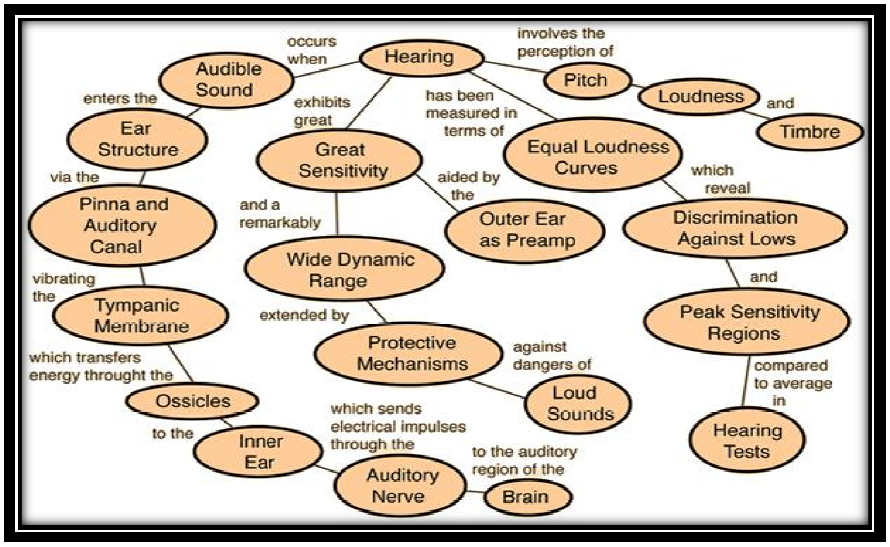

Fig. 1. Hearing and perception of sound (Georg: 1938, p. 172)

Measurement of sound pressure level (SPL) requires sound meter readers such as A4 DaTuner in order to provide accurate percentage of produced sound and sound received in connection to the sound producing environment in the case of a worship auditorium. This is a digital process to assist in plotting a graphical explanation of sound intensity, sound frequency and sound decibel. Table 2 reflects the various sound pressure levels (SPL) with its corresponding sound intensity. These are arranged in order of gravitational effect on the human ear to complement the earlier explanation on the nature of musical sound and how such is received and perceived.

2.6 Possible Harmful Effects of Loud Musical Sound on Human Health

The specific objective of this paper is to examine the effects of loud sound on human health. Over the years now, little consideration is given to how much of loud sound which has caused damage to our system and how it has eventually affected our overall health especially in Africa and Nigeria in particular. Several concerns have been expressed about noise and its adverse impact on human health and the environment. These concerns have also been expressed scholarly by many experts such as [41] and[42] in the musical and medical studies as measures to reduce and or control the health hazards of noise as it affects human existence and life sustenance. However, the health impacts of noise pollution are not likely to decrease unless appropriate action is taken. This act of environmental degradation brings about significant pressure on the climate and human health.

Noise pollution through excessive musical sound productions inside or outside church auditoria is often an overlooked source of environmental stress that can raise human risk of serious health conditions, including heart disease. In the United States of America, it is estimated that about One hundred (100) million people are exposed to unhealthy levels of noise; typically, from automobile and aircraft traffic but also include everything from leaf blowers and lawnmowers to loud music can equally contribute to noise pollution situation (AJPM online: p. 56). In the 1970s, the United States Environmental Protection Agency [43] set a recommended noise exposure limit of 55 decibels in a 24-hour period, with night time's noise weighted more heavily because it can interfere with sleep. For comparison, a quiet suburb has a decibel level of about 50, while freeway traffic is closer to 70 and a chain saw is 120 decibels [44]. However, as noise issues were deemed best handled at the state and local government level, how much noise a person can reasonably handle without health was established by Hartmann, W. M [45] that:

> Once you know the volume and duration of sound you are exposed to; it is a matter of calculating how much attenuation(reduction of volume) is necessary to ensure you are not being overexposed. This will guide you in your

> selection of the appropriate hearing protection device.

In another comment on the dangers of loud musical sound, [46] submits that:

> Exposure to loud sound can overload the hearing system, resulting in symptoms of hearing loss and/or tinnitus, If the exposure to the loud sound continues however, the damage to the hearing system that results is permanent, irreversible and will not respond to any medical or surgical treatment. This damage occurs at the level of the tiny hair cells in the cochlea and is known as hearing loss.

Noise pollution through musical activities may increase human risk of hearing loss, stress, sleep disturbances, and heart disease. A new analysis conducted an environmental assessment of the United States noise pollution as a cardiovascular health hazard, and revealed small decreases in noise could add up to major economic savings. The analysis suggests that a 5 decibel noise reduction would reduce the prevalence of high blood pressure by 1.4 percent and coronary heart disease by 1.8 percent. The annual economic benefit was estimated at $3.9 billion [47]. [48] writes complimentarily that noise exposure levels in 2013 were the same as those assessed in 1981, however, as urbanization has increased it is likely these are underestimates and reductions in noise may impact even more people than the study suggested.

Ochuko, A [49] in his research writes that long-term exposure to traffic noise may account for approximately 3 percent of coronary heart disease deaths (or about 210,000 deaths in Nigeria each year. But, how, exactly, does noise harm human heart? One of the key ways is by elevating stress hormones such as cortisol, adrenaline, and noradrenaline, which, over time, can lead to high blood pressure, stroke and heart failure''. Anomohanran. O et al [50] writes that "arousal associated with night-time noise exposure increased blood and saliva concentrations of these hormones even during sleep. Expressing the same view, [51] states that "Many people become habituated to noise over time. The biological effects of are imperceptible, so that even as you become accustomed to the noise, adverse physiological changes are nevertheless taking place, with potentially serious consequences on human health. Taken together, recent epidemiologic data show us that noise is a major stressor that can influence health through the endocrine, immune, and cardiovascular systems. The impact can be significant. It was also observed by Zannin, P.H.T et al. [52] that chronic noise exposure increased the risk of cardiovascular mortality by 80 percent, also chronic noise exposure leads to health risks beyond human heart, such as hearing loss, diminished productivity, sleep disruption, impaired learning, and more.

Noise-induced hearing loss (NIHL) can occur from continuous exposure to loud musical sounds which eventually translate to noise over time affects about 54 percent of Nigerians [53]. It was further state by Ijaiya that Sound is measured in units called decibels. Sounds of less than 75 decibels, even after long exposure, are unlikely to cause hearing loss. Schessel [54] further stresses to consider some loudness/time facts using decibel as a unit of measurement as expressed in table 3 as follows:

Beyond human heart, excessive musical instruments production can be harmful in many other ways, leading to hearing loss. Many of these are just beginning to be explored. For instance, a study on pregnant women by Gehring, U et al. [55] found that exposure to loud musical sounds may lead to lower birth weight. There is also the issue of disruption and denial of sleep, which is why night time musical sound production is thought to be worse than daytime exposures. If one cannot sleep as a result of excessive loud musical sounds, it can cause a cascade of negative health repercussions. Research has even shown that chronic noise exposure of about 100 decibels leads to a significant reduction in testosterone levels in male rodents. Dzhambov, G.D et al. [56] writes that:

> Chronic psychological distress can cause suppression of the hypothalamic-pituitary-testicular axis and thus lead to male hypogonadism (a condition in which the body doesn't produce enough testosterone), which is associated with psycho-social dysfunction, chronic diseases, and as a result, considerable economic costs. Conversely, noise is a prototypal environmental stressor of growing importance, already linked to birth outcomes and diabetes. However, its effects on male testosterone levels have been paid little attention … Research on humans is highly warranted, especially given the steady trend in Western societies for increasing the

Table 3. Loudness and time measurements in units of decibel

Decibel Rate (DbR)	Effects of Exposure per Day (EED)
At 95 dB	the damage will occur after four hours of exposure per day
At 100 dB	the damage will occur after two hours of exposure per day
At 105 dB	the damage will occur after one hour of exposure per day
At 110 dB	the damage will occur after 30 minutes of exposure per day
At 115 dB	the damage will occur after 15 minutes of exposure per day
At 120-plus dB	the damage occurs almost immediately

Schessel (1992: p. 234)

burden of both male hypogonadism and noise pollution.

Minimizing or total controlling the issues of excessive or loud musical instruments sound production in church auditoria, it is very imperative to consider adding acoustical tile to your ceiling and walls to buffer the noise. Double-paneled windows and insulation can also help. At the very least, church auditoria can be sound-treated by adding heavy curtains on the auditorium windows, rugs on the floors and sealing air leaks.

3. RESULTS AND DISCUSSION

The following results are found out on volume of sound generation musical instruments acoustics in the selected church auditoria in south-western Nigeria as highlighted in the chart below:

Chart 1. Intensity of sound generated in the auditoria of selected churches (dB).

Auditorium	Average Decibel Day One	Average Decibel Day Two	Average Decibel Day Three
Saint Peters' Cathedral, Ake, Abeokuta	90 dB	85.93dB	93.33 Db
Our savior's Church, Ikenne	80.43dB	78.66dB	82.13 Db
Iyeru Okin African Church, Offa	89.51dB	88.66 Db	95.33 Db
Celestial Church of Christ, Akobo, Ibadan	109.18dB	109.50dB	107.15 Db
The Redeemed Christian Church of God, Ilesha.	88.50dB	64dB	76 dB
Dominion Centre Church, Ile-Ife.	95dB	92.50 dB	100 Db
Average Musical Instruments Acoustics Volume	**Day One**	**Day Two**	**Day Three**
	92.03dB	**86.54dB**	**92.32Db**
Average of Noise Level in All the Selected Church Auditoria	**Minimum** *L*Aeq,T	**Maximum** *L*Aeq,T	**Average** *L*Aeq,T
	86.54dB	**92.32dB**	**90.29Db**

Fig. 2. Results are found out on volume of sound generation musical instruments

From the summary above, Maximum *L*Aeq, T, of 92.32 dB was obtained in all the selected church auditoria for the three days' measurement while the minimum value *L*Aeq, T of 86.54dB was obtained for the same period of measurement. The average musical instruments' acoustic in all the six selected church auditoria is 90.29dB. This result shows that congregants in the selected church auditoria are exposed to high sound decibel which is above the recommended 60dB by the World Health Organisation; a situation that constitutes health dangers to the congregants. Finding of this paper established that:100% of the congregation perceived musical instruments' acoustics as sound for praising and worshipping God; Reverberation Time (RT) and Auditorium Acoustic Parameter (AAP) were 89.57% good, 7.63% bad and 2.8% relative ;the musical sound volume in five auditoria with (83.33%) did not take the sizes of the auditoria into consideration while one with (16.66%) did; the average sound decibels of 90.29dB were recorded in all the six selected church auditoria with 86.54dB minimum LAeq, T and 92.32dB maximum LAeq, T which are higher than the recommended 60dB for normal human hearing by the World Health Organisation (WHO);using the acoustic parameters such as acoustic floor tiles, wall tiles, wooden-roofing materials and sound absorbers; one church auditorium with (16.66%) of the selected auditoria was acoustically treated while the other five with (83.33%) were not; and the acoustic treatment of five auditoria with 83.33% of the selected churches were not adequate for the high volume of musical sound output while one with 16.66% was adequate.

4. CONCLUSION

This study established that loud musical sounds coming out from church auditoria are subtle agents to reducing the life span of those who are religiously or culturally, coupled with ignorance, attached to loud musical instruments' acoustics and its amplified productions from which are likely to suffer great consequences. The study further observed that loud musical instruments' acoustics in form of "noise pollution" from such church auditorium has been ignored and has made our society to become very noisy. The study concluded that there was excessively high volume of sound, with maximum sound volume of 92.32dB LAeq, T, this has been the practice of church worship sessions resulting into physical and emotional disturbances of the congregants and the environment in Southwestern Nigeria. The study recommended that minimal musical instruments' acoustics volume of 60dB as suggested by WHO be upheld and appropriately legislated by the government to make the environment more less noisy and ecologically-friendly within and outside church auditoria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adekogbe OS, Daramola OMA. Music Production and Managerial Techniques: An Appraisal of some Digital Recording Studios in South-western Nigeria in the 21st Century. Germany: Verlag Muller VDL Publishers. 2010;96.
2. Olatunji MO. The Indigenization of Military Music in Nigeria: Issues and Perspectives, International Journal of African Culture, Politics and Development. 2008;(2):63-72.
3. Olaniyan Y. Yoruba Dundun Musical Practice, Nigerian Music Review. Special Edition. 2008;(2):32-47.
4. Smith RA. Possible causes of woodwind tone colour, Journal of Sound Vibrations. 1997;32:347-358
5. Emielu Austin. Nigerian highlife music: Nigeria, Centre for Black and African Arts and Civilization (CBAAC). 2013;45-56.
6. Aldred John. Manual of sound recording, london: fountain press, 'Am I Too Loud?' Journal of Audio Engineering Soc. 1978;(25):60-78.
7. Vorländer M. Auralization, fundamentals of acoustics, modeling, simulation, algorithms and acoustic virtual reality: Berlin, Springer-Verlag. 2008;118-201.
8. Sandell GJ. Roles for spectral centroid and other factors in determining blended instrument pairings orchestration. Music Perception. 1995;13(2):209-246.
9. Buglio D. Why is church sound so confusing? ; 1992.Retrieved November 15, 2016
10. from website JdB Sound, Acoustic. Lab. Available:http://www.jdbsound.com/art/art509.htm. Canada: John Wiley & Son, Inc.
11. Sreedhar ED. Tempo and beat analysis of acoustic musical signals." Journal of the Acoustical Society of America. 2000;103(1):115-210.
12. Benade AH. Fundamentals of musical acoustics: Oxford, Oxford University Press; 1990.

13. Airo Erkko J, Pekkarinen P, Olkinuora. Listening to music with earphones: An assessment of noise exposure, Acustica– Acta Acustica.1996;82:885–894.
14. Smith RA., Mercer DMA. Possible causes of woodwind tone colour, Journal of Sound Vibrations. 1994; 32:347-358.
15. Schaffer AH. Noise and its effects: Administrative Conference of the United States Journal (ACUSJO). 1997;4(2):265-288.
16. Enendu LOM. Sound Recording in Theatre Planning and Installation. Ibadan: Kraft Books. 1994;87-102.
17. Schmuziger N. An assessment of threshold shifts in nonprofessional pop/rock
18. Musicians using conventional and extended high-frequency audiometry. Ear Hear. 2007;28(5):643-648
19. Anderton Craig. Home Recording for Musicians. New York: Amsco Publications.1978;8-10
20. Oyedepo SO. Saadu AA. Evaluation and analysis of noise levels in ilorin metropolis, Nigeria Environmental Monitoring and Assessment. 2010; 160:563-577.
21. Siebein W, Kinzey Y. Architectural Acoustics. John Wiley & Sons, Inc. New York. 1999;233-304:72-91
22. Arthur M. Noxon PE. Auditorium Acoustics A three-part article originally featured in Church & Worship Technology. 2002;600-610
23. Ashare PO. Impact of noise and air Pollution on pregnancy outcomes. 2014, www. US National Library of Medicine, National Institute of Health; 1991.accessed on April 22, 2016
24. Baron MJ. Africa and Christianity in the Threshold of the Third Millennium: The Religious Dimension, African Affairs; 2005;576-578.
25. Watters; 1991.
26. Patynen L. Subjective reverberation time and its relation to sound decay. Kongregber. 5. ICA, Liege; 2009.
27. Ikibe S, Babarinde. Religious transformation: Critical issues in the secularization of Gospel music in Nigeria. A paper presented at the crossroads in African Studies Conference (Brazil Africa) at the department of African studies and Anthropology Centre of West African Studies, University of Birmingham, United Kingdom; 2013.
28. Sivian BJ. The Acoustical Foundations of Music. 2nd ed., Chap. 12. Norton, New York; 1981.
29. Sivian BJ. The Acoustical Foundations of Music," 2nd ed., Chap. 12. Norton, New York; 1981.
30. Gaver WW. How do we hear in the world: Los Angelis, Explorations in ecological acoustics, Ecological Psychology. 1993;64-94
31. Gracyk ND. Noise control in buildings: a guide for Architects and Engineers. New York McGraw-Hill, Inc. 1996.
32. Gomery DK. Noise control in buildings: a guide for Architects and Engineers. New York: McGraw-Hill, Inc; 1995.
33. Adesiya, Mikye. An introduction to music management: South Africa, Dolly Publishers Limited. 2005;40-62.
34. Nagata M. Church acoustics, Nagata Acoustics News. 2001;01-9:165.
35. McAdams S. Bregman A. Hearing musical streams. Computer Music Journal. 1979;3(4):26- 60.
36. Thèberge Paul. Any sound you can imagine: Making Music /Consuming technology: Middletown Connecticut, Wesleyan University Press. 1999;67-85.
37. Rosch DT. Acoustics of bar percussion instruments. Percussive Notes. 1978;19(3).
38. Scheirer; 1998.
39. Georg von Békésy. Audiology and the cochlea: Mayo Clin. Proc; 1938.
40. Brown SD. Time-domain simulation of sound production in the brass instrument; 1992.
41. Bruce SW. Pitch discrimination of diotic and dichotic tone complexes: harmonic resolvability or harmonic number? Journal of Acoustics Society of America. 1997;11(3):179-189.
42. Greenwood AC. Musicians ideas about room acoustic qualities. University of Denmark Report; 2009. Retrieved from University of Denmark. Available:www.universityofdenmark.com
43. United States Environmental Protection Agency (USEPA)
44. United States Environmental Protection Agency (USEPA
45. Hartmann WM. Pitch, Periodicity and the Brain. Journal of Acoustical Society of America. 1996;94(A):2457-2483.
46. Trevor JC, D'Antonio P. Acoustic absorbers and diffusers: Theory, design and application. (pp. 2243-2257). Taylor & Francis, London, N.Y; 2009.

47. Environ Health Perspectives: 2007; A536–A537.
48. Theodore C. Grame. Folk Music; Journal of America's Ethnic Music. 2012;132-140.
49. Ochuko A. Evaluation of environmental noise pollution in Abuja, the capital city of Ilorin; 2013.
50. Anomohanran O, Iwegbue CMA, Oghenerhoro IO, Egbai IJC. Investigation of Environmental Noise Pollution Level of Abraka in Delta State, Nigeria, Trends in Applied Sciences Research. 2008;3(4):292-297
51. Ighoroje ADA, Marchie C, Nwobodo ED. Noise induced hearing impairment as an occupational risk factor among Nigerian traders, Nigerian Journal of Physiological Sciences. 2004;9(1&2):9- 14.
52. Zannin PHT, Ferrera AMC, Szeremetta B. Evaluation of noise pollution in urban parks. environmental monitoring assessment. 2006; 118:423-433.
53. Ijaiya H. The legal regime of noise pollution in Nigeria. Beijing Law Review; 2016.Retrieved from Available:http://dx.doi.org/10.4236/blr.51001
54. Schessel; 1992.
55. Gehring U, Tamburic L, Sbihi H, Davies HW, Brauer M. Impact of Noise on Ear. Journal of Acoustics Society of America. 2014;47(1):343-352.
56. Dzhambov GD, Dimitrova GH. March 16) Acoustical control of worship spaces; 2005. Retrieved from Technologies for Worship Magazine December 20, 2016).

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