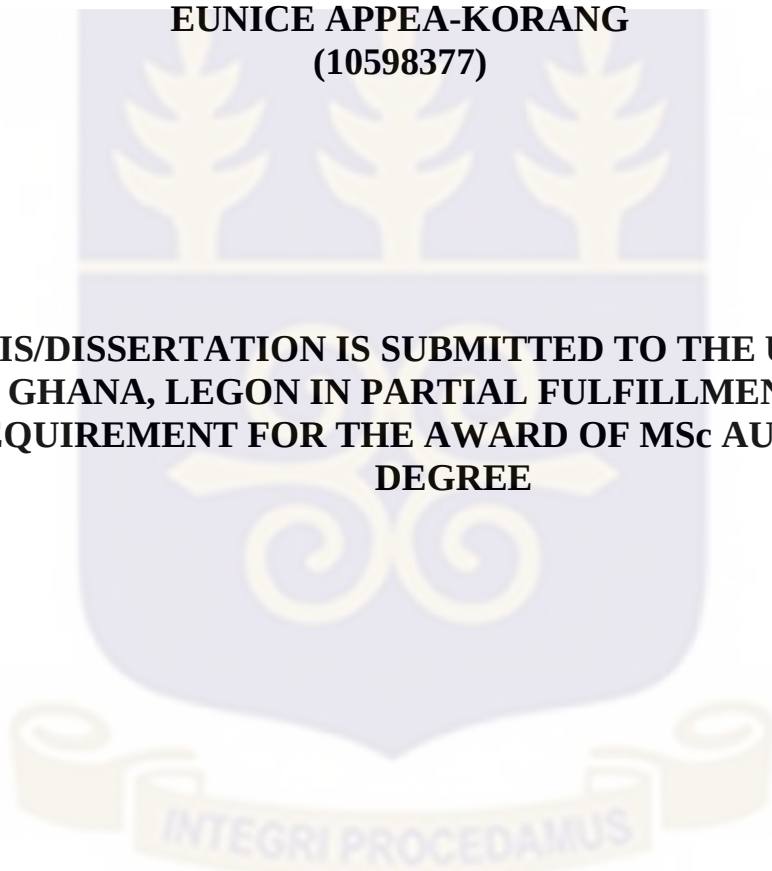


**OCCUPATIONAL HEARING LOSS AMONG NIGHT CLUB WORKERS
IN ACCRA**

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**THIS THESIS/DISSERTATION IS SUBMITTED TO THE UNIVERSITY
OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE AWARD OF MSc AUDIOLOGY
DEGREE**



JULY 2018

DECLARATION

I EUNICE APPEA-KORANG, do hereby declare that this dissertation which is being submitted in fulfillment of the requirements for the Master of Science degree in Audiology is the result of my own research performed under supervision, and that except where otherwise other sources are acknowledged and duly referenced, this work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

I hereby give permission for the Department of Audiology/ Speech and Language Therapy to seek dissemination/publication of the dissertation in any appropriate format. Authorship in such circumstances to be jointly held between me as the first author and my supervisors as subsequent authors.

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DEDICATION

This work is dedicated to my family for their love and support during the period of study.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

AMA	Accra Metropolitan Assembly
ANSI	American National Standards Institute
ASHA	American Speech-Language-Hearing Association
dB	Decibel
dBA	A-weighted decibel scale
dBHL	Decibel Hearing Level
DPOAE	Distortion Product Otoacoustic Emissions
Hz	Hertz
kHz	kilo Hertz
Leq	Equivalent Continuous Noise Level
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OAE	Otoacoustic Emissions
OSHA	Occupational Safety and Health Administration
PTS	Permanent Threshold Shift
TTS	Temporary Threshold Shift
WHO	World Health Organization

DEFINITION OF TERMS

Hearing loss: Hearing thresholds of more than 25dB.

Noise: any undesired sound or unwarranted disturbance.

Noise-induced hearing loss: Hearing loss caused by exposure to excessive levels of noise over a period of time.

Sensorineural hearing loss: Hearing loss caused by an impairment in the function of the cochlea and/ or the auditory nerve.

Prevalence: The number of cases of a disease or condition that are present in a particular population at a given time.

Nightclub: A place of entertainment which opens at night until early morning, and with facilities such as a bar, sophisticated systems for music and an open space for dancing

ABSTRACT

Background: Employees of night clubs are at a greater risk for developing hearing loss because they could be exposed to dangerously high noise levels. Elevated noise levels may lead to adverse effects including elevated blood pressure and sleep interference. Communication in the workplace may also be affected, contributing to the occurrence of accidents. The most serious side effect of noise however is irreversible hearing impairment, and this occurs as a result of damage to the delicate hearing mechanism of the ear.

Aims: The aim of this study was to determine the level of noise that nightclub workers are exposed to and the prevalence of noise induced hearing loss among them.

Methods: Fifty nightclub workers with at least one year continuous working experience, were sampled from five nightclubs in Accra. A structured questionnaire was administered to obtain socio-demographic data, workers' knowledge about the signs and effects of occupational noise exposure, as well as hearing protection devices and their use. Data collection methods employed for the study included noise level measurements, otoscopy and pure tone audiometry. Data was analyzed using the SPSS, Microsoft Excel and R data analysis software.

Results: Average noise levels in all the three clubs was 89.6 dBA. Only 8 (16%) of the respondents knew about hearing protection devices, but none of the fifty used hearing protection during a shift. There was significant association between the duration of employment and the degree of hearing loss at 4 kHz in both left and right ears. Comparison of thresholds at 2 kHz, 3 kHz and 4 kHz showed normal hearing in the frequencies of 2 and 3 kHz (in both ears), with elevated thresholds in the 4 kHz frequency, indicating mild hearing loss.

Conclusion: This suggests a significant association between the duration of exposure and the degree of hearing loss, and that nightclub workers were at risk of developing noise-induced hearing loss.

Keywords: Hearing loss, noise, noise-induced hearing loss, sensorineural hearing loss, nightclub, prevalence.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

A significant percentage of adult-onset hearing loss is caused by occupational noise. Occupational noise is also the cause of 16% of disabling adult hearing loss worldwide (Nelson et al, 2006). Out of this number, 7-21% occurs in the World Health Organization (WHO) sub-regions. This incidence is lowest in industrialized countries and highest in the developing countries (Nelson et al, 2006). Noise-induced hearing loss (NIHL) comes in second to presbycusis as a common form of sensorineural hearing deficit (Rabinowitz, 2000) and it has been established that occupational exposure to noise causes between 7 to 21% of hearing loss among workers (Lie *et al.*, 2016). Excessive noise also accounts for 37% of all adult cases of hearing loss and remains a significant contributor to employment-related morbidity internationally (Kurmis & Apps, 2007). According to the Occupational Health and Safety Administration (OSHA), 5-10 million Americans are at risk of developing NIHL as a result of exposure to sounds exceeding 85 dBA at workplaces on a sustained basis (Mathur, 2016). Also in Europe, approximately 25-30 million workers are exposed to noise in their workplaces (Plontke & Zenner, 2004).

Noise as a crucial occupational and environmental hazard causes extra-auditory effects such as annoyance, sleep, fatigue, and hypertension. Noise-induced hearing loss has long been recognized as the primary and most serious health effect of excessive noise exposure (Hong, Kerr, Poling, & Dhar, 2013). This condition is 100% preventable but once acquired, it is irreversible (NIOSH,

1998). This shows the importance of NIHL as a problem (Kardous, Themann, & Morata, 2016) and efforts must be put in place to tackle it.

As stated on the earlier, incidents of NIHL due to exposure to occupational noise is higher in developing countries, most of which are found in Africa. In Nigeria, sensorineural hearing loss (SNHL) was recorded among workers of a steel rolling mill. Out of 103 workers, 56.8% had a mild to moderate loss. There was also an increase in the degree of loss with increased noise level exposure (Ologe, Akande, & Olajide, 2006). In Ghana, NIHL was present in 23% of workers at a gold mining company, with the characteristic notch at 4 kHz (Amedofu, 2004). There was also evidence of NIHL in 23%, 20% and 7.9% of workers in the sawmill, corn mill and printing press industries respectively (Boateng & Amedofu, 2005). These incidents are results of studies carried out in these industries, but there is very little data concerning the entertainment and music industries, with reference to nightclubs. This study, therefore, seeks to bridge that gap and to help provide education about the causes and prevention of noise-induced hearing loss in the sector, to help improve the quality of life of workers.

1.2 PROBLEM STATEMENT

According to Kelly (2013), the average nightclub bartenders' daily noise exposure for an estimated eight-hour shift is about 92 dBA, which is above the OSHA action level of 85 dBA. Prolonged exposure to such high levels of noise (for many hours each day over many years) may predispose workers to NIHL, but the threat of being unemployed may convince people to remain in environments with noise levels exceeding what they would otherwise tolerate (Mathur 2016). In developing countries including Ghana, urban environmental noise, especially traffic noise and occupational noise are among increasing risk factors for hearing impairment. Also, where there is

effective legislation against noise and programmes to prevent NIHL, they are often poorly enforced and implemented. Presently, there is no study about the level of noise to which nightclub workers are exposed, and many Ghanaians are ignorant of the hazardous effect of prolonged exposure to noise, as well as the Accra Metropolitan Assembly (AMA) by-laws concerning noise in the country. This study has therefore been necessitated by the need to fill that gap and to create awareness among nightclub workers about the effects of prolonged noise exposure, and how to reduce or prevent its occurrence via the use of hearing protection devices.

1.3 SIGNIFICANCE OF THE STUDY

This study will give an overview of the relationship between the duration of exposure to occupational noise and NIHL. Knowledge of signs of excessive noise exposure, NIHL and use of protective hearing devices among the nightclub workers will also be determined, and steps will be taken to provide education on the need to protect the hearing of these workers. Awareness of the importance of the use of hearing protection devices prevents or lessens the effects of occupational noise exposure and also improves quality of life.

1.4 AIM OF THE STUDY

The aims of the study were to determine:

- The levels of noise to which nightclub workers are exposed
- Their level of knowledge about the causes, symptoms, effects and prevention of occupational noise exposure and
- The prevalence of NIHL among them.

1.5 OBJECTIVES

These specific objectives were used to achieve the aim of the study:

- Ascertain the level of knowledge of nightclub workers about the causes, symptoms, effects and prevention of occupational exposure to noise.
- Determine the prevalence of NIHL among nightclub workers in Accra.
- Determine the relationship between the duration of exposure and the degree of hearing loss.

1.6 RESEARCH QUESTIONS

1. What is the knowledge base of nightclub workers about the signs and effects of excessive noise exposure?
2. What is the knowledge of nightclub workers about hearing protection devices?
3. What is the prevalence of hearing loss among night club workers in Accra?
4. What is the effect of duration of exposure on the level of hearing loss?
5. Do night club workers in Accra use hearing protection devices?

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Noise-induced hearing loss is an irreversible disorder of hearing, characterized by a progressive loss of hearing in the high frequencies over time. It is caused by excessive exposures to high levels of noise. In years past, NIHL was commonly associated with people who worked with machinery or in industries that produced high levels of noise (such as power tools, milling machines, industrial production and construction) and some leisure activities such as sport shooting. Recent studies have however shown that, excessive exposure to recreational noise could also result in the development of NIHL (Plontke & Zenner, 2004). A study by Kelly (2013) revealed that the average noise exposed to nightclub workers was 92dBA. However, the National Institute for Occupational Safety and Health (NIOSH) recommended limit of exposure to occupational noise is 85dBA (Occupational Hearing Loss Surveillance, 2017).

2.2 CLASSIFICATION OF NOISE

Noise is defined as any undesired sound or unwarranted disturbance found within a frequency band (Concha-Barrientos, Campbell-Lendrum, & Steenland, 2004).

Noise may be classified according to variations in sound pressure levels (SPL), time and source.

2.2.1 Classification Of Noise According To Variations In Sound Pressure Level and Time

Noise classified by variations in SPL include:

Steady noise: This has negligible fluctuations of sound pressure level within the period of observation.

Non-steady or impulsive noise: SPLs shift significantly during the period of observation with impulsive noises. This kind of noise may either be intermittent and fluctuating noise.

- Intermittent noise - This is constant noise that starts and stops. The level of noise also drops to the level of the background noise several times during the period of observation.
- Fluctuating noise levels change continuously to a great extent during observation

Tonal noise: This kind of noise is characterized by one or two single frequencies and may be continuous or fluctuating (Hanson, 2010).

With respect to variations in time, noise is classified as constant if it remains steady within 5dB over a long time; otherwise it is classified as impulsive when it lasts for less than a second, and consists of one or more bursts of sound energy (Hanson, 2010).

2.2.2 Classification Of Noise According To Source

Environmental Noise: This can be grouped into indoor and outdoor sources of noise. Indoor sources of noise include domestically-generated noise from household gadgets and appliances. Outdoor sources of noise include traffic noise, recreational noise from social centers, festivals and celebrations, as well as noise generated from religious centers (Newton, 2013).

Occupational noise: This is noise produced at the workplace. Occupational noise is common in sectors such as mining, transportation, manufacturing, construction and the military/ security services. This predisposes most workers in these sectors to the development of occupational noise-induced hearing loss if measures are not put in place to reduce the effect of noise or exposure to it (Concha-Barrientos *et al.*, 2004).

2.3 AUDITORY SYSTEM AND MECHANISM OF HEARING

2.3.1 Auditory System

The outer ear is formed by the pinna and the external auditory canal. It is separated from the middle ear by the tympanic membrane as shown in Fig.2.1.

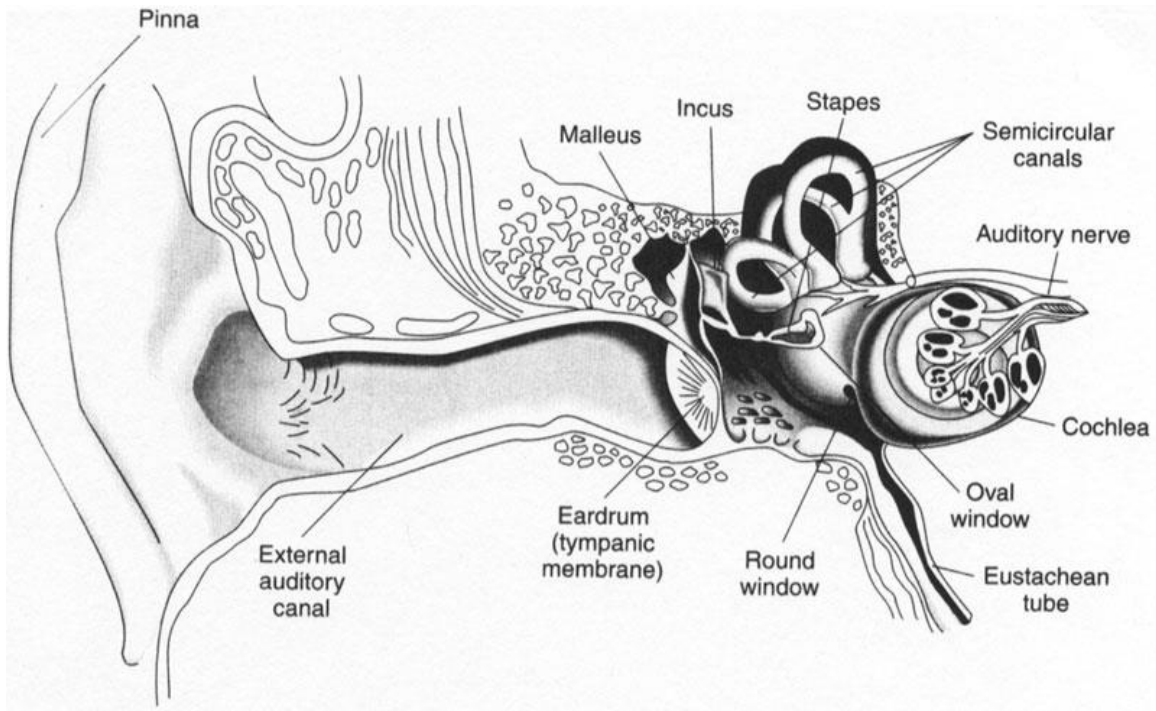


Figure 2.1: Auditory system

Source: www.skidmore.edu

The outer ear is responsible for collecting sound. The middle ear is an impedance matching device, and houses the three ossicles. These are namely the malleus, incus and stapes. This ossicular chain is a system of levers that serve to amplify sound. The outer and middle ear form the sound conducting mechanism and also amplifies sound signals. The inner ear consists of the cochlea and the vestibular labyrinth (semicircular canals). The former transduces vibrations into a nerve impulse whilst the latter houses the organ of balance (Alberti, 2010).

2.3.2 Mechanism of Hearing

Sound waves are collected by the pinna through the external auditory canal. These sound waves set the tympanic membrane into vibration. The vibrations are conveyed through the three ossicles to the oval window. The vibrations stimulate the fluids of the cochlea, which in turn stimulate the hair cells (sensory receptors) of the organ of corti. The response of the hair cells activates the neurons in the auditory nerve, which converts the signal into a neural code. This is now transported through the auditory nerve to the brain to be processed by the nervous system (Gelfand, 2016).

2.4 TYPES OF HEARING LOSS

Hearing loss occurs in diverse forms. It could be conductive (CHL), sensorineural, or mixed. A schematic diagram showing the various types of hearing loss is presented in Fig.2.2.

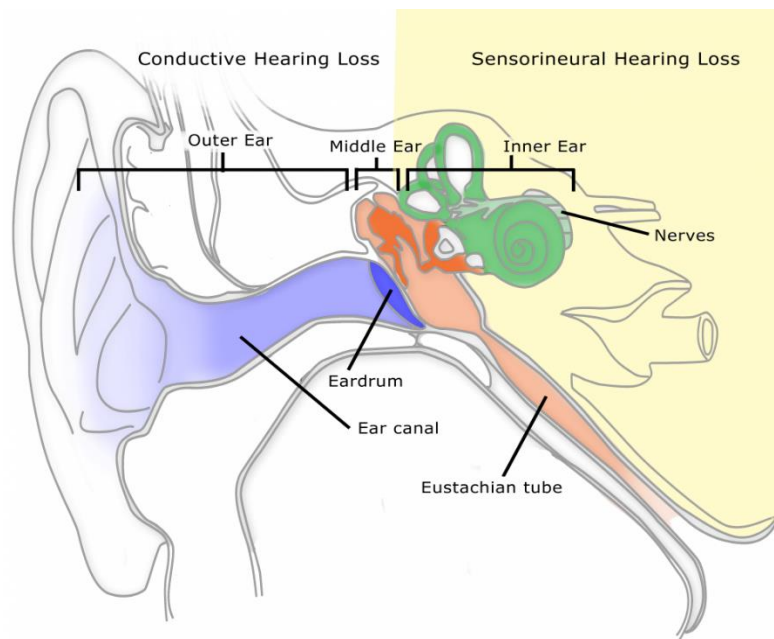


Fig.2.2: Types of hearing loss

Source: The National Hearing Test (2014)

2.4.1 Conductive Hearing Loss

This type of hearing loss is caused by an impairment of transmission of sound waves from the environment to the cochlear. Signals reaching the neural system are therefore attenuated. Conductive losses may be reversed if the sources of impairment such as excessive ear wax (cerumen), a middle ear infection such as otitis media, foreign bodies, growths or tumors, are removed (Gelfand, 2016).

2.4.2 Sensorineural Hearing Loss

This is caused by an impairment in the function of the cochlea and/ or the auditory nerve. Sensory receptors such as the hair cells may also be affected. Sensorineural losses are classified as cochlear or retrocochlear disorders, depending on if they occur in the cochlear or ‘after the cochlear’. Damage to the base of the cochlear results in high frequency hearing loss, with the outer hair cells being more susceptible to damage. Sensorineural losses are mostly irreversible (Gelfand, 2016). Some causes of sensorineural hearing loss are: ototoxic drugs, excessive exposure to loud noise, ageing and head trauma (ASHA, 2015).

2.4.3 Mixed Hearing Loss

This occurs when a conductive and a sensorineural loss occur in the same ear. It may be caused by two separate disorders in the same ear, or by a disorder which has the ability to affect both the conductive and sensorineural systems of the auditory system (Gelfand, 2016).

2.5 DEGREES OF HEARING LOSS

This is the quantification of hearing loss which is an indication of the severity of hearing loss for each ear. The degree of loss is based on the pure tone average of air conduction thresholds of the client at 500 Hz, 1000 Hz and 2000 Hz. A commonly used classification is the Goodman and Clark's, which is a combination of Goodman 1965 and Clark 1981 classifications (Swanepoel & Laurent, 2018), as presented in Table 2.1.

Table 2.1: Classification of hearing loss

Pure tone average in dBHL	Degree of hearing loss
< 15	Normal
16-25	Slight
26-40	Mild
41-55	Moderate
56-70	Moderately severe
71-90	Severe
≥ 90	Profound

Swanepoel & Laurent (2018)

2.6 DESCRIPTORS OF HEARING LOSS

Hearing loss is described as bilateral if the loss occurs in both ears, or unilateral if the loss occurs in only one ear with normal hearing in the other ear.

Hearing loss may be symmetrical if the configuration and degree of loss is the same in both ears; otherwise it is asymmetrical (different degrees of loss and configuration in each ear).

Progressive hearing loss becomes worse with time, while sudden loss happens at once with unknown causes.

Fluctuating hearing loss changes over time, and it can become better or worse.

The hearing loss is described as stable when the loss remains the same over time without any change (ASHA, 2015).

2.7 PATHOPHYSIOLOGY OF OCCUPATIONAL NOISE-INDUCED HEARING LOSS

Damage to the hair cells is influenced by two characteristics:

- increased duration of exposure, and increased duration of intensity, which both lead to increased degrees of hearing loss.
- Individual lifestyle such as smoking, use of ototoxic medication, diabetes or hypertension and age, all affect an individual's susceptibility to hearing loss and the degree of hearing loss after noise exposure (Hong *et al.*, 2013).

Temporary threshold shift (TTS) results from exhaustion of hair cells due to metabolic stress and may be caused by exposure to excessive noise during long hours of work. Temporary threshold shift is transient, and usually followed by a recovery after a period of rest. When TTS becomes repeated with less recovery, it often progresses to permanent threshold shift (PTS). This occurs due to the failure of the hair cells to recover after exposure to excessive noise levels.

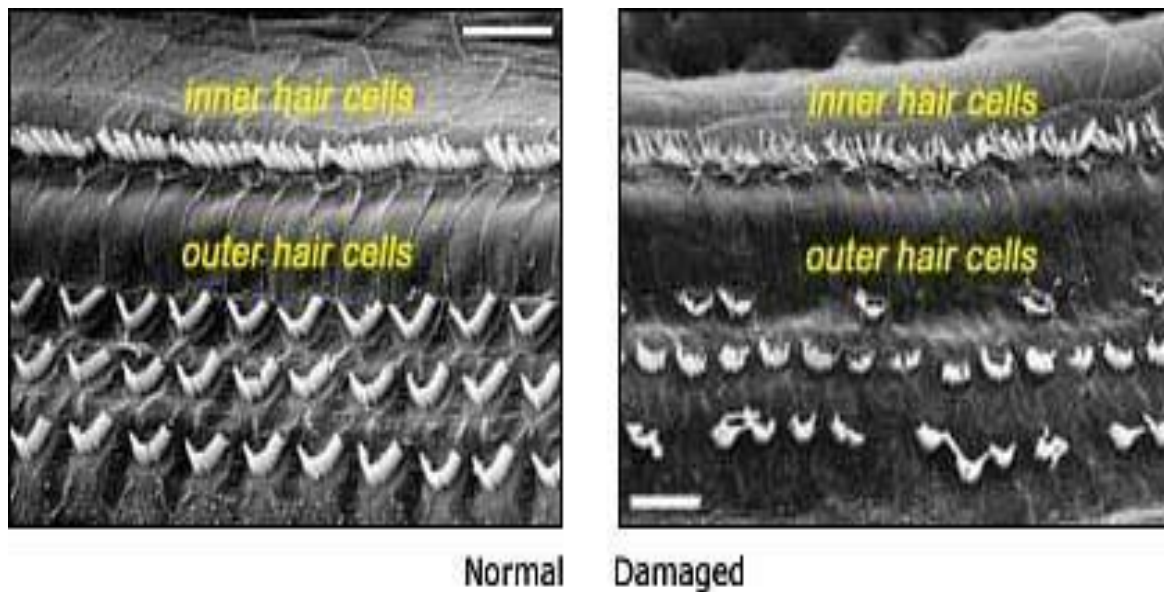


Figure 2.3: Normal and damaged hair cells Source: www.pinterest.com

The outer hair cells of the basilar membrane of the cochlea, and its adjacent areas respond to sound frequencies of 4 kHz, and 3 kHz and 6 kHz respectively. These are the points where PTS (of hair cell recovery) begins. This is shown classically on audiograms as the audiometric notch at 4 kHz (Fig.2.4). The notch usually extends into adjacent frequencies (between 3 and 6 kHz) with continued exposure (Goelzer *et al.*, 2010).

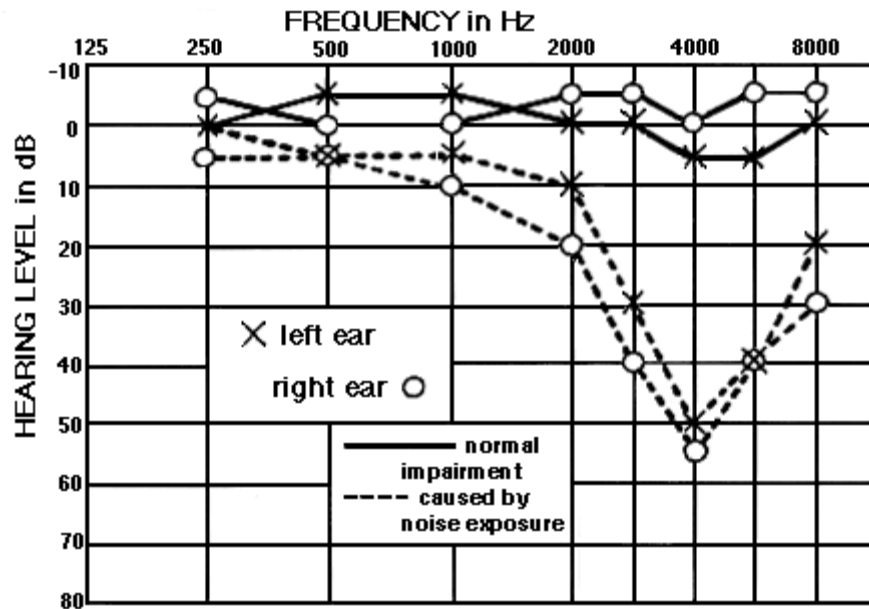


Figure 2.4: Audiogram showing notch at 4kHz Source: <https://www.sfu.ca>

2.8 EFFECTS OF EXCESSIVE OCCUPATIONAL NOISE EXPOSURE

Excessive noise exposure as an occupational hazard has many adverse effects on the affected individual. Effects of noise exposure are auditory as well as extra auditory; auditory effects are however irreversible (Hong *et al.*, 2013). A study conducted by Mahendra & Sridhar (2008), revealed that industrial workers in India exposed to different octave bands of noise showed symptoms such as frequent ear vibrations and pulsations, pains in the neck and back, chronic fatigue, repeated headaches, sudden awakening from sleep and pressure in the eye balls. Also, Welch & Welch (2012) reported that a greater incidence of neurologic, digestive as well as metabolic disorders in workers exposed to noise for many years even after retirement. Hypertension, fluctuations of blood pressure, and impairment in the function of some cardiac muscles were also observed. Basner *et al.*, (2014) have also reported that excessive noise also affects the cognitive development of children of school-going age.

Noise affects the auditory system directly by causing NIHL and tinnitus. This negative effect can be caused by exposure to an impulsive or sudden noise, or when exposure is steady, chronic and exceeds the limit of 85dBA (Basner *et al.*, 2014).

2.9 TINNITUS

Tinnitus is a negative effect of noise exposure and is very common in hearing loss. Tinnitus cannot be attributed to external sources and is predominantly subjective. It manifests as ringing in the ears, ranging from hearing one's own pulse to buzzing, clicking, whistling and humming. Tinnitus causes insomnia, decreased ability to sustain attention and depression (Basner *et al.*, 2014). A study conducted by Masterson *et al.*, (2016) in the USA among workers exposed to noise recorded 23% of hearing loss, 15% of tinnitus and 9% of both hearing loss and tinnitus. These studies and more show the negative effects of noise on the auditory system.

2.10 DESCRIPTION OF OCCUPATIONAL NOISE-INDUCED HEARING LOSS

Occupational NIHL is progressive, sensorineural (irreversible) and almost always bilateral and symmetrical (Concha-Barrientos *et al.*, 2004).

2.11 DIAGNOSIS OF OCCUPATIONAL NOISE-INDUCED HEARING LOSS

To make a diagnosis of NIHL, the loss needs to be identifiable and measurable on an audiogram. The requirements for diagnosis of NIHL are hearing loss in the high frequencies, exposure to potentially hazardous levels of noise, and an audiometric notch which is identifiable in the high frequencies (Coles, Lutman, & Buffin, 2000).

Pure-tone audiometry is mostly the first line test used in measuring and monitoring the progression of NIHL. Tympanometry may also be performed to rule out any middle ear pathologies. Recent

studies have however shown that, otoacoustic emissions (OAE) are more effective in detecting changes in the outer hair cells that may be overlooked by audiometric testing. Attias *et al.*, (2001) proved that OAEs were more sensitive in detecting noise damage to the hair cells in the cochlea than pure tone audiometry. They also reported an association between the emissions and severity of loss, where emissions narrowed with smaller amplitudes as the degree of hearing loss increased.

2.12 DAILY PERMISSIBLE NOISE EXPOSURE LIMITS

The severity of NIHL is dependent on the intensity of noise and also the duration of exposure. Limits have therefore been set to serve as a guide for individuals and agencies, so that workers' exposure limits will not exceed or be equal to the values stated in the table. This will help regulate excessive exposure to occupational noise and decrease its effects (NIOSH, 1998).

Exposure limits at 90 dBA, with an exchange rate of 5 dB using an 8 hour time-weighted average was previously set by OSHA. This limit however, does not cover all industries such as mining, transportation, and construction. NIOSH therefore recommends a 3 dB exchange rate (shown in Table 2.2), which has been supported by scientific evidence for assessing hearing impairment as a function of noise level and duration. This exchange rate is therefore more efficient in the prevention of occupational NIHL, and has also been supported by national and international consensus (NIOSH 1998).

Table 2.2: Exposure limits for occupational noise

Exposure level (dBA)	Duration of exposure	
	Hours	Minutes
80	25	
83	12	
85	8	
86	6	
88	4	
90	2	
92	1	
95		47
98		23
100		15
105		4
110		1

Source: NIOSH (1998)

2.13 HEARING CONSERVATION PROGRAM

This is a program which is designed to prevent workers exposed to excessive noise levels from developing NIHL even if they are exposed to noise for the entire duration of their working lives.

The hearing conservation program designed by OSHA is summarized as follows:

- Monitoring of noise levels in the workplace

Noise levels are monitored with a calibrated sound level meter to help identify employees who are exposed to levels of noise equivalent to, or more than 85 dBA, using a time-weighted average (TWA) of 8 hours.

- Audiometric testing of workers

It involves routine audiometric assessment to monitor a worker's exposure to industrial or occupational noise. A baseline audiogram is obtained before the employee starts work and is potentially exposed to excessive levels of noise. This audiogram forms the basis against which subsequent annual audiometric test results are compared. Follow-up audiometric tests also help to evaluate if the hearing conservation program is helping to prevent hearing loss among employees (OSHA 2002).

- Provision of hearing protection devices. In this method, hearing protection devices (HPDs) are provided for workers exposed to levels of noise equivalent to, or more than 85 dBA, using a TWA of 8 hours. Hearing protection devices selected should be comfortable and provide enough protection to help prevent NIHL.

- Training of workers

Workers exposed to TWA of 85 dB or more must be trained on the effects of excessive noise exposure on their hearing, the types and correct usage of HPDs. Training may be done in sections, scheduled according to the employees' work schedule to ensure flexibility. Workers who receive this training will be more motivated to use their HPDs since they will know and understand the rationale behind it.

- Proper record keeping

Records of employees' noise exposure measurements and audiometric test results must be properly kept for the duration of employment and two years after the end of employment (OSHA, 2002).

2.14 OCCUPATIONAL NOISE IN OTHER WORK SETTINGS

Exposure to occupational noise has been found to be a common cause of noise-induced hearing loss in other settings where workers are exposed to excessive noise levels. In the USA, approximately 22 million workers are exposed to harmful levels of noise at their workplaces, with hearing loss presenting as the third most common chronic physical condition. A sample of 1,413,789 audiograms of workers analyzed by the Centers for Disease Control and Prevention (CDC) from 2003 to 2012 showed that, the mining sector had the highest number of workers with hearing impairment (17%), with the construction sector coming in second with 16%. Workers in the public safety sector such as the police force, fire and protection services, prisons and correction services as well as the ambulance services recorded the lowest number of workers with hearing impairment (7%) (Masterson, Bushnell, Themann, & Morata, 2016).

A study by Agarwal *et al.*, (2015) among 341 steel factory workers in India showed that even though the workers showed normal hearing thresholds using the pure tone average of 500, 1000, 2000 and 4000 Hz, some of them had developed signs of early onset of NIHL. This was in the form of the notch at 4 kHz, which was seen on the audiograms. Results of this study showed threshold shifts greater than 25 dB in the 4 kHz frequency, in 198 right and left ears.

Another study among miners in Tanzania also showed the 47% prevalence NIHL among 256 workers. The severity of loss also increased with the number of years worked at the mines, with

miners who worked underground being more affected (71%) than their colleagues who worked in the open pits (28%) (Musiba, 2015).

In Nigeria, SNHL was recorded among workers of a steel rolling mill. Out of 103 workers, 56.8% had a mild to moderate loss. There was also an increase in the degree of loss with increased noise level exposure (Ologe et al., 2006).

A number of studies have also been done in Ghana to confirm the presence of noise-induced hearing loss among workers in Ghana. Noise levels recorded in a study in a gold mining company were above 85 dBA. Fifty-nine (59) out of 252 workers sampled for the study showed the classical notch at 4 kHz indicating noise-induced hearing loss. The study also reported that the severity of loss increased with an increase in the duration of exposure. Out of 81 workers who had been exposed to noise prior to employment at the mines, 41 (51%) of them presented with severe losses (Amedofu, 2004).

Boateng & Amedofu, (2005) conducted another study which revealed the presence of NIHL in 23%, 20% and 7.9% of workers in the corn mill, saw mill and the printing industry respectively. Early NIHL was also reported in 19.3% in the left ear and 14.3% in the right ear of a total of 140 workers in a study conducted in a stone crushing industry in Ghana (Kitcher, Ocansey, & Tumpi, 2012). A subsequent study by Kitcher, Ocansey, Abaidoo, & Atule, (2014) showed that majority of mill workers in Accra did not use hearing protection devices: only 5% out of the 101 workers sampled used hearing protection. Out of the 101, 24.8% had hearing loss with the characteristic 4 kHz notch which is indicative of NIHL. Another study among 400 workers selected from five different quarries in the Ashanti region of Ghana reported that all machines used in the various quarries produced noise in the range of 85.5 dBA to 102.7 dBA. Out of the 400 workers, hearing

thresholds above 25 dB were recorded in 176, representing 44% of workers (Gyamfi, Amankwaa, Owusu Sekyere, & Boateng, 2016).

2.15 OCCUPATIONAL NOISE IN NIGHTCLUBS

Studies have been conducted to assess the level of noise that nightclub employees are exposed to, and most findings revealed that nightclub employees are mostly exposed to noise levels which exceed the OSHA action level of 85 dBA.

A study by Gunderson *et al* (1997) to ascertain the risks of developing NIHL among workers of urban music clubs showed that, the overall participants' noise exposure levels in the study ranged from 91.9 dBA to 99.8 dBA. This included noise from both performances and ambient noise levels. The participants also reported symptoms of noise exposure such as tinnitus and subjective hearing loss. These symptoms also correlated with the participants' noise intensity exposures. This study concluded that employees of music clubs were at risk of developing NIHL because their chronic exposure to music exceeded the safe levels of 85 dBA.

In another study, 20 bar staff of 19 nightclubs in the UK were monitored and noise levels recorded in their various workplaces (Whitfield, 1998). It was confirmed that the noise levels in all the nightclubs exceeded the legally acceptable limit of dBA, where protection must be made available, and 85 dBA, where it is mandatory to use hearing protection (Basner *et al.*, 2014). Most of the workers were also ignorant of the effects of excessive noise exposure on their hearing, and took no protective action through the use of hearing protection devices to protect their hearing (Whitfield, 1998).

A report from the Occupational Health and Safety Service, (2004) revealed that nightclub employees in the UK, as well as the workers in pubs, were constantly exposed to noise around 110 dB which is equivalent to the intensity of sound produced when an aircraft takes off.

In another study conducted by Kelly *et al* , (2012), all 17 employees from 9 nightclubs in Ireland worked in environments where their noise exposure per shift was 92dBA. Interestingly, hearing protection was mandatory for employees in only a single nightclub out of the 9 used for the study. Data gathered from employees using questionnaires showed that none of the employees knew the average noise level that was not to be exceeded in a day. Neither did they know the level of noise exposure at which hearing protection devices had to be worn.

Employees were also observed working without the use of any hearing protection devices in a study conducted in Canada in which results indicated that all 60 nightclubs had an average noise level of 96 dB. This was more than the accepted limit of 85 dB (Dobson & Gastmeier, 2015).

2.16 PREVENTION OF NOISE-INDUCED HEARING LOSS AMONG NIGHTCLUB EMPLOYEES

According to Lewin (2017), some measures were outlined to reduce the effect of noise on the hearing of nightclub employees. Among these measures is the directional positioning of loudspeakers to concentrate the noise onto the dance floor and away from the location of staff workers, rotation of staff to limit the exposure of workers to noise and adaption of hearing conservation programs. This includes routine audiometry, noise assessment of the work area and the supply of hearing protection devices to workers found to be at risk of developing a permanent NIHL.

2.17 CONCLUSION

The literature reviewed shows that there is relevant data concerning NIHL among workers of other industries in Ghana and other parts of the world. Studies concerning the risk of NIHL and the level of noise exposure in the entertainment and music industry have also been conducted in other parts of the world. However, in Ghana, no such study has been conducted among nightclub workers. It is therefore imperative that such a study is conducted, and the methodology for this study is outlined in the next Chapter.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This Chapter outlines the approach employed in conducting the study. This includes study design, study site, study population, sampling design, data collection instruments/ techniques as well as data analysis.

3.2 STUDY DESIGN

A cross-sectional, descriptive and analytical research design was adopted in this study. A structured questionnaire was used as a demographic data collection tool. Other sources of data included workers' knowledge about symptoms of noise exposure, as well as effects of occupational exposure to noise. Level of noise in the nightclubs was assessed using a sound level meter, and audiometric testing was employed to assess the hearing acuity of workers.

3.3 STUDY SITE

Three nightclubs were selected as study sites within Accra. These clubs were selected because permission was given by their managers to have the research conducted in their premises. All three nightclubs had similar architecture which includes a bar, where drinks are served, an enclosed space which serves as a dance floor. Loud speakers were placed at vantage points within the enclosed space. The intensity of music was also increased as the clubs filled up with more people. The clubs were opened from Wednesday to Sundays, however, they were most patronized from Friday through to Sunday nights.

3.4 STUDY PARTICIPANTS

Persons who worked at the bar, as well as waiters and waitresses who moved around within the clubs to serve clients constituted the study population. The workers' shifts started from 3pm in the afternoon and lasted till 4:30am -5:00am the following day, but music was only played to attract clients from 6pm. The duration of shift from when the workers report to work to when they close was between 13 and half hours to 17 hours. The duration from when the music starts playing to when the shift ends is however between 8 and 10 and half hours.

3.5 SAMPLE SIZE CALCULATION

A study conducted in Ghana reported the proportion of workers with NIHL as 20.4% (Arthur, 2016). Based on this proportion, the sample size was calculated using the equation below;

$$n = \frac{[Z]^2 P[1-P]}{E^2}$$

where;

n is the estimated minimum sample size

E is the allowable confidence level (margin of error) (0.09)

Z is the critical score for 90% confidence interval (1.64)

P is the proportion of workers with NIHL in the population (0.204)

Using the given values, a minimum sample size of 44 participants was generated. Based on this calculation, fifty workers were purposively selected from three nightclubs within Accra for the study. The research study was focused on particular characteristics of the population of interest (exposure to sound), which would best enable the research questions to be answered.

3.6 SAMPLING TECHNIQUE

A meeting was scheduled between the researcher and the managers of all three nightclubs at different times, depending on their availability. At these meetings, the purpose of the research, as well as all the processes involved in conducting the study were explained to the managers. Copies of an introductory letter obtained from the Department of Audiology, Speech and Language Therapy was also made available to them. The researcher was then introduced to workers who were eligible and were willing to participate in the study. Details of the study including data collection procedures was explained to the workers again, after which they were made to sign a consent form to confirm their willingness to participate in the study.

The independent and dependent variables for the study were occupational noise levels and hearing loss respectively. Other variables of interest in this study were duration of employment, duration of shift, knowledge of workers about noise-induced hearing loss as well as hearing protection devices and their use.

3.7 INCLUSION AND EXCLUSION CRITERIA

3.7.1 Inclusion Criteria

Participants were considered eligible for the study if they had been employed for a duration of one year or more, as well as signing a consent form to indicate that they had agreed to participate in the study after all details and procedures had been explained to them in full.

3.7.2 Exclusion Criteria

Workers who have had an ear infection within the last three months within which the study was conducted, as well as those who have had surgery in either ear, or had previously been treated with ototoxic medications were exempted from the study. Workers with a family history of deafness

were exempted from the study. Lastly, the club managers and security men who did not spend as much time inside the club did not participate in the study.

3.8 DATA COLLECTION PROCEDURE

3.8.1 Noise Level Measurement

Sound levels in the nightclubs was recorded using a Type 2 general purpose sound level meter. This was taken at vantage points within all three clubs such as at the bar and at the dance floor. Measurements were taken on Wednesdays and Saturdays, Wednesdays being the less busy days and Saturdays being the days when the clubs were most busy with music on maximum levels. Time for the measurements were between 11pm and 12 mid night on Wednesdays and 2am to 3am on Saturdays.

3.8.2 Ear Examination

Participants' ears were examined with an otoscope prior to testing to ensure that their ears were free of cerumen and to rule out the presence of tympanic membrane perforations, foreign bodies as well as middle ear infection.

3.8.3 Pure Tone Audiometry

Pure tone testing was conducted on the premises of the night clubs as the workers were not available outside their working hours to report to the Hearing Assessment Center of the Korle Bu Teaching Hospital. Background noise in the testing room was therefore measured with a sound level meter to make sure it was quiet enough to ensure an environment for accurate testing. Ambient noise levels recorded were found to be 35dB. Testing was also periodically done to ensure that the ambient noise levels did not exceed 35dB. This was done to ensure that ambient noise was within the level suitable for testing. Fans, air conditions and other equipment that served as sources

of noise were also put off. Participants were then seated comfortably and the test procedure was explained to them individually as they sat for the test. The sitting position was such that the participant was facing away from the tester. This ensured that they could not observe the hand movements of the tester when the tones were being presented.

3.8.4 Instructions

The participants were told that both ears were going to be tested one after the other, and they were instructed to listen carefully to the tones presented through the head set and to press the response button only when they heard the tone. They were also instructed to press the response button irrespective of the ear in which the tone was presented, and also to respond no matter how faint the tone was. The head set was then fixed and adjusted correctly to prevent collapsing of the ear pinna and attenuation of the sound presented.

3.8.5 Determination of Pure Tone Threshold

The Hughson-Westlake procedure was used to determine the pure tone threshold of the participants: Testing begins by presenting a tone at 30 dB HL above the client's presumed threshold. The tone is decreased in 10 dB steps until there is no response. Exploration of threshold then begins by increasing the tone in 5dB steps until a threshold is reached. The tone where there is a response 50% of the time is the pure tone threshold loss (Katz *et al*, 2015).

Each ear was evaluated at eight different frequencies in Hz- 500, 1000, 2000, 3000, 4000, 6000 and 8000. A warble or pulse tone was used for audiometric testing, depending on if the participant presented a complaint of (per answer given on the questionnaire). Audiograms were analyzed and degree of hearing loss was classified as indicated in the Goodman (1965) classification of hearing loss.

3.9 DATA COLLECTION EQUIPMENT AND INSTRUMENTS

A Cirrus Research plc sound level meter model number CR: 161B (Type 2) was used for noise level assessments in the nightclubs. This instrument was used because it has both the A and C weighting and also measures the fast and slow response. It meets the guidelines set by OSHA and has been built for occupational noise measurements.

A Heine mini 3000 otoscope was used to directly visualize the ear canal to rule out any middle ear infections or pathologies, as well as to determine the presence of tympanic membrane perforation or cerumen before audiometric testing was carried out on the participants. Interacoustics AD 226 audiometer was used for audiometric assessment of participants' hearing acuity and to establish their hearing thresholds. Instruments for data collection are presented in Figures 3.1 to 3.3.

A modified two-part questionnaire was used to collect data from participants. Section A collected information about demographic data whilst section B collected information about participants' knowledge about: signs of occupational noise exposure, noise-induced hearing loss, hearing protection devices as well their use and the availability of hearing protection devices at their workplaces.

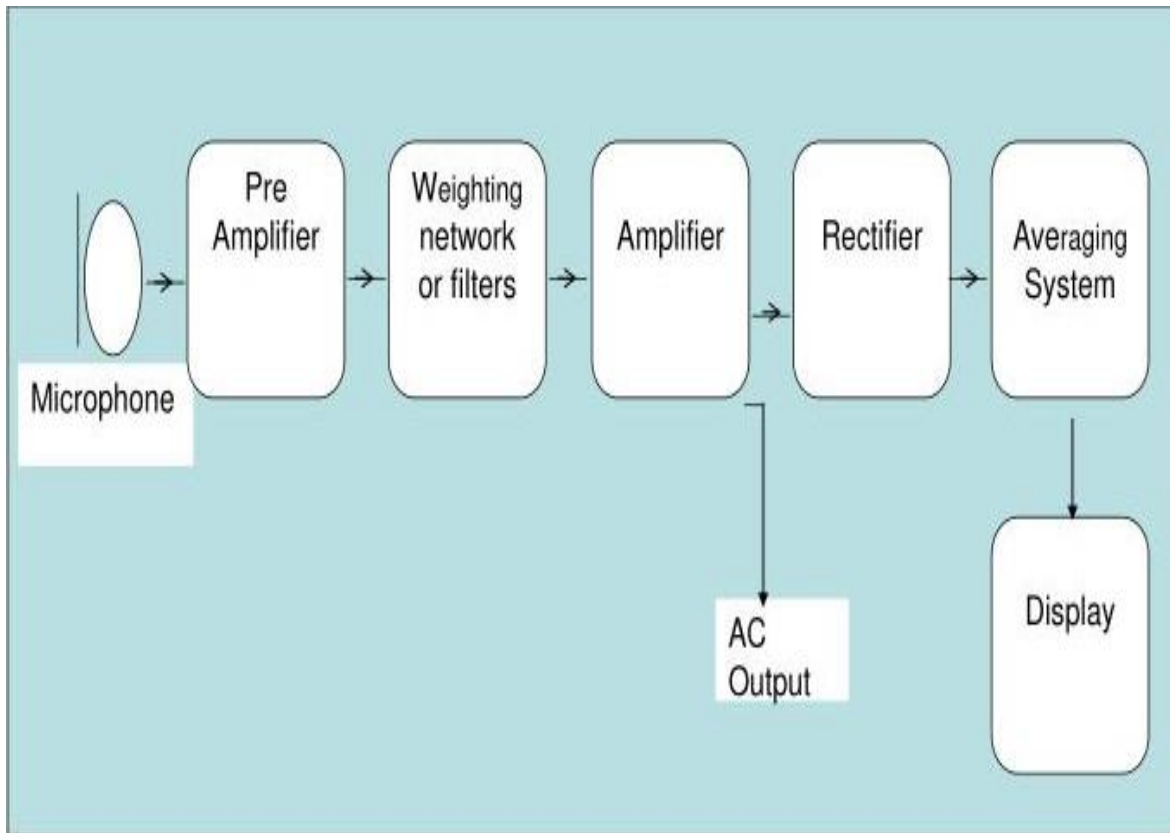


Figure 3.1: Block diagram of Sound level meter Source: (www.slideserve.com)

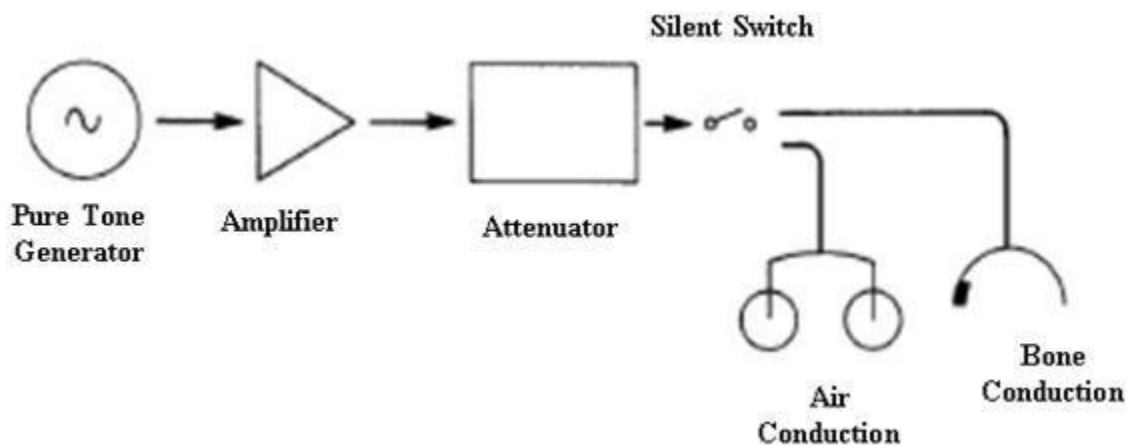


Figure 3.2: Block diagram of the audiometer Source: www.researchgate.net

3.10 DATA PROCESSING AND ANALYSIS

Data collected from questionnaires and audiograms was coded and analyzed using Statistical Package for Social Sciences (SPSS) version 22, Microsoft Excel and R Data Analysis software. Demographic characteristics of participants were described and presented using descriptive statistics. Responses from the questionnaires showing level of knowledge of participants about the causes, symptoms, effects and prevention of occupational exposure to noise were reported in percentages. The association between the duration of exposure (employment and shift) and degree of hearing loss was determined using chi-square test, and a p-value of less than 0.05 was considered as significant.

3.11 ETHICAL CONSIDERATION

Ethical clearance was sought from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, University of Ghana (Appendix II). Participants signed an informed consent form after the purpose of the study and the procedure for data collection had been explained to. This ensured that they willingly participated in the study. Codes were generated for participants to ensure anonymity and confidentiality of the data collected from questionnaires and pure tone audiometry.

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

In this Chapter, the findings on the study conducted to investigate the prevalence of NIHL among nightclub workers in Accra as well as their knowledge about causes, symptoms, effects and prevention of occupational exposure to noise are presented. The participants' demographic data, their knowledge about causes and signs of NIHL, and the use of hearing protection devices, as well as audiometric results and statistical associations between variables are also presented.

4.2 DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

A total of 50 workers from 3 nightclubs in Accra participated in this study. Their age and gender demographics is presented in Table 4.1, while the details of their work shift are presented in Table 4.2.

Table 4.1: Demographic data of participants

Demographic variables		Frequency	Percentage (%)	Mean $\pm$ Std.dev
Gender	Male	41	82	
	Female	9	18	
Age (years)	20-25	9	18	
	26-30	24	48	28.68 $\pm$ 3.72 years
	31-35	15	30	
	36-40	2	4	
	Total	50	100	

Table 4.2: Employment and duration of work shift of participants

Duration of employment			Duration of work shift		
Time (yrs)	Frequency	Percent (%)	Time (hours)	Frequency	Percent (%)
1.0	5	10	8	7	14
2.0	10	20	10	7	14
2.5	1	2	11	4	8
3.0	11	22	12	19	38
4.0	7	14	14	5	10
4.5	2	4	15	2	4
5.0	6	12	16	4	8
6.0	4	8	17	2	4
6.5	1	2			
7.0	3	6			
Total	50	100		50	100
Mean± std. dev		3.58			11.92

There were more males ($n=41$, 82%) than females ($n=9$, 18%). The workers' ages ranged from 20 to 40 years, with a mean of 28.68 ± 3.72 years. Most of the workers had either 2 years ($n=10$, 20.0%) or 3 years ($n=1$, 22.0%) of working experience. The mean duration of employment was 3.58 years for the workers whose working experience ranged from 1 to 7 years. Nineteen (38%) out of 50 participants worked in shifts ranging from 8 to 17 hours (mean: 11.92 hours).

4.3 SIGNS OF OCCUPATIONAL NOISE EXPOSURE

The participants' responses on signs of occupational noise exposure are presented in Table 4.3.

Table 4.3: Participants' responses on signs of occupational noise exposure

Occupational exposure	Response (%)		
	Yes	No	
Raising of voice during a shift	34	66	
Subjective report of decrease in hearing level	10	90	
Experience of tinnitus after a shift	Always	Sometimes	Never
	56	26	18

Seventeen (34%) of the workers confirmed that they raised their voices while talking to colleagues during a shift, and 33 (66%) did not raise their voices. Five (10%) of the participants also reported subjectively that they had noticed a decrease in their hearing level. The remaining 45 (90%) reported that they had normal hearing. Although 9 (18%) workers never experienced tinnitus after a shift, 13 (26%) reported occasional experiences of tinnitus whilst 28 (56%) always experienced tinnitus after a shift.

4.4 KNOWLEDGE ABOUT NEGATIVE EFFECTS OF EXCESSIVE NOISE

EXPOSURE AND NOISE-INDUCED HEARING LOSS

The results of the assessment of participants' knowledge about the adverse effects of exposure to excessive noise and NIHL are shown in Table 4.4. In particular, 28 (56%) answered yes whilst 22 (44%) answered no. Also, only 12 (24%) knew about NIHL as a hearing impairment condition, while 38 (76%) answered in the negative.

Table 4.4: Knowledge of negative effects of noise exposure and NIHL

Knowledge assessment index	Response (%)	
	Yes	No
Knowledge of negative effects of excessive noise exposure	28 (56.0%)	22 (44.0%)
Knowledge of NIHL as a condition	12 (24.0%)	38 (76.0%)

4.5 USAGE OF HEARING PROTECTION DEVICES DURING SHIFT ROTATION

Hearing protective devices are important for attenuating acoustic noise exposure and preserving normal hearing. In this study, the results of the participants' responses about use of hearing devices and shifts in rotation are presented in Table 4.5.

Table 4.5: Knowledge of hearing protection devices

Knowledge assessment	Responses (%)		Type
	Yes	No	Ear muffs
Knowledge about hearing protection devices	8 (16.0)	42 (84.0)	8 (16.0%)
Use of hearing protection devices	0 (0.0)	50 (100.0%)	
	Available	Not available	
Reason for not using protection devices	0 (0.0%)	50 (100.0%)	
	Yes	No	
Shift rotation	19 (38.0%)	31 (62.0%)	

As noted in Table 4.5, none of the 50 participants used hearing protection devices during a shift, and explained that the hearing protective devices were not available. Fewer workers (38%) confirmed shift rotations at their workplaces, while majority (62%) answered no.

4.6 ASSOCIATION BETWEEN DURATION OF EMPLOYMENT AND DEGREE OF HEARING LOSS

Association between duration of employment and degree of hearing loss was determined using threshold averages of 2000 Hz, 3000Hz and 4000Hz. This was computed by splitting the participants' duration of employment into two groups: from 1 to 3 years, and from 4 to 7 years. Average air conduction thresholds were subsequently computed for both groups using frequencies of 2000, 3000 and 4000Hz. This was done for both left (LAC) and right (RAC) ears (Table 4.6).

Table 4.6: Pure tone average of left and right ears using 2000Hz, 3000Hz and 4000Hz

Duration of employment (years)	Pure tone averages		
	PTA right ear		PTA left ear
1-3	12.90		12.83
4-7	21.15		21.81
Average of thresholds at 2000Hz, 3000Hz, and 4000 Hz using duration of employment			
	RAC2K	RAC3K	RAC4K
Average thresholds of 1-3years of employment	11.66	12.96	14.07
Average thresholds of 4-7years employment	13.69	17.17	32.60
	LAC2K	LAC3K	LAC4K
Average thresholds of 1-3years of employment	11.66	12.59	14.25
Average thresholds of 4-7years of employment	13.91	18.47	33.05
RAC- right air conduction LAC- left air conduction PTA = pure tone averages			

It was observed that the mean thresholds of the 4000Hz frequencies in both ears were higher than in the 2000Hz and 3000Hz frequencies. The pure tone averages (PTA) of the three frequencies (2000Hz, 3000Hz and 4000Hz) were also found using the formula:

$$PTA = \sum (\text{thresholds at 2, 3 and 4Kz}) \div 3$$

The results showed that the PTA of participants with 4 to 7 years duration of employment was higher in both the left and right ears, even though they were within normal hearing range.

4.7 FREQUENCY OF THRESHOLDS AT 4000 Hz

The frequency thresholds at 4000Hz are presented in Table 4.7.

Table 4.7: Frequency distribution of thresholds at 4 kHz

Ear	Thresholds	Frequency	Percentage, %	Mean
Right	10	15	30	22.6
	15	4	8	
	20	7	14	
	25	3	6	
	30	9	18	
	35	9	18	
	40	3	6	
Left	10	14	28	22.9
	15	6	12	
	20	6	12	
	25	2	4	
	30	9	18	
	35	9	18	
	40	4	8	

There was a small difference in thresholds at 4000Hz for the left and right ears. Twenty-nine (58.0%) participants had thresholds between 10 and 25 dB, which show normal hearing levels, while the remaining 21 (42%) recorded thresholds between 30 to 40 dB in the right ears. For the left ears, 56% recorded thresholds between 10 and 25dB, with 44% recording thresholds between 30 to 40 dB.

4.8 MULTIPLE LINEAR REGRESSION ANALYSIS AT 4000HZ

Multiple regression analysis was used to test if the number of shift hours and the duration of employment contributed to hearing loss. Hence, the loss and notch at 4000 Hz were used. The results (Table 4.8) showed a p -value < 0.05 in both ears.

Table 4.8: Association between duration of shift and employment and 4000 Hz

Ear	Predictors	R^2	B	T	p -value
Right		0.65	-8.02	-1.72	0.0917
	Duration of shift		1.62	3.37	0.0015
	Duration of employment		3.12	4.53	0.00004
Left		0.62	-5.98	-1.21	0.2321
	Duration of shift		1.38	2.70	0.00942
	Duration of employment		3.44	4.70	0.000022

The results showed a significant association between the number of shift hours, the duration of employment, and hearing loss in the 4000 Hz frequency, which is indicative of NIHL.

4.9 COMPARISON OF HEARING LOSS AT 4000Hz

Analysis of variance (ANOVA) was used to test the differences between means of the duration of employment, split into two groups, i.e., 1 to 3 years and 4 to 7 years. With a confidence interval of 95%, a significant difference was established between the two means. The group with longer years of employment (4-7 years) presented with higher means in both ears (Table 4.9).

Table 4.9: Comparison- duration of employment and hearing loss at 4kHz (right ears)

Duration of employment		Mean	SE	<i>df</i>	Confidence level	
Ear	(years)				Lower	Upper
Right	1-3	14.07	0.96	48	12.14	16.00
	4-7	32.60	1.04	48	30.51	34.70
Left	1-3	14.25	1.01	48	12.22	16.29
	4-7	33.04	1.09	48	30.84	35.24

Confidence level of 95% used

4.10 NOISE LEVELS RECORDED IN THE CLUBS

Noise levels in the nightclubs were recorded using a sound level meter and the mean noise levels for all the study sites were calculated (Table 4.10). The mean noise level was used to calculate the mean *Leq* using the mean hours of shift worked. Time-weighted average (TWA) of noise exposure to the workers were also computed with an occupational noise calculator using the number of hours per shift, as shown in Table 4.10. The recorded maximum and minimum peak dBs were used for the calculations.

Table 4.10: Recorded noise levels at study sites

Site	Time range	Peak dB	Average noise level dBA	Mean shift duration (hrs)	Mean L_{eq} , (dBA)
A	00:47-03:10	89.8-90.3	90.5	12	92.4
B	23:56-02:14	89.6-90.3	88.5		91.4
C	00:15-02:15	89.7-90.0	89.6		92.9

Table 4.3: Workers' noise exposure limits per hours worked

Site	Peak noise levels (dBA)		TWA for hours per shift							
			8	10	11	12	14	15	16	17
Site A	Min	89.8	89.8	91.4	92.1	92.7	93.8	94.3	94.8	95.2
	Max	90.3	90.3	91.8	92.6	93.2	94.3	94.8	95.3	95.7
Site B	Min	86.6	86.6	88.2	88.9	89.5	90.6	91.1	91.6	92.0
	Max	90.3	90.3	91.9	92.6	93.2	94.3	94.8	95.3	95.7
Site C	Min	89.7	89.7	91.3	92.0	92.6	93.7	94.2	94.7	95.1
	Max	90.0	90.0	91.6	92.3	92.9	94.0	94.5	95.0	95.4

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

Occupational hearing loss has mostly been associated with workers in industries such as the mines, quarry, milling and production factories etc. however, some recent studies have shown that exposure to recreational noise (such as music played in nightclubs or pubs) is equally hazardous to the hearing mechanism of the inner ear. This study set out to determine noise exposure levels of nightclub workers and the prevalence of NIHL among them. The level of knowledge of the nightclub workers about the signs and effects of occupational noise exposure, hearing protection devices, as well as the relationship between the duration of exposure and degree of hearing loss was also established.

5.2 SIGNS OF OCCUPATIONAL NOISE EXPOSURE

Results of this study showed that 34% of the respondents raised their voices during a shift. Another 18% reported they experienced ringing in their ears after a shift, whilst 26% also experienced same some of the time. Out of the 50 respondents, 10% reported a decrease in their hearing level. This is comparable to a study by Gunderson *et al.* (1997) which intended to find the risk of hearing loss among other workers in a music club, aside the musicians themselves.

Results of their study showed that the workers in the music club were exposed to high music levels, with an average sound level of 94.9 to 106.7dBA recorded during performances. Out of the 31 music club employees sampled for the study, 16% reported symptoms of noise exposure. This included tinnitus and a reported subjective decrease in hearing acuity. The study concluded that the workers were at risk of developing noised-induced hearing loss with repeated, continuous

exposure over time. The researchers also suggested the adoption of hearing conservation programmes which include the frequent use of hearing protection devices. Literature from ASHA, (2018) also confirms raising of the voice and tinnitus as signs of being exposed to noise which is excessively loud. The Lombard effect accounts for the reason why workers may raise their voices in the nightclubs during a shift. This theory states that the presence of noise above a speaker's threshold causes them to speak more loudly involuntarily, in an effort to monitor/hear their own voices as they speak (Katz *et al*, 2015).

5.3 PREVALENCE OF HEARING LOSS

This study reported normal hearing levels in both 2 and 3kHz frequencies for all 50 respondents, with 21(42%) and 22(44%) having thresholds >25 in 4kHz in the right and left ears respectively, indicative of mild hearing loss in that frequency. This shows the classical sign of development of NIHL. This may be accounted for with the fact that, 54% of the employees were within the employment range of 4 to 7 years, while 86% were in the 10 to 17hour duration of shift category. The participants also worked four days a week, having three days off (from Monday to Wednesday or Sunday to Tuesday). These days served as periods of rest and a possible reversal of temporary threshold shifts that may have occurred during the other working days. There was also rotation of shifts for 19 (38%) out of the 50 workers. This ensured that they rotated between areas of high noise levels as well as low-level noise areas, thereby reducing their exposure time.

Another factor which may have accounted for this result is that even though some of the workers spent between 10 to 17 hours at work, their hours of exposure to loud music were between 8 to 10 hours since music is mostly played at high intensities to attract patrons from the fourth or sixth hour of the shift, depending on when they reported to work.

This result is comparable to a study by Helleman & Dreschler, (2015), which investigated the effect of a break in exposure to nightclub music on temporary threshold shifts (TTS) of 18 participants. Subjects were exposed to the dance music for two hours consecutively or two hours with a one hour break in between. Results of this study showed that TTS of 1.7dB for the right ears and 3.4dB for the left ears immediately after stopping the music. The right ears showed recovery to baseline conditions with the left ears showing a clinically relevant but small remaining shift of approximately 1dB, one hour after exposure. This showed that a break in duration of exposure had a positive effect on possible reversal of TTS.

5.4 EFFECT OF DURATION OF EXPOSURE ON LEVEL OF HEARING LOSS

Results from the multiple regression analysis showed a significant association between both duration of shift and duration of employment on the level of loss at 4 kHz. Significant P –values of 0.0015 and 0.00004 in right ears, and 0.00942 and 0.000022 in left ears, were recorded for duration of shift and duration of employment respectively. A comparison of means using ANOVA (with a confidence interval of 95%) also showed higher means for the 4-7years of employment range, compared to those in the 1-3 years of employment range. This result showed that workers in the 4-7 year duration group had been more exposed to the noise levels than their colleagues who had worked for only 1-3years, therefore increasing the risk of the development of noise-induced loss as evidenced by the 4000 Hz notch.

This result is in agreement with the results of a study conducted in Australia among one thousand 18-35 year-old young adults and their exposure to leisure noise that included noise from live music concerts, entertainment centers and nightclubs. Results of the study concluded that these people were exposed annually to leisure noise about 0-6.77 times more than the acceptable limits of noise

exposure. The active young adults from the study who participated in more of such activities with increased noise exposure all showed early warning signs of hearing damage (tinnitus and a 4khz notch on audiograms), with noise from nightclubs as the greatest risk factor (Beach, Gilliver, & Williams, 2013).

5.5 KNOWLEDGE ABOUT HEARING PROTECTION DEVICES AND NOISE-INDUCED HEARING LOSS

It was interesting to note that out of the 50 participants of this study, only 16% knew about hearing protection devices (HPD), with all 16% naming ear muffs as the type of HPD they knew about. However, none of the participants used any form of HPDs at work, all stating unavailability as the reason why they did not use any. Also from the results of this study, 28 (56%) of the 50 participants had informal knowledge that exposure to excessive noise was bad for their ears but only 12 (24%) knew that it could cause irreversible hearing loss. Their sources of information were radio, television, literature and social media respectively.

This result is comparable to a study done in Canada, where workers in a nightclub were observed to be working without any HPDs, even though they were found to be exposed to sounds higher than Leq85 (equivalent continuous noise level) (Dobson & Gastmeier, 2015). Kelly (2013), conducted a study in Ireland which sought to explore the risk of occupational noise exposure among workers in amplified music venues. Results from the study showed that employees from the twenty nightclubs sampled had limited knowledge about hearing protection devices, and the devices were used by workers of only one of the venues out of the twenty that were used for the study. Workers were educated about the importance of the use of HPDs in the prevention of NIHL, however, they did not use them since the club management did not provide them.

Another study by Whitfield (1998) involving 20 bar staff from 16 nightclubs in the United Kingdom revealed that most of the employees had little or no knowledge of the risk of exposure to excessive noise levels. Their employers also did not provide them any hearing protection devices to protect their hearing.

5.6 NOISE LEVELS EXPOSED TO NIGHTCLUB WORKERS

From the results, the mean noise levels (Leq) that the workers were exposed to are 93.4, 91.4 and 92.9dBA respectively. These noise levels were found to increase as the night progressed and more patrons filled the nightclubs. The levels recorded are comparable to those recorded in other studies involving music avenues and nightclubs. The study by Kelly (2013) reported the average exposure (Leq 8 hrs) of the bartender in a nightclub as 92dBA. Another study by Dobson & Gastmeier (2015) to assess the risk of hearing damage to employees and patrons of nightclubs in Canada showed that, the average sound levels recorded in all 60 nightclubs was 96dBA.

Gunderson et al.,(1997) also recorded average sound levels of 91.9dBA to 99.8dBA for both ambient and performance noise in the 8 live-music clubs used in their study. The recorded noise levels and the referenced studies exceeded the limit of 85dBA, thereby exposing workers in these environments to the danger of excessive noise exposure and hence the development of NIHL. It is however important to note that, even with the same levels of exposure, individuals will have different susceptibility to developing NIHL based on factors such as lifestyle, pre-morbid state (e.g. presence of diabetes and/or hypertension), age as well as previous exposure to impulsive or continuous noise (Hong *et al.*, 2013).

CHAPTER SIX

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

6.1 INTRODUCTION

This Chapter presents a summary of the results of the study, recommendations as well as the limitations of the study.

6.2 CONCLUSION

This study was aimed at determining the level of noise that nightclub workers in Accra were exposed to, their level of knowledge about signs and effects of excessive noise exposure and noise-induced hearing loss as a condition. Their level of knowledge about hearing protection devices and their use was also established.

The results of the study revealed that, nightclub workers are exposed to an average Leq_{12} of 92.2dBA. Most workers had normal hearing thresholds with some of the workers presenting with mild hearing loss (between 30-45dB) in the 4 kHz frequency in both ears, which was indicative of a permanent threshold shift at that frequency and the development of noise-induced hearing loss. There was also a significant association between the duration of exposure and the loss at 4 kHz. Very few of the workers had knowledge about noise-induced hearing loss as a condition and the negative effects of excessive exposure to noise. None of the workers used any hearing protection devices at work. This showed that workers in nightclubs were at risk of developing noise-induced hearing loss with continued exposure to excessive noise levels at work.

6.3 RECOMMENDATIONS

The following recommendations were made based on the results of the study:

- Education on the negative effects of excessive noise exposure and the importance of the correct and effective use of hearing protection devices should be provided for the managers and the workers of the nightclubs.
- Workers in nightclubs should have a pre-employment audiometric assessment to serve as a baseline audiogram, which subsequent annual assessment results can be compared to. This will monitor and identify permanent threshold shifts and the development of noise-induced hearing loss.
- Managers of the nightclubs should be encouraged to provide hearing protection devices for the workers, and also put in measures to enforce and ensure their use. Hours per shift could also be reduced for the workers to reduce the duration of exposure

6.4 LIMITATIONS

The first limitation of this study is the use of only pure tone audiometry as the determinant of noise induced hearing loss. This was due to the unavailability of a machine to test for presence of otoacoustic emissions. A study by Attias *et al.*, (2001) showed that distortion product otoacoustic emissions (DPOAEs) was a test that helped to monitor the state of the cochlea and hair cells after noise exposure. It therefore provided greater accuracy and objectivity, and served as a means of complementing results from pure tone audiometry. Otoacoustic emissions testing would have made the test battery more conclusive for determining, confirming and diagnosing noise-induced hearing loss.

Secondly, some of the managers did not consent to the study being carried out in their premises which led to a limited number of sampled participants for the study. Results of the study may

therefore not be representative of the entire population of nightclubs in Accra. Also, since this study was a cross sectional one, a relationship between cause and effects could not be established.

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APPENDIX I: SAMPLE OF LETTER TO RESEARCH SITES



UNIVERSITY OF GHANA
DEPARTMENT OF AUDIOLOGY, SPEECH
AND LANGUAGE THERAPY
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

Ref. No: March 13, 2018

TO WHOM IT MAY CONCERN

Dear Sir

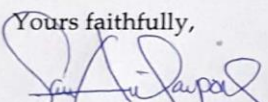
**PERMISSION TO CARRY OUT MSc AUDIOLOGY RESEARCH STUDY AT YOUR
PUBLIC ENTERTAINMENT CENTRE (CLUB)**

The Department of Audiology, Speech and Language Therapy of the University of Ghana School of Biomedical and Allied Health Sciences (SBAHS) presents its compliments to the management of your Club and requests your kind consideration of the above subject.

Ms. EUNICE APPEA-KORANG a 2nd year MSc Audiology student of the University of Ghana and is conducting a research study on "**Occupational Hearing Loss among Night Club Workers in Accra**" under the supervision of Dr. N. Bofo (Audiologist) and Dr. S. Anim-Sampong (Physicist) of the Department of Audiology, Speech and Language Therapy.

The Department would therefore be most grateful if you could kindly grant her permission to carry out this important research study for the common good of the University and your club. Thank you very much.

Yours faithfully,


DR. S. ANIM-SAMPONG
(Ag. Head of Department)

cc: Prof. S. Ofori-Aquah, Dean, SBAHS
Dr. N. Bofo

DEPARTMENT OF AUDIOLOGY
SPEECH & LANGUAGE THERAPY
SCHOOL OF BIOMEDICAL AND ALLIED
HEALTH SCIENCES

COLLEGE OF HEALTH SCIENCES

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APPENDIX II: ETHICAL CLEARANCE



UNIVERSITY OF GHANA SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

30th January, 2018.

Ref. No.:

Ms. Eunice Appea-Korang,
Dept. of Audiology, Speech and Language Therapy,
SBAHS,
Korle Bu.

Dear Ms. Appea-Korang,

ETHICS CLEARANCE

Ethics Identification Number: SBAHS – ASLT. /10598377/AA/5A/2017-2018.

Following a meeting of the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences held on Tuesday 30th January, 2018. I write on behalf of the Committee to approve your research proposal as follows:

TITLE OF RESEARCH PROPOSAL: OCCUPATIONAL HEARING LOSS AMONG NIGHT CLUB WORKERS IN ACCRA

This approval requires that you submit three-monthly review reports of the protocol to the Committee and a final full review to the Committee on completion of the research. The Committee may observe the procedures and records of the research during and after implementation.

Please note that any significant modification of the research must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this research to the Committee within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this research. You will therefore, be required to furnish the Committee with any manuscript for publication.

This reviewed report is valid till 31st. August, 2018

Please always quote the ethical identification number in all future correspondence in relation to this protocol.

Thank you.

Yours sincerely,

Dr. S. D. Amanquah
(Chairman, Ethics and Protocol Review Committee)

Cc: Dean
School Administrator
Head, Dept. of Audiology, Speech and Language Therapy

COLLEGE OF HEALTH SCIENCES

• P. O. Box KB 143, Korle Bu, Accra, Ghana.
• Telephone: +233 (0) 303 972268 / 0303970950 • Email: sbahs@ug.edu.gh • Website: www.sbahs.ug.edu.gh

APPENDIX III: PARTICIPANT INFORMATION FORM

Title of research: Occupational hearing loss among workers exposed to noise: A study among nightclub workers in Accra.

Principal investigator: Eunice Appea-Korang

Department of Audiology, Speech and Language Therapy

Professional MSc Audiology

Tel: 0243504355

Email: amaappeagh@gmail.com

General information about Research

I am a graduate student at the University of Ghana, Department of Audiology, Speech and Language Therapy, conducting a research on Occupational hearing loss among nightclub workers in Accra. The purpose of the study is to determine the level of noise that nightclub workers are exposed to determine the presence of hearing loss among them.

Possible Risks and Discomforts

There are no risks for participating in this study since there are no side effects associated with the testing equipment and procedure.

Possible benefits

Participating in the study provides you with the opportunity of having your hearing status assessed, and to determine any hidden hearing problems (if present), at no cost.

Voluntary participation and right to leave research

Participation in this study is voluntary. You have the right to withdraw at any time or refuse to participate entirely without any jeopardy or whatsoever.

Confidentiality

All information provided will remain confidential and will only be reported as group data with no identifying information. All data, including test results, will be kept in a secure location and will only be assessed by those directly involved in the research.

Alternatives to Participation

In the event of any noticed problem, the participant will be referred to the appropriate department for further testing and management.

Contacts for Additional Information

For any information, clarification or questions about the study, please contact the principal investigator, Eunice Appea-Korang on 0243504355.

Your rights as a Participant

This research has been reviewed and approved by the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana. If you have any questions about your rights as a research participant, you can contact the EPC office between the hours of 8am-5pm through the landline +233-302-687974/5 or postal address: Box KB 143, Korle-Bu, Accra.

APPENDIX IV: INFORMED CONSENT FORM

The document describing the benefits, risks and procedures for the research: occupational hearing loss among workers exposed to noise: A study among nightclub workers in Accra has been read and/ or explained to me. I have been given the opportunity to ask questions about the research and the answers given to me are to my satisfaction. I, therefore, agree to participate as a volunteer.

.....

.....

Date

Signature or thumb print of volunteer

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

.....

.....

Date

Signature of witness

I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this research have been explained to the above individual.

.....

.....

Date

Signature of person who obtained consent

APPENDIX V: STUDY QUESTIONNAIRE

DEPARTMENT OF AUDIOLOGY, SPEECH AND LANGUAGE THERAPY

SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

OCCUPATIONAL HEARING LOSS AMONG NIGHT CLUB WORKERS IN ACCRA

DEMOGRAPHIC DATA:

AGE { } 20-25 { } 26-30 { } 31-35 { } 36-40

GENDER { } M { } F

DURATION OF EMPLOYMENT

DURATION OF SHIFT

CODE

CLUB NUMBER

QUESTIONS:

Do you find yourself raising your voice when you talk to your colleagues during a shift? Yes ()

No ()

Is there a rotation of shifts in your workplace? Yes () No()

Do you hear any ringing sounds in your ear after a shift?

All the time () Sometimes () Never ()

Have you noticed a decrease in your hearing level? Yes () No ()

Do people complain about you not hearing them during conversations?

Yes () No()

Have you ever had surgery in any of your ears? Yes () No()

Have you had any ear infection within the last three months? Yes () No ()

Do you know that exposure to excessive levels of noise can affect your hearing level negatively?

Yes () No ()

Do you know about noise-induced hearing loss? Yes () No()

If yes, where did you get your information from? Radio () Tv ()

Social media () literature() Other.....

Do you know about hearing protection devices? Yes () No()

If yes, which one(s) do you know about?.....

Do you use hearing protection during a shift? Yes () No()

If yes, which one do you use?.....

If you answered 'no' to question 13, please give a reason for your answer

.....

AUDIOMETRIC RESULTS

	250Hz	500Hz	1000Hz	2000Hz	3000Hz	4000Hz	6000Hz	8000Hz
Right AC								
Left AC								
Right BC								
Left BC								